Acerca de este libro

Esta es una copia digital de un libro que, durante generaciones, se ha conservado en las estanterías de una biblioteca, hasta que Google ha decidido escanearlo como parte de un proyecto que pretende que sea posible descubrir en línea libros de todo el mundo.

Ha sobrevivido tantos años como para que los derechos de autor hayan expirado y el libro pase a ser de dominio público. El que un libro sea de dominio público significa que nunca ha estado protegido por derechos de autor, o bien que el período legal de estos derechos ya ha expirado. Es posible que una misma obra sea de dominio público en unos países y, sin embargo, no lo sea en otros. Los libros de dominio público son nuestras puertas hacia el pasado, suponen un patrimonio histórico, cultural y de conocimientos que, a menudo, resulta difícil de descubrir.

Todas las anotaciones, marcas y otras señales en los márgenes que estén presentes en el volumen original aparecerán también en este archivo como testimonio del largo viaje que el libro ha recorrido desde el editor hasta la biblioteca y, finalmente, hasta usted.

Normas de uso

Google se enorgullece de poder colaborar con distintas bibliotecas para digitalizar los materiales de dominio público a fin de hacerlos accesibles a todo el mundo. Los libros de dominio público son patrimonio de todos, nosotros somos sus humildes guardianes. No obstante, se trata de un trabajo caro. Por este motivo, y para poder ofrecer este recurso, hemos tomado medidas para evitar que se produzca un abuso por parte de terceros con fines comerciales, y hemos incluido restricciones técnicas sobre las solicitudes automatizadas.

Asimismo, le pedimos que:

+ *Haga un uso exclusivamente no comercial de estos archivos* Hemos diseñado la Búsqueda de libros de Google para el uso de particulares; como tal, le pedimos que utilice estos archivos con fines personales, y no comerciales.

+ *No envíe solicitudes automatizadas* Por favor, no envíe solicitudes automatizadas de ningún tipo al sistema de Google. Si está llevando a cabo una investigación sobre traducción automática, reconocimiento óptico de caracteres u otros campos para los que resulte útil disfrutar de acceso a una gran cantidad de texto, por favor, envíenos un mensaje. Fomentamos el uso de materiales de dominio público con estos propósitos y seguro que podremos ayudarle.

+ *Conserve la atribución* La filigrana de Google que verá en todos los archivos es fundamental para informar a los usuarios sobre este proyecto y ayudarles a encontrar materiales adicionales en la Búsqueda de libros de Google. Por favor, no la elimine.

+ *Manténgase siempre dentro de la legalidad* Sea cual sea el uso que haga de estos materiales, recuerde que es responsable de asegurarse de que todo lo que hace es legal. No dé por sentado que, por el hecho de que una obra se considere de dominio público para los usuarios de los Estados Unidos, lo será también para los usuarios de otros países. La legislación sobre derechos de autor varía de un país a otro, y no podemos facilitar información sobre si está permitido un uso específico de algún libro. Por favor, no suponga que la aparición de un libro en nuestro programa significa que se puede utilizar de igual manera en todo el mundo. La responsabilidad ante la infracción de los derechos de autor puede ser muy grave.

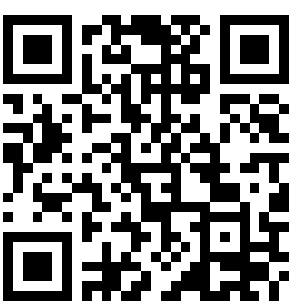
Acerca de la Búsqueda de libros de Google

El objetivo de Google consiste en organizar información procedente de todo el mundo y hacerla accesible y útil de forma universal. El programa de Búsqueda de libros de Google ayuda a los lectores a descubrir los libros de todo el mundo a la vez que ayuda a autores y editores a llegar a nuevas audiencias. Podrá realizar búsquedas en el texto completo de este libro en la web, en la página `http://books.google.com`

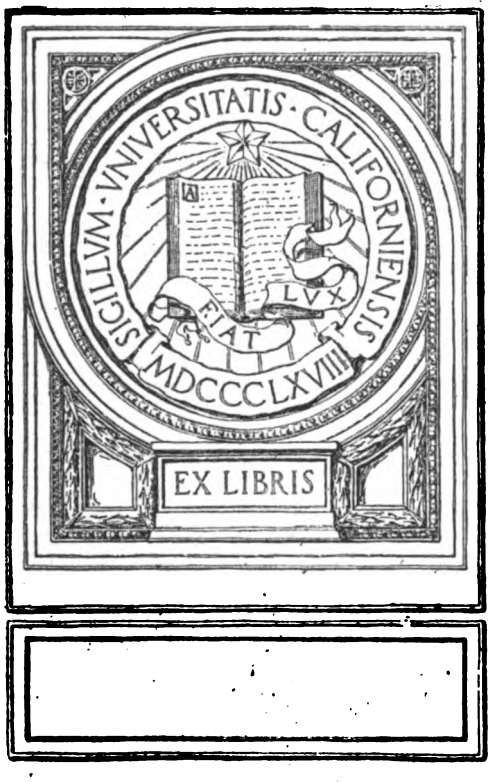
This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

Google™ books

https://books.google.com



Digitized by Google



Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY JOURNAL OF ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE & FINANCE.

No. 2,029. [No. 1. VOL. LXXIX.] FRIDAY, APRIL 6, 1917. PRICE SIXPENCE
Registered at the General Post Office. Address: 1, 2 & 3, SALISBURY COURT, FLEET STREET, LONDON, ENGLAND. By post 7d. Abroad 9d.
Ann. Sub. (U.K.), 28s. Abroad, 30s.

Contractors to
ADMIRALTY,
WAR OFFICE,
INDIA OFFICE,
CROWN AGENTS,
LEADING RAILWAYS,
Etc.

Electromotors Limited

OPENSHAW:
London Office: 49, Queen Victoria Street, E.C.

D.C.
DYNAMOS
AND
MOTORS
TO
100 B.H.P.

CABLES
OF EVERY KIND.

LIBRARY OF THE UNIVERSITY OF CALIFORNIA

JOHNSON AND PHILLIPS LTD
CHARLTON, LONDON, S.E.

Westinghouse
Electric Motors
For all Industrial and Domestic Purposes.
The British Westinghouse Electric and Manufacturing Co., Ltd., Trafford Park, Manchester.

A.C. Control Gear
AND CIRCUIT BREAKERS.
GEORGE ELLISON, PERRY BARR, BIRMINGHAM

Osram
DRAWN WIRE
Lamps

HENLEY'S CABLES
of all types and for all purposes.
Lists free from W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED,
BLOMFIELD STREET, LONDON, E.C.

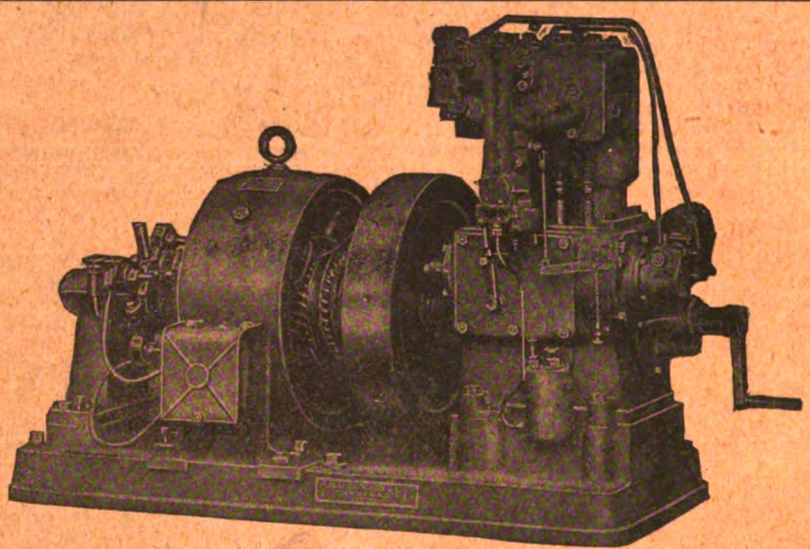
Digitized by Google

W. H. ALLEN, SON & CO., LTD.

BEDFORD, ENGLAND.

OIL AND GAS ENGINES.

VERTICAL, ENCLOSED, FORCED LUBRICATION.



8 kw. Oil Engine Driven Electric Generating Set.

SUITABLE FOR WORKING WITH: PARAFFIN, PETROL, TOWN OR PRODUCER GAS, &c.;
AND FOR DRIVING DYNAMOS, PUMPS, FANS, &c.

"ANTI-SULPHURIC" ENAMEL.

The only reliable material for protecting Metal, Wood, &c., from the destructive action of Sulphuric Acid and other Chemical Fumes.

Sole Manufacturers—

GRIFFITHS BROS. & CO., LONDON, LTD.,
BERMONDSEY, LONDON, S.E.

HAVE YOU ORDERED YOUR COPY OF THE 1917
BIG BLUE BOOK?

HOOPER'S

Telegraph & India Rubber Works, Ltd.

31, LOMBARD ST., E.C. (*Established 1860*) | MILLWALL DOCKS, **LONDON, E.**

PURE TAPE AND STRIP, &c., &c.

HOOPER'S Vulcanised India Rubber Cables for Electrical Work maintain the highest quality, and their durability has been proved.

Telegrams: LINEAR London. Telephone: 1169 Avenue and 84 East.

The Mines of South Africa

BUY

£15,000,000 of Machinery and Stores Yearly.

To participate in this it is necessary to Advertise in the only Technical Journal published on the Mines.

The South African Mining Journal.

(Established 1891.)

Published Weekly in Johannesburg.

Reaches every Mine Official and Buyer every week.
The Official Organ of the Mine Managers' Association.

Advt. Tariff and Subscription Rates can be obtained from the Agents for Great Britain:

ARGUS SOUTH AFRICAN NEWSPAPERS, LTD.,
Byron House, 82-85, Fleet Street, London, E.C.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

VOLUME LXXIX.

FROM APRIL 6, 1917, TO SEPTEMBER 28, 1917.

ALL RIGHTS RESERVED.

LONDON:
Printed by THE FLEETWAY PRESS, LTD., 1, 2 and 3, Salisbury Court, Fleet Street, E.C. 4, and Published by BENN BROTHERS, LTD., at 8, Bouverie Street, London, E.C. 4.

1917.

Digitized by Google

TK1
E54
v.79

INDEX TO "THE ELECTRICIAN."

VOL. LXXIX.

SPECIAL INDEXES.

	PAGE
*Municipal, Foreign and General Notes	vi.
Companies' Meetings, Reports, Dividends, Statutory Returns, &c.	viii.
Companies (New Electrical, &c.) Registered	viii.

* *Entries in these Indexes are* not *included in the* GENERAL INDEX.

SUB-HEADINGS IN GENERAL INDEX.

	PAGE		PAGE		PAGE
Accounts	ii.	Obituary	iv.	Telegraphy	vi.
Educational	iii.	Parliamentary Intelligence ..	v.	Telephony	vi.
Institution of Electrical Engineers	iii.	Personal	v.	Wireless Telegraphy and Telephony	vi.
Legal Intelligence	iv.	Railways, Electric	v.		
		Reviews of Books	v.		

Names of Authors of Articles and Papers are indexed alphabetically in the GENERAL INDEX, *and not under the sub-headings.*

General Alphabetical Index.

***Heavy figures* denote that the subject matter is a "Leading Article" or in the "Editorial Notes." When the letter (C) is placed after a title it signifies that the article in question appeared in the Correspondence columns.**

A

ACCOUNTS—
Aberdeen, 406, 872, 910, 1023
Accrington, 1023
Adelaide (S. Australia), 287
Aldershot, 948
Aylesbury, 910
Barrow-in-Furness, 406
Belfast, 523, 757
Bexhill, 834
Bingley, 561
Birkenhead, 601, 985
Birmingham, 327, 406, 444
Blackburn, 287
Bolton, 872
Bradford, 910
Brighton, 561
Burnley, 717
Burton-on-Trent, 523
Bury, 640
Carlisle, 795
Chester, 757
Colchester, 561
Coventry, 406, 640
Darwen, 872
Dundee, 561, 948
Durban (Natal), 287
Eastbourne, 1022
Glasgow, 406, 483, 601, 717, 757, 910
George Town (Penang), 910
Greenock, 834
Grimsby, 483
Harrogate, 640
Hereford, 948
Heston and Isleworth, 834
Huddersfield, 444
Hull, 523, 717
Hull Corporation Telephones, 523
Islington (London), 872
King's Lynn, 834
L.C.C. Tramway Accounts, 640
Leeds, 287, 327, 483, 872
Leith, 757
Lincoln, 523
Liverpool, 79
Luton, 561
Manchester, 406, 640
Marylebone (London), 287, 872
Norwich, 795
Nottingham, 406, 444
Oldham, 601
Poplar (London), 910, 985
Portsmouth, 795, 1024
Reading, 287
Rochdale, 287, 601
Salford, 79, 444, 795
Sheffield, 483
Stafford, 561
Stalybridge, Hyde, Mossley and Dukinfield, 1024
Stoke-on-Trent, 562, 795
Southampton, 834, 872
Sunderland, 483, 640
Sutton Coldfield, 717
Swansea, 757
Taunton, 640
Torquay, 872
Walsall, 445, 601, 757
W. Bromwich, 834
W. Ham, 795
W. Hartlepool, 445, 449
Winchester, 640
Wolverhampton, 910
Yarmouth, 1024
York, 834

Accumulator, Prospects of the, [Strasser] 619
ACHARD, F. H., KENNELLY, A. E., and DANA, A. S.: Experimental Researches on the Skin Effect in Steel Rails, 692
Acoustics, Practical, **137**
Acoustics, Researches in, 613
ADDICKS, L.: Current Density in Copper Refining, 498
ADLER, Dr. L.: Inductive Resistances for Weakening the Field of Tramway Motors, 855
Aeronautical Research, 652
AGNEW, P. G., MANNARD, W. H., and FEARING, J. L.: System of Remote Control for an Electric Testing Laboratory, 396
Agriculture and Electricity, 58
Aircraft Construction, Testing of Materials, 338
Albert Medal Awarded to Orville Wright, 652
ALBERTI, E.: Determination of Torque of a Direct-current Meter, 226
ALEXANDERSON, E. F. W., and HILL, C. H.: Single-phase Power Production, 26
Alloys, Magnetic Aluminium, 374
Alloys, Non-Corrosive, 342
Alternating Current Bridge Method of Comparing Two Fixed Inductances at Commerical Frequencies, [Parnell] 771
Aluminium Resources, Empire's, 635
American Banking Facilities Abroad, 981.
American Copper and Steel Prices, 1027.
American Electrical Exports, 791
American Export Trade, 751
American Gear Manufacturers' Association, 574
American Power Station, 256
American Universities Research, 418
American War Organisation, **255**
Anglo-Italian Trade Development, 159
Anomalies, Electrical Trade, [Munro] 746
Apprentices, Education of, **97**, [Paul] (C) 119, [Denton] (C) 197, **702**, 707
Apprentices, Engineering, Training of, 257
Arc Lamp Globes, Colouring of, 920
Arcs Under Pressure, 575
Argentina, Trade Marks, 943
Armature Windings, Repetitions of E.M.F., [Hawkins] 888, 928, 958
Armature Windings, Theory of, [Smith] 258, 300, 340, (C) 357
Army Cantonments, Electricity in, U.S.A., 1028.
Arora Elec. Fires, 992.
Asbestos, Canadian, 947
ASHTON, A. W.: (C) City and Guilds Examinations in Electrical Engineering, 235
Association of Consulting Engineers, 429
Association of Engineering and Shipbuilding Draughtsmen, 309
Association of Municipal Elec. Engineers in S. Africa, 996.
Association of Supervising Electricians, 958.
Atmospheric Electricity and Ocean Magnetic Work, Observations of, 728
Australasia, 721
Australian Metals, 943
Australian Minimum Wages Award, **985**, 1015
Automobile Headlights, 660
Automotive Electric Association, 496
Auto-Starter, Rating of, **150**

B

BAILLIE, P.: Calculation of Coupling Coefficient of Two Coaxial Flat Spiral Coils, 974, 1004
Balfour's, Lord, Committee, 363
BARIMAR, LTD.: (C) Technical Press and National Service, 977
BARNARD, J., HOLFORD, G. W., and PRIESTLY, P.: Tramway Finance, 961
BARRY, Sir JOHN WOLFE: Standardisation of Engineering Materials; Its Influence on the Prosperity of the Country, **216**, 218
Batteries, Application of Radio-Active Salts, 958
Batteries, Rectifier for Charging, 256
Battleships, Electric Propulsion, 186
Bauxite, French, 416
Beama Journal, 298, 728
Belfast, Elec. Progress, 494
Belgian and British Trade Relations, 751
BELL, Dr. L.: Water Power and Power Transmission in the United States, 585
Bell Transformers: Design and Tariffs, [Wirz] 536
BELLINI, E.: (C) Italian Wireless Telegraph Inventions, 357
BENNETT, E.: High versus Low Antennæ in Wireless Telegraphy and Telephony, 18
Berthelot, Prof., Memorial, 418
Bessemer and Open Hearth Practice, Temperature Measurements, 806
BIERMANNS, J., and STERN, G.: Tests on Oil Switches, **881**, 884
BINDER, L.: Short-circuit Heating in Power Stations and Transmission Lines, 730
BIRKS, L., and WEBB, E.: Resistance of Earth Connections, 343
Birmingham and District Electric Club, 534
Birmingham Physical Laboratory, 690
Birthday Honours, **378**
Bituminous Coal Mines, Elec. Power, 878
Blast Furnace Gas, Cleaning by Electricity, 136
Blast Furnace Gas in Sweden, Utilisation of, 136
Board of Trade Committee on Elec. Power, Some Points for, **137**, [By a Power Supply Engineer] 153
Board of Trade Committee on Elec. Supply, [Lackie, Chattock] (C) 117, 138
Board of Trade Elec. Power Supply Committee, **297**, 298, 496, **533**, 534, 652
Boiler Drums, Electric Welding, 804
Boiler House Elevators, 825
Boilers, Elec. Heat Storage, 376
Boilers, Gas-Fired, [Woodhouse] 427
Bolivian Tungsten & Antimony, 572
Bonuses, War, for Teachers, **418**
Bonuses, War, for Workmen, **418**
BOSSU, PIERRE: (C) Decimal System, 118
BOWDEN, J. H.: Individual Interest in Municipal Enterprise, 460, (*Discussion*) 473, **508**
BOWN, R.: Characteristics of Iron in High-Frequency Magnetic Fields, 109, 614
BOYCE, R. A. M.: (C) Rating of Intermittent Motors, 234
Boy in Industry, **215**
Brass Scrap, 791
Brazilian Electricity, 675
Bridge, Resistance, for Workshop Use, [De Wette] 393
British Association, 10, 612
British Columbia Copper, 249
British Empire Producers' Organisation, 844
British Engineers' Association, 456, 690
British Industries Federation, 441, 464, **689**, 705
British-Italian Commercial Association, 675
British Science Guild, 138, **175**, 195, 534
British Trade Corporation, 239, **255**, 281, 323, 414, 441, **456**, 479
British Westinghouse Company, 235
British Westinghouse Switchgear, 397
British Westinghouse Turbo-Alternators, 1001
BROUGHTON, H. H.: Note on the Rating of Intermittent Motors of Large Output, **175**, 187, (C) 277, [Boyce] (C) 234
BRUNDIGE, J. A.: Expansion Effects as a Cause of Deterioration in Suspension Type Insulators, 656
Brushes, Carbon, Standardisation, 275
B.T.-H. Report, 675
BURGESS, C. F.: Characteristics of Small Dry Cells, **788**, 786
Burners, Gas, for the Firing of Boilers, 433
Businesses, Alien Enemy, 363
Business Names, Registration, 33, 123, 519, 829

C

Cable, Bombarded, 177
Cables, High-Tension, Investigations on, 806
Cables, Rubber, in India, 989.
Cables, Underground, Heating, 418
Calcium Carbide, 1019
California, Low Power Rates, 918
Cambridge University: Its Place in Science and Industry, **728**, 729
Canada, 721
Canada, Trade, 981
Canadian Exhibition, 489
Canadian Industrial Research Work, 336
Canadian Mineral Production, 214
Canadian Nickel, 292, 913
Canadian Scientific Investigation, 419
Canadian Society of Civil Engineers, 359
Capital and Labour, Relations of, 791
Captives of War, Student, 257
Carbon Imports, 557
Carbonisation, Low Temperature, and Power Supply, 663
Carron Co.'s Elec. Kitchens, 667
CASE, T. W.: Conversion of Light into Electricity, **767**, 776
Cast Iron, Corrosion of, 574
Cast Iron, Testing, 10
C.A.V. Starters, 1032
Cells, Selenium, in Photometry, 816
Cells, Small Dry, Characteristics, **788**, [Burgess] 786
Cement Industry in Japan, 855
"Central," The, 575
Chambers of Commerce, Work of, 943
Channel Tunnel, 250, 454
Charging Stations, **920**
CHATTOCK, R. A.: (C) Board of Trade Committee on Elec. Supply, 117
Chemical Composition versus Electrical Conductivity, [Fink] 777
Chemical Engineer, Training and Work, 690
Chemist Education of, [Dobbie] 309
Chicago, Elec. Truck Service, 918
Chicago, Electric Traction, 10
Chicago Electrical Progress, 46
China, Metric System in, 944
Chinese Imports, 557
City and Guilds Examinations in Electrical Engineering, [Ashton] (C) 235, [Denton] (C) 315, **338**, [Maycock] (C) 395, [Lundberg & Sons] (C) 513
Civil Service, 769
Clearing House, Goods, for Docks, 217
Coal Carbonisation Scheme, Nottinghamshire, 120
Coal Concreted from Ashes or Dusts, [Lovell] **417**, 428, 691
Coal Conservation and Electrical Power, 791
Coal Consumption, Economy, 535
Coal Conveyor Plant at Port Natal, 84
Coal Cutting by Machinery, 134
Coal Distribution, 586, 592
Coal Economy, [Wilkinson] 438
Coal for Domestic Heating, Purchase and Use, 920
Coal Mine Breathing Apparatus, 690
Coal Transport Re-organisation Scheme, 612
Coal, Weathering of, 180
Coals, Analyses of, 690
Cobalt Alloys, Non-Corrosive, 188
Coke Firing, Grates, 424
Coke Firing, Some Tests, 422
Coke, Hand Firing, Personal Experiences, [Crowther] 423
COLLBOHM, M. H.: Protection of Transformer Neutrals against Destructive Transient Disturbances, 29
Collieries, American, Elec. Safety Lamps, 46
Collieries, Electrification, 132, 416
Collieries, U.S.A., Elec. Lamps in, 174
Colliery Haulage Road Signalling, 334
Commerce, Ministry of, 597.
Commerce of the Empire, 281
Commercial Intelligence, 829, 905, 951, 981.
Committee of the Privy Council for Scientific and Industrial Research, Second Annual Report, **894**, 899, 936

Digitized by Google

Companies, Manufacturing, 401
Compensation, Workmen's, 829
Competition, Foreign, 557
CONRADI, C. G.:
Electric Vehicles, 140
Justification of the Differential, 860
Consular Service, 557, 675, 867, **881**
Contract Prices, 635
Contracts, Effect of War on, 33
Contracts, Pre-War, 323, 713
Controlled Establishments, 441
Cooking Apparatus, Elec., Present Position, 385, **390**
Cooking Plant, Large Electric, 28
Co-operative Societies and Taxation, 123
Copper in U.S.A., 751
Copper Mining, Elec. Power, 214
Copper Refining, Current Density, [Addicks] 498
Cotton Bale Press, Electrically-driven, 186
Country Institutions, Elec. Supply for, 952
County of London Elec. Supply Co.'s Majority, 612, 652
Crane Cabs, Elec. Heating Units for, 59
Creosote Order, 635
CRONKHITE, W. W.: Electricity in Pulp and Paper Industry, 852
Crossings, Level, Electrical Indicators, 429
CROWLEY, J. F.: Production and Distribution of Power and its Influence on the Development of Irish Industry, **767**, 783, 821
CROWTHER, J. A.: Personal Experiences with Hand Firing of Coke, 423
Crucibles, Palladium-Gold, as Substitute for Platinum, 612

D

DALLADAY, A. J., and PARKER, R. G.: On a Precision Method of Uniting Optical Glass—The Union of Glass in Optical Contact by Heat Treatment, 188
DANA, A. S., KENNELLY, A. E., and ACHARD, F. H.: Experimental Researches on the Skin Effect in Steel Rails, 692
DAVIES, A. E. V.: Large Generator and Transformer Failures on the Rand Power Companies' Systems, **57**, 60, **66**
Daylight Saving in United States, 806
Decimal Coinage, [Dittmar] (C) 29, [Parshall, Rogers, Bossu] (C) 118, [Goichot] (C) 235
Decimal Coinage and Foreign Trade, 216
Decimal System of Coinage, Weights and Measures, **9**, 16, 323, **496**, 507
DE GROOT, C. J.: The Nature and Elimination of Strays, 846
DENTON, F. M.:
(C) City and Guilds' Examinations, 315
(C) Education of Apprentices, 197
Technical Education, 14, **24**
Design, Electrical, Gt. Britain's Position, **742**
Design of Electromagnetic Machines, [Smith] 658, 696, 734, 773, 812
DE WETTE, O.: Resistance Bridge for Workshop Use, 393
Diesel Engine Users' Association, 29, 98, 457, 652
Diesel Engines' Depreciation, 496
Diesel Engines, Tar Oil Fuel, 553, 959
Differential, Justification, [Conradi] 860
Diffusa Reflector Fitting, 645
Diplomacy, New, 675
Directors, Registration, 787
DITTMAR, A.: (C) Decimal Coinage, 29
Dividing Boxes, Callender's, 372
DOBBIE, Sir JAMES J.: Education of the Chemist, 309
Dock, Floating, Ferro-Concrete, 958
Dynamo Electric Machines, Heating with Various Loads and at Different Speeds, [Maclean and Mackellar] 465, 500

E

Earth Connections, Resistance, [Birks and Webb] 343
Ebbw Vale Three-phase Winder, 177
Edison Medal awarded to Nikola Tesla, 418
Education, Commercial, 401, 597, 635, 829
Education, National, **138**, **767**

EDUCATIONAL—

Aeronautical Training, 639
Apprentices Education, **97**, (Paul) (C) 119, (Denton) (C) 197, **702**, 707
Apprentices', Engineering, Education, 285
Apprentices, Technical Training, **958**, 984
Armstrong College, Newcastle-on-Tyne, 285, 755, 794, 832, 871, 908, 947, 984, 1022
Australian Engineering Education, 403
Battersea Polytechnic, 947, 1022
Birkbeck College, 794
Birmingham University, 639, 755, 832
Bristol University, 832, 984
Cardiff Technical College, 639
Chemist, Education, [Dobbie] 309
City & Guilds Institute, 482, 755
City & Guilds Technical College, Finsbury, 871, 908, 947
Commercial Education, 401, 597, 635, 829
Dudley Technical School, 1022
Edinburgh University, 203, 794, 832, 871, 908
Educational Bill & the Workman, 909
English, Teaching of, **57**
Evening Schools, Future of, **468**
Finsbury Technical College, 832
Heriot-Watt College, Edinburgh, 639
Huddersfield Technical College, 522

Educational—*continued*.

Institute of Chemistry, 1022
King's College, 947, 084, 1022
Liverpool University, 560, 639
Manchester High School of Commerce, 909
Manchester Municipal School of Technology, 522, 909, 947, 984, 1022
Manchester University, 560, 755, 794
Manual Training in Schools, 832
Mechanical Science, Bequest, 984
Munition Workers, Training of, 909
National Education, **138**, **767**
Newcastle School of Wireless Telegraphy, 403
N. Wales University College, 871
Northampton Polytechnic Institute, **968**, 984
Optics, Technical Training, **417**, 534
Reform, Educational, **10**, 162
Royal Technical College, Glasgow, 871, 947
Salaries of Teachers in Secondary and Technical Schools, **805**, 832
Scholarships, 162
Scholarships, Engineering, 482
Science in the Educational System, 755
Science Teaching in Secondary Schools, **843**
Sheffield University, 242
South-Western Polytechnic Institute, 794, 909, 947
Teaching the Teacher, **176**
Technical Education, [Denton] 14, **24**
Technical Institute, New, 639
Technical School, New, 285
Technical Teachers' Salaries, **805**
W. Ham Municipal Technical Institute, 203, 242
Wireless Operators, Training, 984
Wireless Telegraphy Classes, 522
Workshop Managers' University Training, 629
Workshop Training, 162
University College, 639, 908, 1022

Educational Reform, **10**
EDWARDES, E. H.: Standardisation of Conditions of Labour and Rates of Pay, 544
Electric Power Supply, **297**, 298
Electric Supply Company's Majority, 612, 652
Electrical Association of Australia, 59
Electrical Industry, Problems of, 75
Electrical Supply Undertakings in 1916, Expansion of Output, 176
Electrical Supply, Variations, Card Representation, 177
Electrical Traders' Benevolent Institution, 10, 120
Electricity & Gas Supply, 450
Electricity Supply Costs, [Whysall] 654, **664**
Electricity Supply from the Gas Point of View, 138
Electricity *v.* Gas, **417**
Electrochemistry and the Automobile, 339
Electroculture, 496, 613, 800
Electrometer, Salt-recording, for Atmospheric Electricity, [Rudge] 345
Electro-Tanning, 940
Elevators, Boiler House, 825
Empire Economic Policy, 212
Employers & Workers' Alliance, 374
Employment Exchanges, 829
Enamels & Varnishes, Testing Acid Resistances, 86
Engineer in National Affairs, 741
Engineers' Demands, 947
Engineers, Mining, and Metallurgists, Census of, 418
Engineers, Mobilising the, **215**
Engineers' Patriotism, **338**
Engineering Foremen, National Association of, 844
Engineering, Human Side, 806
Engineering Materials, Standardisation, and its Influence on the Prosperity of the Country, [Barry] **216**, 218
Engineering Organisation, 239
English, Teaching of, **57**
Evening Schools, Future of, **468**
Excess Profits' Duty Appeals, 519
Excess Profits' Duty Decision, 401
Excess Profits Tax, 33, 159, **190**, **216**, 239, 281, 519, **574**, 597, 606, 665
Excess Profits Tax in U.S.A., 401
Explosions, Sound of, 921
Export Trade, American, 751
Exports to Neutral Countries, 675
Eyes, Glasses for Protection from Injurious Radiations, 729

F

Factories, Electric Power for, 201
Factory Inspector's Report, 359
Fan, Elec., Standardisation, 46
Faraday, 1791-1867, 313
Faraday House "Journal," 456
FARADAY, MICHAEL: His Work and Life, 58
Faraday Society, 58
Fares, Return, [Mason] 543
Farms, Canadian, Electricity, 807
FEARING, J. L., AGNEW, P. G., and STANNARD, W. H.: System of Remote Control for an Electric Testing Laboratory, 396
Feed Water for Boilers, Investigations, 534
Ferguson, Pailin & Co.'s Truck-type Switchboard, 512
Filaments, Straight and Helical, Radiation, 575
FINK, C. G.: Chemical Composition *v.* Electrical Conductivity, 777
Fireclay Industry, 33
Fires, Elec., Arora, 992
Firing, Coal and Gas Combined, [Morgan] **957**, 967
Firing, Machine, by Coal and Gas, Dual Method, 436
First London Engineer Volunteers, 149
Fish Trap, Illuminated, 958
FLEMING, A. P. M.: Industrial Research in U.S.A., **456**, 471
Flow-Meter in Boiler Room, 996
Fluorescence and Phosphorescence and their Use to Produce Luminous Effects, **10**, 20
Foreign Trade and British Methods, [Trumpeter] (C) **805**, 822
Foreign Trade Development, 159, 201
FOURNIER, E. E. D'ALBE: (C) Reading by Ear, 197
France, Electrical Progress, 837
Franklin Medal Awarded to Dr. H. A. Lorentz and Dr. D. W. Taylor, 844
French Industrial Reorganisation, 479
French Rolling Mills, 799
French Water-power Development, 882
Fuel and Power Supply, [Nicol] 420
Fuel Economy, [Robertson] 462, (*Discussion*) 474, **495**, [Samuelson] (C) **573**, 591
Fuel Economy, Bonus Scheme, 791
Fuel Problems, **430**
Fuel Saving, 806
Furnace, Elec. Annealing, 837
Furnace, Elec., Progress, **455**, 457
Furnace, Elec., Steel, 371
Furnace, Heroult, Electric, 138
Furnace, Rennerfelt Electric, 610
Furnaces, Elec., Induction Effects, 256
Furnaces, Hand Fired, Combustion in the Fuel Bed, 845

G

Galilith, 11
Galvanometers, Electromagnet Moving-coil, Study for Use in Alternating-current Measurements, [Weibel] 738
Gas and Coal Machine Firing, Dual Method, 436
Gas Fired Boilers, [Woodhouse] 427
Gas Firing, and Coal, Combined, [Morgan] **957**, 967
Gas, Natural, in Hungary, 799
Gas Producers, Operating Details, 806
Gas Works, Electricity, 376
Gases, Electrical Properties of, 314, 505
General Electric Report, 597
Generator and Transformer Failures on the Rand Power Companies' Systems, [Davies] **57**, 60, **66**
Generator, Elec., Oil Driven, 332
Generators, Alternating-current, Internal Temperatures, [Kelly] 260
Generators, Drying, 418
German Electrical Industry, 44
German Iron and Steel Institute, 691
German Preparations for Peace, 323
German Reconstruction Schemes, 867
German Research Work, 989
Glass and Glassware, 1019
Glass Manufacture, Refractory Materials Available, 652
Glass, Optical, On a Precision Method of Uniting, The Union of Glass in Optical Contact by Heat Treatment, [Parker and Dalladay] 188
Glass Research by Institute of Chemistry, 996
Glass Technology at Sheffield, 882
Gloves, Rubber, for Linesmen, Testing, 544
GOICHOT, L.: (C) Decimal Coinage, 235
GOOCH, E. C.: Magnetic Control as Applied to Large Mine Hoists, 886
Golpa Power Station, Limitation of Short-Circuit Currents, [Klingenberg] 1007
Government Contracts, 75, 479
Government Co-operation with Manufacturers, **957**, 981
Great Britain's Position in Electrical Design, **742**
GUREWITSCH, P.: Electricity Supply in Russia, 354

H

Hackney Preferential Charges, 630, **652**, 671
Halifax Corporation Electricity Department, 784
Halifax Corporation Sub-station, 684
Hammer, Conversion of Steam into Electro-Pneumatic, 956
HART, F. A.: Measurements of Radio Antenna on Shipboard and Some Interesting Comparisons, 388, [Kroger] (C) 937
HAWKINS, C. C.: Repetitions of E.M.F. in Armature Windings, 888, 928, 958
Headlights, Automobile, 660
Heat, Effect on Copper and Paper, [Schuler] 617
Heat, Spontaneous Generation, in Recently Hardened Steel, 301
Heating, Industrial Electric, in Canada, 807
Heating, Short-circuit, in Power Stations and Transmission Lines, [Binder] 730
HIGGITT, H. V.: Capacity Test for Localising a High Resistance Break in Short Lengths of Submarine Cables, 897
High Frequency Resistance of Multiple Stranded Insulated Wire, 338
High-tension Alternating Currents, Air-Blast Rectifier, 613
"Hightensite," 807
HILL, E. W.: (C) Phase Lag in Current Transformers, 671, 785
HILL, W., and ALEXANDERSON, E. F. W.: Single-phase Power Production, 26
Hiring of Apparatus, 401
Hoists, Differential Drum, 302
HOLFORD, G. W., BARNARD, J., and PRIESTLY, P.: Tramway Finance, 961
Hosiery Factory, Electric Drive, 646
HOWE, G. W. O.: (C) Range of Wireless Stations, 234
HUND, A.: New Method for Determination of Magnetic Flux Density and Permeability, 817

I

Illumination in the United States, National Committee, 806
Illuminating Engineering Society, 257, (Annual Meeting) 299
Illustrations, Concerning, [Maycock] (C) 1014
I.M.E.A. 10, Convention **455**, 458, 502
I.M.E.A. and the Electrical Industry, **727**, 746
Imperial Commerce, 913
Import Restriction Modification, 751
Import Restriction Removed, 713
Imports, Chinese, 557
Imports, New Zealand, 990
Imports, Prohibited and Restricted, 981
India and Enemy Trading, 405
Indian Electrical Inspectors' Conference, 930
Indian Electricity Supply Policy, 84
Indian Water Power, 123
India's Copper, 557
Inductances, Two Fixed, at Commercial Frequencies, Alternating-current Bridge Method of Comparing, [Parnell] 771
Induction-Generator Plant, [Siegfried] 1005
Industrial Conditions, Post-War, 323
Industrial Co-operation, 1019
Industrial Democracy, with Particular Reference to the Relations between Capital and Labour, [Weston] 778, **780**
Industrial Fatigue, 747
Industrial Power, Cheap, 48
Industrial Power, Cost of, **690**
Industrial Reconstruction, **805**, 824, **995**, 1014
Industry and Education, 997
Industry, Financing, 713
Industry, Future of, 568
Industry's Pledge, 138
INGALLS, W. R.: Shall Great Britain and America Adopt the Metric System, **377**, 394 590
Institute, Industrial, International, 959
Institute of Chemistry, 176
Institute of Metals, 882
Institution of Civil Engineers, 139

INSTITUTION OF ELECTRICAL ENGINEERS—

Annual General Meeting, 307, **297**
Cablegram from American Inst. of Elec Engineers, 456
Commandeering of I.E.E. Offices, 59
Council, I.E.E., Nomination of, **9**
Discussions, **98**
Election of Committees, 176
Election of Council, 138
Engineering Specifications, Some Points in Connection, [Shepherd] 69, (*Discussion*) 116
Machine-Switching Telephone Gear, [McBerty] (*Concluded from* Vol. LXXVIII.) **10**, 12, (*Discussion*) 62, 194
Military Honours, Nomination of President, Annual General Meeting, 217
President, New, of the I.E.E., **97**, [Robinson] (C) 119
President, Retiring, 257
Reading Room and Library, 98
Rotary Converters, Voltage Regulation of, [Juhlin] (*Concluded from* Vol. LXXVIII.) (*Discussion*) 108
Students' Section, 574
Transmission Lines, High-Tension Overhead, [Twiss] 154, 178, 232, (*Discussion*) 272
Voting by Proxy, 472
Wattmeter, Concentric Standard Dynamometer, for Heavy Currents; and Concentric Non-Inductive Standards of Low Resistance, [Moore] **533**, 539, 576
Wayleaves, [Vernier] 100, **110**, 142

Institution of Heating and Ventilating Engineers, Symbols Recommended, 629
Institution of Mechanical Engineers, Mr Michael Longridge's Address, **216**, 220
Instrument Industry, Scientific, **843**
Instruments, Elec. Current Measuring, with Parabolic Law of Deflection, [Salomonson] 901
Insulation, Moulded, Standard Methods of Testing, **611**, 622
Insulation Tests, Crest-voltage Detector, 177
Insulator, New Form, 378
Insulator Situation, [Peaslee] 552
Insulators, Suspension Type, Expansion Effects as a Cause of Deterioration, [Brundige] 656
Invention Departments, 837
Ireland, Electric Power, 252
Irish Industry, Influence by Production and Distribution of Power, [Crowley] **767**, 783, 821
Irish Peat Utilisation, 653, 729
Iron Alloys, Electrical Resistivity, 806
Iron-Aluminium Alloys Melted in Vacuo, Magnetic and other Properties, 807
Iron and Steel Institute, 58, 844, 997
Iron and Steel Output, 98
Iron and Steel Trades, 875
Iron, Case Hardening by Boron, 256
Iron Characteristics in High-frequency Magnetic Fields, [Bown] 109, 614
Iron Ore Imports, 713
Iron Ores, Elec. Smelting, 766
Iron Smeltine, Electric, 613
Italian Business Undertakings, Registration, 943

353624

Digitized by Google

J

Japan Cement Industry, 855
Japanese Electrical Progress, 72
Japanese Foreign Elec. and Allied Trades, 27
Japanese Government Laboratory, 338, 958
Japanese New Physico-Chemical Institute, 256
Japanese Scientific Instruments, 713
Japan's Commercial Progress, 943
"Jitney" Competition in Canada, 291
JUHLIN, G. A.: Voltage Regulation of Rotary Converters (concluded from Vol. LXXVIII.) (*Discussion*), 108
JUHNKE, P.B.: Effect of Current-limiting Reactors on Turbo-Generator Systems under Conditions of Short-circuit, **573**, 589
Junior Institution of Engineers, 882

K

KAPP, G.: Determination of the Sequence of Phases from Wattmeter Readings, 854
KELLY, R.: Internal Temperatures of Alternating-current Generators, 260
KENNELLY, A. E., ACHARD, F. H., and DANA, A. S.: Experimental Researches on the Skin Effect in Steel Rails, 692
Kentish Coal & Iron, 532
Kitchens, Elec., by Carron Co., 667
KLINGENBERG, C.: Limitation of Short-Circuit Currents in the Power Station at Golpa, 1007
Kyoto Imperial University Memoirs, 728

L

Labour, Dilution of, 98
Labour Exchanges, 323
Labour, Rates of Pay, Standardisation of Conditions, [Edwardes] 544
Labour Unrest, 441, 479, **651**, 670
LACKIE, W. W.: (C) Board of Trade Committee on Elec. Supply, 117
Lacquers, Insulating, 822
Lamp, Elec., Sales in U.S.A., 376
Lamp, Incandescent, Ribbon-Filament, 98
Lamp, Nernst Vapour, 397
Lamps, Elec., Safety, 174
Lamps, Miners' Electric Safety, 496
Lamps, Miners' "Kinesway" Elec. Hand, 292
Lancashire and Cheshire Linking-up, 768, 814, **818**
LANGMUIR, I.: Condensation Pump: Improved Form of High Vacuum Pump, 579
Lanterns, Weatherproof, 452
Lead, Dealings in, 75
Lead Order, Ministry of Munitions, 943
Lead Output of the U.S.A., 494
Leeds, Exhibition of Women's Work, 574
Leeds University Textile Assoc. "Journal," 959

LEGAL INTELLIGENCE—

Accidents in Dark Streets, Liabilities, 32
Assessment, Electricity Works, 515
Bosch Magneto Patents, 319
British Thomson-Houston Co. v. Corona Lamp Works, 278
Centrifugal Fan Patent Revoked, 594
Contracts, Effect of War, 515
Dundalk U.D. Council v. Attorney-General for Ireland, 476
E.S. Co. v. Tredegars, 672
Ellis (A.) and Another v. R. Birkett, 360
Fowler, G. W., v. Midland Elec. Corpn. for Power Distribution, 198
Gas Light & Coke Co. v. Hackney Borough Council, 630, **652**, 671, 709
German Telegraph Contracts Severed, 32
Gordon & Co. v. Kirk & Co., 516
Heater, Elec., Damage, 788
Italian Wireless Telegraph Inventions, 72
J. Walsh (John) (Ltd.) v. Webster, 319
Kensington & Knightsbridge & Notting Hill Elec. Supply Co.'s Arbitration, 631
Lamp, Electric, Filament Patents, 476
London United Tramways, 398
Mears, J., v. Weston & Sons, 553
N. of Scotland Elec. Light & Power Co. v. N. of Scotland Fish Guano Co., 236
Osram-Robertson Lamp Works v. Pope's Electric Lamp Co., 515, 554
Patent, Alien Enemy, 515
Patent, Amendment, by Alien Enemy, 398
Patents, Enemy Owned, 156, 360
Plant, Commandeered, Claim for, 319
Preferential Charges, Alleged, 630, **652**, 671, 709
Pruit v. Westminster County Council, 632
Regulations, Electrical, Breach, 825
Restraint of Trade, Alleged, 278
Security for Electric Supply, 236
Signs, Electrically Lighted, 709
Supply Companies Agreement, 631
Telephone Service, 515
Tickets, Tramway Transfer, 398
Trade Marks Registration, 516
Traffic, Extraordinary, on Roads, 236
Tramcar Conductor's Duties, 516
Tramwaymen's Duty, 710
Transformers, Instructions for Use, 788
Veithardt & Hall v. Rylands Bros., 554
Wireless Telegraph Litigation, 278
Workmen's Compensation, 72, 120

LERICI, C. M.: (C) Vibration Tension Meter, 276
Library, National Technical Lending, 58
Libraries, Commercial, 557, 751
Lift Accidents, 209
Light, Conversion into Electricity, **767**, [Case] 776
Lighting, Concealed, Count Rumford as a Pioneer, 183
Lighting, Good, Benefits, 959
Lighting Problems, Practical, Eye in Relation, 379
Linking up in Lancashire and Cheshire, 768, 814, **818**
Linking-up in London, 920
Linotype Pot, Electric, 568
Load Equalisers, Flywheel, [Tilney] 618
Locomotives, Elec., for Chili, 88
Locomotive, Elec., for Experimental Service, 807
London United Tramways, 479
LONG, F. M.: Presidential Address, I.M.E.A., 458
Longridge, Mr. Michael, Presidential Address, **216**, 220
LOVELL, R. G.: Coal Concreted from Ashes or Dusts, **417**, 428, 691
Luminous Compound, Radium, 378
Luminous Compounds, Radio-active, Theory of Decay, 575
LUNDBERG & SONS: (C) City and Guilds' Examination, 513
LYDALL, F.: Choice of Voltage for Railway Electrification on the Direct-Current System, 223, 263, 303, [Smith] (C) 356, 475

M

Machine Firing by Coal and Gas, Dual Method, 436
Machine Tool Makers' Co-operation, 239
Machine Tools, 519, 597
Machinery Imports, 867
Machines, Electromagnetic, Notes on the Design of, [Smith] 658, 696, 734, 773, 812
MACKELLAR, D. J., and MACLEAN, M.: Heating of Dynamo Electric Machines with Various Loads and at Different Speeds, 465, 500
MACLEAN, M., and MACKELLAR, D. J.: Heating of Dynamo Electric Machines with Various Loads and at Different Speeds, 465, 500.
Magnetic Control as Applied to Large Mine Hoists, [Gooch] 886
Magnetic Flux Density and Permeability, New Method for Determination, [Hund] 817
Magnetic Separators, 574
Magneto, High-tension, with Special Reference to the Ignition of Aeroplane Engines, [Young] **919**, 922, 963, 998
MAKOWER, A. J., and WUST, A.: Phase Lag in Current Transformers, 581. (C) 671, [Hill] (C) 671, 785
Manchester Municipal School of Technology "Journal," 728
Manchester Steam User's Association, 331
Manganese and Special Manganese Steel, Magnetic Properties, 807
MANLEY, J. J.: Lubrication of Resistance Box Plugs, 862
Manufacturers' Advisory Committee to Ministry of Munitions, 209
Manufacturers' Certificate, 33
Marconi Report, 713
Marine Engines, Standard, 496
MARRIOTT, R. H.: Engineering Precautions in Radio Installations, 583
MARSILI, B., and VEROLE, P.: New High-speed Three-phase Locomotives of the Italian State Railways, 380
MASON, A. V.: Return Fares, 542
Matter, Electrical Theory, Astronomical Consequences, 768
MAYCOCK, W. P.: (C) Concerning Illustrations, 1014
MCBERTY, F. R.: Machine-Switching Telephone Gear (*Concluded from Vol. LXXVIII.*), **10**, 12. (*Discussion*) 62, 194
Mechanic, Skilled, **310**
Megaphone, Tramcar, 532
Metal Properties, Influence of Surface Tension, 575
Metallic Resistance, Nature of, 390
Metallurgical Research in Germany, 683
Metals, Non-Ferrous, Elec. Melting of, 11, 726
Metals, Thin and Scaly, Method for Welding, 958
Meter, Direct-current, Determination of Torque, [Alberti] 226
Meters, Demand, Indicating and Recording, 183
Meters, Direct-current Watt-hour, [Ziegenberg] 860
Metric System, 33, 159, 201, 545
Metric System in China, 844
Metric System in the United States, 138
Metric System, Shall Gt. Britain and America Adopt it? **377**, [Ingalls] 394, 590
Mica and Commutation Troubles, [Murgatroyd] 545
Mica Exports, Indian, 597
Mine Fatalities in the United States, 691
Mine Hoists, Magnetic Control Applied, [Gooch] 886
Mines and Quarries Report, 1006
Mines, Safety Rules, 176
Mines, U.S.A., Electricity, 849
Mineral Resources, Empire's, 378, 519
Mineral Wool from Basalt Rock, 958
Minerals, British, Development, 33
Minerals in the United States, 437
Mining in Japan, 528
Mining in N.S.W., 880
Minister of Reconstruction, **727**
Ministry of Commerce, 597
Ministry of Munitions Appointments, 905
Monazite Supplies, 875
MONTSINGER, V. M.: Effect of Barometric Pressure on Temperature Rise of Self-Cooled Transformers, 58, 1011
MOORE, A. E.: New Concentric Standard Dynamometer Wattmeter for Heavy Currents, and Concentric Non-Inductive Standards of Low Resistance, **533**, 539, 576
MORGAN, A. W.: Combination Coal and Gas Firing, **957**, 967
Motor Ambulances, Improved, 913
Motor Control Panels, B.T.-H., 197
Motor Industries, Technical Committee, 298
Motor Industry after the War, 686
Motor Omnibus as an Aid to Tramways, **495**
Motor Omnibus, Future, 479
Motor Omnibuses or Light Railways, **97**, 123
Motors, Control, for Industrial Work, 512
Motors, Induction, Speed Control for Steel Mill Drive, [Wright] 266
Motors, Intermittent, Rating of, [Broughton] **175**, 187, [Boyce] (C) 234, (C) 277
Moulded Insulation, Standard Methods of Testing, **611**, 622
Moulding Presses, Electrically-heated, 691
MOZLEY, H.: Presidential Address to Municipal Tramways Assoc., 960
MUELLER, E. F.: Wheatstone Bridges and Some Accessory Apparatus for Resistance Thermometry, 64
Municipal Electricity Works, Working Expenses, 479
Municipal Enterprise, Individual Interest, [Bowden] 460. (*Discussion*) 473, **508**
Municipal Industrial Development, 169
Municipal Tramways Association, 882. (Annual Conference) 960, 996
Municipal Undertakings Reserve Funds, 867
Munitions Council, 829
Munitions, Women's Work, 996
MUNRO, J. M. M.: Electrical Trade Anomalies, 746
MURGATROYD, F.: Mica and Commutation Troubles, 545
MURRAY, W.: Differentiation in Fares for Workmen and other Passengers on Tramways, 960

N

National Elec. Light Assoc. and Technical Training, 535
National Electrical Safety Code, [Stratton] (C) 195
National Labour Supply, 905
National Physical Laboratory, Annual Report, 457, 511, **534**, 550
National Service and the Technical Press (Barimar, Ltd.), (C) 977
National Service Ministry, 905
Nernst Vapour Lamps, 397
New Issues, Restrictions, 75
New Zealand Imports, 990
Nickel, Canadian, 84
NICOL, E. W. L.: Fuel and Power Supply, 420
Nitrates, Synthetic, Manufacture by Elec. Power, [Scott] 668
Nitrogen Fixation in New Zealand, 766
Nitrogen, Fixation of, 690
NORTON, A.: Manufacture, Life and Maintenance of Tramway Car Tyres, 542
Norwegian Water Power, 249
Norwich Commercial Library, 751
Nottinghamshire Coal Carbonisation Scheme, 120

O

OBITUARY—

Akred, Pte. H., 729
Alcock, Bombardier F. A., 299
Allen, Lieut. M. R. H. A., 11
Allright, J., 613
Audsley, Pte. J., 729
Avery, Lieut. C. H., 99
Baeyer, Prof. A. von, 921
Baker, 2nd Lieut. N. E., 729
Baldwin, Pte. G., 653
Ball, Pte. Walter, 653
Barnes, Corpl. A., 497
Bates, Corpl. W., 497
Bates, G. J., 177
Battelli, Prof. A., 11
Bazin, H., 419
Beisty, Driver W., 535
Bent, Pte. F. H., 997
Bingley, Bom. W., 883
Binnie, Sir Alex., 299
Birkeland, Prof. K., 535
Blyth, R. H., 257
Bowes, Pte., 845
Bracegirdle, Pte. W., 497
Brooker, A., 11
Buckton, Capt. A. S., 257
Burnham, R. H., 177

Obituary—*continued.*

Butler, Lieut. H., 99
Cade, Warrant Telegraphist J., 177
Cadman, Gunner W., 497
Chamberlain, Capt. J., 299, 339
Chaplin, 2nd Lieut. R. E. E., 177
Charnock, Pte. J., 613
Child, Corpl. G., 883
Clements, Lieut. F. C., 11
Colder, 2nd Lieut. W. P., 535
Cunliffe, Capt. J. G., 769
Dorman, H. M., 959
Dumaresq, Lieut.-Col. A. H., 613
Dunford, V. M., 217
Dynes, Rfmn. John, 921
Ferranti, Major Basil de, 613, 653
Foster, Sig. L., 921
Frankenburg, T., 217
Fullerton, 2nd Lieut. F., 769
Ganz, Prof. A. F., 883
Garnett, Lieut. K. G., 845
Gauntlett, R. W., 339
Gillibrand, Pte. J., 921
Goldsworth, Pte. A., 997
Grainger, Gunner C., 339
Grantham, 2nd E. R. H., 99
Green, Capt. E. M., 139
Greenfield, Sapper F. W., 535
Greey, Commander R., 613
Gurney, Sergt. G., 613
Halliwell, W. H., 11
Hands, Capt., 379
Harle, E., 99
Harpur, W., 339
Harris, Lieut. W. L., 11
Haslam, Capt. W. K., 257
Hesketh, Gunner A., 613
Hesketh, Lnce.-Corpl. W., 613
Hobbs, 2nd Lieut. H. V., 99
Hodgins, P. O. T., 497
Holmes, Lnce.-Cpl. J., 379
Holt, Gunner A., 729
Hood, 2nd Lieut. D. E., 257
Hunter, 2nd Lieut. T., 653
James, 2nd Lieut. R. L., 845
Jenkins, Gunner J. S., 99
Johnson, Capt. R. C., 419
Johnson, Pte. J., 883
Johnston, 2nd Lieut. A. A., 139
Jordan, G., 613
Keenan-Hook, Capt. C. W., 257
Kember, Capt. H., 456
Kennedy, Rankin, 217
King, Pte. L. W., 997
Kinsey, Pte. J., 883, 921
Knight, J. H., 959
Lancaster, 2nd Lieut. R., 339
Lees, Lnce.-Corpl. T., 535
Lewis, Sergt. T., 497
Lorrain, J. G., 845
Macdonald, Eng.-Comm. W. N., 613
Macdonald, Sir W. C., 419
McDonald, Pte. C., 535
M'Intyre, Sergt. J., 299
Milburn, Sir C. S., 613
Moore, Capt. B. J. W. M., 456
Morris, Gunner J. R., 921
Moseley, A., 653
Munton, W. H., 339
O'Sullivan, Lieut. J. A., 379
Owen, Pte. G., 883
Palmer, 2nd Lieut. W. S. H. 997
Parker, Pte. W., 845
Payne, Lieut. J. N., 729
Pickett, R., 653
Place, Sergt. J., 139
Pollitt, Pte. F., 99
Preston, S. T., 99
Price, Lnce.-Corpl. E. A., 997
Prince, Pte. J., 845
Purcey, Driver J. E. W., 997
Radford, R. H., 769
Rapp, 2nd Lieut. E. J., 497
Raven, Lieut., F. 11
Rickards, Capt. A. T., 997
Riley, Gunner A., 613
Rowlands, Pte. J., 497
Royse, Pte. F., 379
Runge, Lieut. O. J. T., 613
Sayle, Pte. C., 883
Scott, Capt. A. H., 729
Seaton, G. D., 535
Simpson, Pte. J., 845
Snowden, Capt. S. J., 99
Solomon, 2nd Lieut. L., 613
Squires, Pte. S., 99
Staveley, A. W., 177
Stewart, Capt. W. B., 379
Stone, W. H., 379
Stooks, Lieut. H. D. S., 339
Strong, 2nd Lieut. O. L., 921
Symmes, Major H. C., 177
Tague, Pte. W., 497
Tempest, 2nd Lieut. B., 257
Thomas, Sergt. J. T., 769
Thomson, Corp. J., 299
Thorne, Capt. G. S., 585
Tingey, W. H., 769
Treglown, Lieut. C. H., 99
Turner, Capt. B., 299
Turton, 2nd Lieut. T. C., 299
Walker, Lieut. L. A., 845
Ward, 2nd Lieut. N. H., 11
Whapshott, Gunner W., 997
Wheadon, Gunner A., 883
Wheater, 2nd Lieut. K. R. M., 257
White, H. A. S., 139
White, Pte. G., 997
Wiggin, Sir Henry A., 217
Wilson, Gunner G., 729
Woodward, Corpl., 497
Wright, Lieut. J. C., 139

Digitized by Google

Ocean Magnetic Work and Atmospheric Electricity, 728
Oerlikon Electrical Engineering, 572
Officials, Public, Increase of, 239
Oil Switches, Tests, [Stern and Biermanns] **881**, 884
Oils, Resistance to Emulsification, 768
Omnibuses, Electric, Charging Apparatus for, 357
Optical Indicator, Autographic Load-Extension, 216
Optical Projection, Efficiency, 256
Optical Research, 419
Optics, Technical Training, **417**, 534
Order of the British Empire, **844**, 845
Ores, Flotation, Recent Literature, 811
Organisation, Commercial, 597
Organisation, Influence on History, 690
Oscillograph, Application to Tests of Internal Combustion Engines, 306
Overseas Trade, 254

P

Panama Elec. Supply Concessions, 169
Paper Situation, **877**
PARKER, R. G., and DALLADAY, A. J.: On a Precision Method of Uniting Optical Glass, The Union of Glass in Optical Contact by Heat Treatment, 188

PARLIAMENTARY INTELLIGENCE—

Admiralty Inventions Board, 278
Armorduct Mfg. Co., 788
Ashton-under-Lyne Corporation Bill, 278
Board of Invention and Research, 319
Board of Trade Electric Power, 476
Channel Tunnel, 825
Clerical Staff of Elec. Light and Gas Companies, 761
Contractors, Government Competition, 825
Companies (Foreign Interests) Bill, 32, 235
Company Directors, 278
Education Reform, 788
Electric Lighting Provisional Orders, 516
Leaving Certificates Abolished, 825
Nottinghamshire and Derbyshire Tramways Bill, 278, 632
Petroleum, Home Supply, 825
Richmond (Surrey) Electricity Supply Bill, 278
Royal Assent, 319, 632, 761
Sheffield Corporation Bill, 476, 632
Soldiers, Discharged, Employment of, 198
Trade Union (Amalgamation) Bill, 278
Workmen's Compensation, 788

PARNELL, T.: Alternating-Current Bridge Method of Comparing Two Fixed Inductances at Commercial Frequencies, 771
PARSHALL, H. F.: (C) Decimal System, 118
Patent Law, 660
Patent Law, Bolivian, 131
Patent Law Reform, 201, **683**
Patent Law, Swedish, 650
Patentee and his Patents, **574**
Patents in 1916, 318
Patents in India, 416
Patents in War Time, 905, 1019
PAUL, R. W.: Education of Apprentices, **97**, (C) 119
PEASLEE, W. D.: The Insulator Situation, 552
Peat, Dehydration, 799
Permanent Magnets, Chromium Steel for, 256

PERSONAL—

Allen, Lieut.-Col., 217
Appointments, Military, 845
Appointments, Naval, 883
Beatty, P. W., 59
Berry, W. J., 339
Bousfield, W. R., 257
Codd, Pte. J. C., 769
Chamier, Capt. J. A., 299
Clerk, G. M., 997
Coe, Capt. G. D., 769
Coe, Lieut. E. D., 11
Colderwood, W. T., 217
Connolly, Hon. J. D., 99
Cramb, A. C., 497
Cresswell, Eng.-Lieut. F. G., 59
Cridge, A. J., 419
Dennett, S., 883
Desforges, A. H., 139
D'Eyncourt, Sir E. H. T., 339
Elliott, C., 217
Ellis, Lieut. F. A., 419
Ewer, G. C., 535
Feddon, S. E., 613
Fenton, 2nd Lieut., 729
Geddes, Vice-Admiral Sir, 339
Gilling, Capt. A. C., 535
Goodwin, Engineer Vice-Admiral, 339
Graves, R. E., 139
Greaves, H. A., 99
Gripper, L. A., 575
Hirst, 2nd Lieut. H. H., 217
Hollingworth, A., 883
Hooper, Mr., 11
Inglis, J. J., 379
Jackie, W. W., 217
Livesey, Col. H., 339
Maccall, R. B., 217
Mackenzie, J., 653
Marsh, W., 299
McBride, Sir Richard, 379
McHutchon, 2nd Lieut. E. G., 299

Personal—*continued*.

McLennan, Dr. J. C., 99
Mott, H. R., 653
Murray, Sir Oswyn A. R., 920
Nakagawa, K., 217
Oxenham, Lieut. H. A., 299
Parshall, Dr. H. F., 339
Pender, Sir James, 217
Raworth, Mrs. J. S., 11
Rouse, F. R. C., 575
Saldana, R. C., 217
Schuster, Prof. A., 457
Seabrook, A. H., 139, 457
Springall, Driver G., 769
Stanley, Capt. R., 419
Stanscombe, Lieut. T. R., 299
Sticht, R. C., 139
Tapper, W. C. P., 457
Tarver, F. H. C., 11
Tough, G., 419
Trotter, A. P., 691
Vignoles, W. A., 419
War Casualties, 339, 379, 497, 575, 769, 845, 921, 997
War Honours, 139, 497, 613, 653, 921, 997
Watts, H. R., 535
Whitelegge, Sir Arthur, 959
Yerbury, H. E., 613

Petrol Engine Ignition, 256
Phases, Sequence, Determination from Wattmeter Readings, [Kapp] 854
Phosphorescence and Fluorescence and their Use to Produce Luminous Effects, **10**, 20
Phosphoroscope, New, 183
Photometry, Use of Selenium Cells, 816
Physical Apparatus, Manufacture, **533**
Physical Society, [Fleming, Johnstone, Chatley] 316, [Patterson, Walsh and Higgins, Whipple] **378**, 389, [Parnell, Vander Pol] 514
Physico-Chemical Institute in Japan, 256
Pig Iron Prices, 635
Pin Plug & Lampholder Adaptor, Combination, 48
Pipes, Frozen, Thawing by Electricity, 174
Plant Depreciation, 75
Platinum, Diminishing Output, 418
POL, B. VAN DER: Wave-Lengths and Radiation of Loaded Antennæ, 891
Porcelain, Manufacture of, for Elec. Purposes, 58
Potash, British Sources, 959
Potentiometer, Thermo-Couple, and Other Instruments, 748
Power Cable Span, Longest in the World, 728
Power, Cheap, and Industrial Progress, 401
Power, Cheap, Importance, 867
Power, Cheaper, 519
Power, Elec., Development, 401
Power, Electric, Progress of, 441
Power Famine, 239
Power Load, Importance, 519
Power Plants of Canal Supply Boats, 875
Power, Production and Distribution, and its Influence on the Development of Irish Industry, [Crowley] **767**, 783, 821
Power Production, Single-Phase, [Alexanderson and Hill] 26
Power Supply, Local Co-operation in Developing, 575
Preferential Charges at Hackney, 630, **652**, 671
PRESS, A.: Vector Analysis of Electrical Vector Diagrams, 745
PRIESTLY, P., BARNARD, J., and HOLFORD, G. W.: Tramway Finance, 961
Prisoners of War, Books for, 216, 769
Privy Council Committee for Scientific and Industrial Research, **894**, 899, 936
Property, Alien Enemy, 363
Prussia, State Electricity Supply, 388
Public Officials, Increase of, 239
Pulp and Paper Industry, Electricity in, [Cronkhite] 852
Pumps, Condensation, Improved Form of High Vacuum, [Langmuir] 579
Pyrites, Utilisation in Coal, 996

Q

Queensland Electric Supply & Tramway Undertakings, 136

R

Rails and Scrap Iron Regulations, 33
Railway Work, Reinforced Concrete for, 496

RAILWAYS, ELECTRIC.

Chicago, Milwaukee and St. Paul Railway Electrification of New Section, 966
Choice of Voltage for Railway Electrification on the Direct-Current System, [Lydall] 223, 263, 303, [Smith] (C) 356, 475
Italian Elec. Railway, Methods of Suspension, 58
Italian State Railways, High-Speed Three-phase Locomotives, [Verole and Marsili] 380
London & N. Western and Bakerloo Electrification, 106, 144, 184
Norfolk & Western Railway, Results, 1008
Riksgrans Railway Electrification, 770, 808

Railways, Light, *v.* Motor Omnibuses, **97**, 123
Ramsay, Sir Wm., Memorial, 456, 496, 844, 920
Rand Power Companies' Systems, Generator and Transformer Failures, [Davies] **57**, 60, **66**
Ranges & Heaters, Elec., in America, 686
Rate Aid by Trade Departments, 363
Rating of Auto-Starters, **150**
Rating of Intermittent Motors, [Broughton] **178**, 187, (Boyce) (C) 234, (C) 277
Reactors, Current-limiting, Effect on Turbo-Generator Systems under Conditions of Short Circuit, [Juhnke] **573**, 589
Reading by Ear, [Fournier D'Albe] (C) 197
Reconstruction Committee, 159, **546**, **970**
Reconstruction Minister, **727**
Redditch Electricity Supply, 298
Refrigerating Apparatus, Small Electric, 785
Registration of Business Names, 33, 123
Remote Control System for an Electric Testing Laboratory, [Agnew, Stannard and Fearing] 396
Research at the American Universities, 418
Research, Industrial, [Rowell] 661
Research, Industrial, in the United States of America, **456**, 471, 620
Research, Industrial, S. African, 159
Research Institute, Combined, for the Entente Nations, 138
Resistance Box Plugs, Lubrication, [Manley] 862
Resistance Bridge for Workshop Use, [De Wette] 393
Resistance, High Frequency of Multiple Stranded Insulated Wire, 338
Resistance, Metallic, Nature of, 390
Resistance Thermometry, Wheatstone Bridges and Some Accessory Apparatus for, [Mueller] 64
Resistors, Standardisation of, **337**, 346
Reviewers, Revelation Concerning the Ways of, 629

REVIEWS OF BOOKS—

Air Supply to Boiler Rooms of Modern Ships of War [Allan], 546
Alternating-Current Machinery Proposals [Lawrence], 932
Alternating Currents in Theory and Practice [James], 353
Annuaire pour L'An 1917, 353
Colour and its Application [Luckeish], 932
Contractor, Electrical, [Moxey, Jr.] 1008
Depreciation and Wasting Assets and their Treatment in Computing Annual Profit and Loss [Leake], **350**, 353
Discovery: or the Spirit and Service of Science [Gregory], 110
Dynamo and Motor Attendants and their Machines [Broadbent], 193
Electric Switch and Controlling Gear [Garrard], 193
Electrical Engineering: Advanced Course [Berg], 231
Electricity, Emission from Hot Bodies [Richardson], 228
Engineering Applications of Higher Mathematics [Karapetoff], 231
Engineer's Year Book of Formulæ, Rules, Tables, &c. [Kempe], 150
Functions of a Complex Variable [Macrobert], 856
Hydro-Electric Power [Lyndon], 271
Lecons sur le Fonctionnement des Groupes Electrogènes en Regime Troublé [Barbillion], 624
Manufacturing Costs and Accounts [Church] 549
Pole and Tower Lines for Electric Power Transmission [Coombs], 664
Practical Physics, Manual [Hadley], 25
Public School System in Relation to the Coming Conflict for National Supremacy [Bryant], 859
Spon's Electrical Pocket Book, [Molesworth] 935
Submarine Telegraph and Telephone Cable, Theory, [Malcolm] 970
Telephone, Principles, [Jansky and Faber] 702
Theoretical Elements of Electrical Engineering [Steinmetz], 193
Theoretical Physics, Eight Lectures, [Planck] 25
Underground Transmission and Distribution for Elec. Light and Power [Meyer], 859
Ventilation, Some Modern Methods [Grierson], 546
Wireless Telegraphy and Telephony Year Book 1917, 1008
Wiring of Finished Buildings [Croft], 627

Right Man in the Right Place, **624**
ROBERTSON, J. A.: Fuel Economy, 462, (*Discussion*) 474, **495**, [Samuelson] (C) 591
ROBINSON, L. L.: (C) I. E. E. Nominations, **97**, 119
Rochdale Corporation Generating System, 21
ROGERS, W.: (C) Decimal System, 118
Rolling Mills, Electricity, 371
Rontgen Images, Influence of Stray Radiation, 176
Rotary Converters, Siemens, 699, 731
Rotor, Turbo, Body Stress, [Roberts] 850
ROWELL, H. W.: Industrial Research, 661
Royal Institution, 176
Royal Society, 216, 419, 496
Royal Society of Arts, 534, 612
Royal Society of Edinburgh, 418
R. ROBERTS: Turbo Rotor Body Stress, 850
RUDGE, W. A. D.: Self-Recording Electrometer for Atmospheric Electricity, 345
Rumford, Count, as a Pioneer of Concealed Lighting, 183
Russian Electricity Supply, [Gurewitsch] 354
Russian Exhibition, 768
Russian Scientific Work, 691
Russian Trade and Industry, 675

S

Sailors and Soldiers, Disabled, Training for Elec. Sub-station Work, 155, 996
Salford Electricity Supply, 441
SALOMONSON, Prof. J. K. A. W.: Elec. Current Measuring Instruments with Parabolic Law of Deflection, 901
SAMUELSON, F.: (C) Fuel Economy, **573**, 591
Sanitation and Safety Congress, 959
SCHULER, L.: Effect of Heat on Cotton and Paper, 617
Science and Industry, Place of Cambridge University, **728**, 729
Science, Committee on Neglect, 769
Science in Warfare, 419
Science Teaching in Secondary Schools, **843**
Scientific Investigation in Canada, 419
Scientific Mission, Allied, to U.S.A., 378
Scientific Societies, Conjoint Board, 497
Scientific Societies, Meetings in War Time, **844**
Scientific Training, 653
SCOTT, E. K.: Manufacture of Synthetic Nitrates by Electric Power, 66
Separators, Magnetic, 574
Shanghai Electric Vehicles, 291
Shanghai Municipal Elec. Dept., 83
Sheffield Electricity Supply, 977
SHELTON, E. K.: Protection of Telephone Circuits used in Elec. Power Distribution, 349
SHEPHERD, J.: Some Points in Connection with Engineering Specifications, 69, (*Discussion*) 116
Ships, Elec. Propulsion, 256
Ships, Ferro-Concrete, 298
Short-Circuit Current Limitations at Golpa Power Station, [Klingenberg] 1007
SIEGFRIED, J. H.: Experience with Induction-Generator Plant, 1005
Siemens Rotary Converters, 699, 731
Siemens-Schuckert Works, Blind Operators, 176
Signalling Apparatus, 235
Signals, Winding Shaft, Visible and Audible, 958
Signs, Illuminated, 371
Silver Sulphide, Elec. Properties, 976
Skin Effect in Steel Rails, Experimental Researches, [Kennelly, Achard and Dana] 692
Smelting, National, 159
SMITH, Dr. S. P.:
(C) Choice of Voltage for Railway Electrification on the Direct-current System, 356
Notes on the Design of Electromagnetic Machines, A.C. Generators, 658, 696, 734, 773, 812
Theory of Armature Windings, 258, 300, 340, (C) 357
Société de Chimie Industrielle, 496
Société Internationale des Electriciens, 256
Society of Glass Technology, **919**
Sound, Absolute Measurement, 883
Sound Devices, Inefficiency of, **137**
Sourabaya (Java) Exhibition, 209
South African Elec. Trade, 905
South African Engineering, **455**
South African Industrial Research, 159
South American Trade, 713
Spanish Port Improvements, 131
Spinnings, Large, 292
Spooner, Prof., on Industrial Fatigue, **851**, 670
Spraco Products, 197
SQUIER, G. O.: Multiplexing in Cable Telegraphy, 733
Standardisation, Elec., in France, 690
Standardisation Rules, Export, 323
STANNARD, W. H., AGNEW, P. G., and FEARING, J. L.: System of Remote Control for an Electric Testing Laboratory, 396
Starters, C.A.V., 1032
State and Commerce, 323
State Control, Desirability of, **137**
Steam Station, Buffalo, 210,000 kw., 98
Steel and Wrought Iron Scrap, 867
Steel, Elec. Furnace, 371
Steel, Elec., in U.S.A., 800
Steel for Aeronautical Purposes, 585
Steel Gauges, Hardening, 496
Steel Hardening, Wild-Barfield Process, **612**, 629
Steel Rails, Experimental Researches on Skin Effect, [Kennelly, Achard and Dana] 692
Steel Works Electrification, Direct Drive of, 20-in. Bar Mill, 914
STERN, G., and BIERMANNS, J.: Tests on Oil Switches, **881**, 884
STOCKER, E.: Pressure of Trolley on Overhead Wire, **957**, 969
Storage Battery Combination, 441
STRASSER, Dr. L.: Prospects of the Accumulator, 619
STRATTON, S. W.: (C) National Electrical Safety Code, 195
Street Cleaning, Motors for New York, 688
Street Lighting, Standard Specification, 338, **856**
Submarine Craft Without Periscope, 663
Submarines, Detection, 931
Submarines, Literature, 844
Sulphur, Silican, 281
Sulphuric Acid Control, 363
Sulphuric Acid Production, 806
Supply Undertakings, Should they Wire Houses, 490
Swedish Chemical Industry, 82
Swedish Electrical Industry in 1916, 86
Swedish Elec. Power Stations, 1027
Swedish Industries, 943
Switch, Wall Socket & Plug Combined, 722
Switchboard, Truck Type, Ferguson, Pailin & Co.'s, 512
Switchboards, Ironclad, 277
Switches, Oil, Tests, [Stern and Biermanns] **881**, 884

Digitized by Google

Switchgear, B.T.-H. Ironclad Draw-out Oil Break, 630
Switchgear, B.T.-H. Truck-type Ironclad, 939
Switchgear, British Westinghouse, 397
Switchgear, Totally Enclosed Industrial, 939

T

Tables of Electricity Supply, **298**, 338
Tar Oil, Licences for Use as Fuel for Diesel Engines, 959
Tasmania, Elec. Power, 635
Taxicab, Elec., in U.S.A., 683
Taxicab, Electric, Sale & Rental Scheme, 804
Teaching the Teacher, **176**
Technical Education [Denton], 14, **24**
Technical Teachers Salaries, **805**
Tees Steel Works Development, 412

TELEGRAPHY—
Argentina Telegraphy and Telephony, 371
Australia-N.Z. Submarine Cable, 869
British Control of Cables, 920
Cables, Protection against Electrolysis, 938
Canadian Telegraph Service, 527
Federated Malay States, 906
German-American Submarine Cable, 906
International Bureau of the Telegraphic Union Statistics, 10
Japanese Telegraphs, 869
Morse Code & Submarine Cables, 831
Multiplexing in Cable Telegraphy, [Squier] 733
Phototelegraphy between Berlin & Constantinople, 883
Postal and Telegraph Services, 411
P.O. Telegraph & Telephone Service, 283
Power-Cable Span, Longest in the World, 728
Submarine Cable, High Resistance Break, Capacity Test for Localising, [Higgitt] 897
"Theory of the Submarine Telegraph & Telephone Cable," 652
Venezuela Telephone Projects, 906

TELEPHONY—
Argentina, Telephony, 131
Australian Telephone Metering Apparatus, 125
Cable, World's Largest Telephone, 690
Canadian Telephone Progress, 125
Cross-Talk, Definition, 612
Directory, Telephone, 831
Indian Telephony, 77, 203
Machine - Switching Telephone Gear, [McBerty] (*Concluded from* Vol. LXXVIII.) **10**, 12, (*Discussion*) 62, 194
Persian Telephone Work, 1021
Protection of Telephone Circuits used in Elec. Power Distribution, [Shelton] 349
Railway Work, Telephone in, 494
Spain, Telephone, 831
Telephone Traffic, 638

Temperature Indicators for Electrical Machinery, 706
Temperature Measurements in Bessemer and Open Hearth Practice, 806
Temperature Rise of Self-Cooled Transformers, Barometric Pressure, Effect on, [Montsinger] 58, 1011
Terminal Boxes, Henley's, 838
Textile Mill Electrification, 274
Thermostatic Metal, 724
Things We Do Not Know, **932**
Tilney, M. J. E.: Flywheel Load Equalisers, 618
Tools, Cutting, Making by Elec. Welding, 59
Tools, Portable, Electric, 567
Track Grinder, Reciprocating, 898
Traction, Elec., in Chicago, 10
Trade, British, in Foreign Countries, **689**, 705, **805**, [Trumpeter] (C) 822
Trade, British, in Neutral Countries, 239
Trade, British, with China, 159, 210
Trade Catalogues and Price Lists, 829
Trade Commissioners, 281, 829
Trade, Government Control, **727**, 747
Trade & Industry after the War, 212
Trade Literature Standardisation, 954
Trade Mark, Empire, 791
Trade Marks, Argentina, 943
Trade Relations, Belgian and British, 751
Trade Union Entrance Examination, 363
Train Control, Automatic, 412
Trains, Early Elec. Lighting, 882
Trains used with Insufficient Air Pressure, Prevention, 817
Tramcar, Improved Type, 916
Tramway Bye-Laws, 981
Tramway Fares, Differentiation for Workmen and other Passengers, [Murray] 960
Tramway Finance, [Barnard, Holford, and Priestly] 961
Tramway Gear Cases, 534
Tramway Motors, Field, Inductive Resistances for Weakening [Adler], 855
Tramways and Light Railways Association, 256, 542, 418
Tramways and Road Subsidence, 75
Tramways, Motor Omnibus as an Aid, **495**
Tramways with Rectified Current, **57**, 71
Transformer Neutrals, Protection against Destructive Transient Disturbances [Collbohm], 29
Transformers, Bell, Design and Tariffs, [Wirz] 536
Transformers, Current, Phase Lag [Makower & Wust], 581 (C), 671, [Hill], (C), 671, 785
Transformers, Self-Cooled, Barometric Pressure on Temperature Rise, [Montsinger] 1011
Transmission Systems, Hydraulic Electric, 176
Transport, Aerial, After the War, 298
Trench, Capt. R. C: Range of Wireless Stations, 102, 147, 181 [Howe] (C), 234
Tribunal and the Generating Station, **768**, 793
Trolley, Pressure on Overhead Wire, [Stocker] 969
Truck, Elec., Economy, 842
Truck, Elec., Results in San Francisco, 994
Truck, Platform Electric, 170
Trucks, Elec., in a Blizzard, 136
Trumpeter (C): British Methods in Foreign Trade, **805**, 822
Tungsten Deposits in Rhodesia, 959
Tungsten Filaments, 252
Turbines, Steam, Westinghouse, 113
Turbo-Alternators, British Westinghouse, 1001
Turbo-Generator, 25,000 kw. Notable Performance, 115
Turbo-Generator Systems under Conditions of Short Circuit, Effect of Current Limiting Reactors [Juhnke], **573**, 589
Twiss, G. V.: High-Tension Overhead Transmission Lines, 154, 178, 232, (*Discussion*) 272
Tyneside Electrical Industries, 519
Tyres, Tramway Car, Manufacture, Life and Maintenance [Norton], 542

U

Ultra-Violet Light, Filters for, 575
Ultra Violet Rays, Production, 256
United States Water Power, 578
U.S.A. Copper, 751, 943
U.S.A. Army, Electric Service, 764
U.S.A. Electrical Energy Sales in 1916, 44
U.S.A. Electrical Exports, 1019
U.S.A. Fleet Electrical Equipment, 806
U.S.A. Foreign Trade, 867
U.S.A. Mines, Electricity, 849
U.S.A. Research Work, 620
U.S.A. Suggested Tax on Electricity, 652
U.S. Engineering Council, 920

V

Valuation of Munitions Factory, 829
Van Der Pol, B.: Wave-Lengths and Radiation of Loaded Antennae, 891
Van, Elec. Tipping, 726
Vector Analysis of Electrical Vector Diagrams, [Press] 745
Vehicle, Elec., as a Load for Central Stations, 359
Vehicle, Elec., Committee, 418, 497
Vehicle, Elec., Cost Accounting System, 876
Vehicle, Elec., Long Run, 761
Vehicle, Elec., Progress, 837
Vehicle, Elec., Running Costs, 88
Vehicle, Elec., Tests, 653
Vehicles, Elec., and their Use on Cleansing Work in Sheffield, 627
Vehicles, Elec., Economy, 898
Vehicles, Elec., in Madrid, 169
Vehicles, Elec., in Municipal Service, **611**, 621
Vehicles, Elec., Loans, 519
Vehicles, Elec., Progress, Croydon, Ilford, Surbiton, 365
Vehicles, Electric, [Conradi] 140
Vehicles, Electric, in Shanghai, 291
Vernier, C.: Wayleaves, 100, **110**, 142
Vercle, P. T. Marsili, B.: New High-Speed Three-Phase Locomotives of the Italian State Railways, 380
Vibration Tension Meter, [Lerici] (C) 276
Victoria, Electricity Supply, 374
Victorian Electricity Supply, 363
Viscometers, Standard Substances, 535

W

War Orders, 845
War Organisation in America, **255**
Wasting Asset, **350**, 353
Water Power and Power Transmission in the United States [Bell], 585
Water-Power Development in France, 882
Water Power in United States, 578
Water Power of India, 123
Wayleaves, Proposed Parliamentary Action, **255**, 276, 317
Webb, E. and Birks L.: Resistance of Earth Connections, 343
Weibel, E.: Study of Electromagnet Moving Coil Galvanometers for Use in Alternating Curent Measurements, 738
Western Union Telegraph Report, 597
W. Hartlepool, 449
W. Indies Electrical Progress, 956
Westinghouse Steam Turbines, 113
Weston, G.: Industrial Democracy: with Particular Reference to the Relations between Capital and Labour, 778, **780**
Wheatstone Bridges and some Accessory Apparatus for Resistance Thermometry [Mueller], 64
Whysall, F. H.: Electricity Supply Costs, 654, **664**
Wild-Barfield Process for Hardening Steel, **612**, 629
Wilkinson, G.: Coal Economy, 438
Winder, Three-Phase, at Ebbw Vale, 177
Winding Plant, Steam and Electric, Efficiency Cost of, 138
Winding Systems, Elec., Comparison, **98**, 99
Winnipeg Hydro-Electric Power, 605

WIRELESS TELEGRAPHY AND TELEPHONY—
Antennæ, High *versus* Low, in Wireless Telegraphy and Telephony, [Bennett], 18
Antennæ, Loaded, Wave-Lengths and Radiation, [Van der Pol] 891
Brazilian Radio-Telegraph Stations, 638
Coils, Flat, Spiral, Calculation of Coupling Co-efficient of Two Coaxial, [Baillie] 97, 1004
Engineering Precautions in Radio Installations, [Marriott] 583
French Radiotelegraphy, 125
Italian Wireless Telegraph Inventions [Bellini] (C) 357
Italy, Radiotelegraphy, 754
Load Despatching, Radio-telephones, 883
Mexico, Radio-telegraphy, 989
Progress in Wireless Telegraphy, 1021
Radio Antenna on Shipboard, Measurement and Some Interesting Comparisons, [Hart 388, [Kroger] (C) 937
Radiotelegraph Notes, 203
Radiotelegraphy, 11
Range of Wireless Stations, [Trench] 10 147, 181, [Howe] (C) 234
S. American Wireless Telegraphy, 869
School, Wireless Telegraph, at Wimbledo 907
Strays, Nature and Elimination of, [D Groot] 846
Skin Effect at Radio-Frequencies, 379
Transatlantic Wireless Service, 754
Tuning-Fork Recorder of Complex Wave Forms, 107
U.S.A.-Argentina Wireless Telegraphy, 28
U.S.A. Radio Stations, 44, 77
Wireless Air Raid Warnings, 754

Wires and Cables, Electric, 378
Wiring, House, by Supply Authorities, **458**, 4
Wiring System, Prescot Twin House, 863
Wirz, E.: Bell Transformers: Design ar Tariffs, 536
Women in Electrical Industry, 992
Women in Industry, **337**, 358
Woodhouse, W. B.: Gas-Fired Boilers, 427
Worcester Electricity Works, 454
Workmen's Compensation, 557
Workmen's Compensation Act Litigation, 12

WORKS, DESCRIPTION OF—
Redditch Electricity Supply, **919**, 925
Rochdale Corporation Generating System,

Works Lighting, 997
Works Organisation, **288**
Works Organisation and Efficiency, 339
Workshop Managers, University Training 629
Wright, J. D.: Speed Control of Inducti Motors for Steel Mill Drive, 266
Wust, A. & Makower, A. J.: Phase Lag Current Transformers, [Makower, Hill] 5 (C) 671, 785

X

X-Ray Absorption, 921
X-Ray Industry, British, Future of, 194 25 883
X-Rays, Composition from Various Metals, 17

Y

Yorkshire Elec. Power Progress, 905
Young, A. P.: High-Tension Magneto with Special Reference to the Ignition of Aeroplane Engines, **919**, 922, 963, 998

Z

Zirgenberg, R.: Direct-Current Watt-Hou Meters, 860
Zinc Ore, Spelter & Smelting, 532
Zinc Sulphide, Phosphorescent, 996

Municipal, Foreign and General Notes.

ELEC. SUPPLY—
Extensions.

Aberdeen, 282
Aylesbury, 76, 364
Ayr, 282
Barrow, 124
Bath, 598
Battersea (London), 520
Bedford, 982
Belfast, 160
Birmingham, 124
Blackpool, 124
Bootle, 944
Bradford, 1020
Bristol, 714
Buckfastleigh, 34
Bulk Supply Order, 636
Burnley, 636, 714, 982
Burton-on-Trent, 76, 240, 282
By-Product Steam Boiler Plant, 792
Cardiff, 676
Chester, 124, 202, 752
Colchester, 752
Croydon, 124, 364, 558, 676
Derby, 442, 676, 752
Dover, 752
Eccles, 792, 982
Erith, 598
Finchley, 160, 364, 830
Gloucester, 240
Hackney (London), 442, 558
Halifax, 520, 676, 714
Hanley, 202
Hayes, 364
Ilford, 364, 714
Islington, 714
Kilmarnock, 124
Kingston-on-Thames, 558
Knaresborough, 752
Leeds, 752
Leek, 752
Leicester, 714
Liverpool, 240, 558
London County Council, 34, 480, 714
Londonderry, 76, 714
Louth, 830
Luton, 202, 240, 442, 752
Motherwell, 34
Newport (Mon.), 676
Nuneaton, 636, 714
Poplar (London), 160, 324, 500, 676
Rochdale, 34, 282
Rotherham, 598
Royton (Lancs.), 944
St. Anne's-on-the-Sea, 480
St. Helens, 240
St. Pancras, 202
Salford, 240
Sheffield, 76, 240, 598, 792, 830, 944, 1020
Shoreditch, 324
Southampton, 324
Southend, 160
Spenborough, 34
Stafford, 520, 752
Stoke Newington, 34
Stoke-on-Trent, 520
Todmorden, 202
Tonbridge, 442, 830, 1020
Walthamstow, 598, 714
Wednesbury, 324
West Bromwich, 714
Willesden, 364
Wolverhampton, 124, 442, 480, 714, 982
Worcester, 558

General.

Aberdeen, 906
Agriculture, Electricity in, 520
Baildon, 240
Barnes, 124, 520
Barnstaple, 520
Bath, 240, 792
Battersea (London), 76
Beckenham, 240, 480
Bedford, 598
Belfast, 76, 364, 402, 558, 792, 868
Bethnal Green, 868
Bettws-y-Coed, 714
Beverley, 830
Bexley, 364
Birkdale, 520
Birmingham, 364, 402, 442, 480, 714, 752
Board of Trade Elec. Power Supply Committee, 364, 402, 442, 480, 636, 676, 752, 792, 1020
Boilers, Steam, Coal for, 480
Bolton, 364, 558, 752
Bootle, 34, 442
Bradford, 34, 76, 714, 752, 982
Brighton, 558, 714
Bristol, 282, 1020
Burton-on-Trent, 598
Camberley, 906
Cardiff, 906
Carlton (Notts.), 792
Cheltenham, 402, 480
Chesterfield, 676
Chichester, 364
Chippenham, 752
City of London, 636
Clayton, 160, 442, 676
Coal Distribution for Electricity Works, 944
Colchester, 598
Coventry, 324
Crayford, 868
Crickhowell, 830
Crompton, 364, 676
Croydon, 676
Cuddington, 34
Deal and Walmer, 792
Derby, 442
Donaghadee (Ireland), 636
Doncaster, 520
Dublin, 240, 402, 480, 520
Dundee, 868
Ealing, 324
Edinburgh, 636, 714
Electrical Industry, Future, 982
Electricity & Gas Supply, Future, 1020
Electric Lighting Orders Extensions, 402
Epsom, 1020
Ewell, 364
Exeter, 676, 792
Falkirk, 442
Finchley, 906
Folkestone, 402
Forfar, 868
Gillingham, 520, 792
Glasgow, 34, 324, 868
Greasborough, 636, 792
Great Harwood, 906
Greenock, 752, 792
Grimsby, 558
Hackney (London), 160, 636, 1020
Halifax, 442, 636
Hammersmith, 868
Hanley, 202
Hebden Bridge, 34, 402, 9 1020
Hendon, 160, 982
Heston and Isleworth, 715
Hornsey, 324
Hove, 982
Hucknall, 598
Huddersfield, 676
Hull, 715
Ilford, 202, 558
Increased Charges for E Energy, 76, 240, 402, 48 480, 598, 752, 792, 944, 9
Installations, Elec., Ins tion, 752
Ipswich, 282
Islington, 202, 240
Itchen, 324, 636
Jamaica, Elec. Apparatus Imports, 752
Keighley, 364, 402
King's Lynn, 160
Kingswood (nr. Bristol), 906
Lancaster, 240
Launceston, 982
Leek, 402
Lees (Lancs.), 558
Leith, 598
Liverpool Strike, 364
Llandudno, 676, 830

Digitized by Google

Municipal, Foreign and General Notes.—*Continued.*

London County Council, 558
London Electric Supply, 830, 906
Londonderry, 124
Loughborough, 715, 792
Lurgan, 906
Maidstone, 715, 944
Manchester, 34, 240, 282
Mansfield, 160
Marylebone(London),160,480
Meltham, 944
Mexborough, 480
Mexborough-Swinton Elec. Supply, 364
Midhurst and Dist. Electric Lighting Order, 1914, 160
Mytholmroyd, 160, 830
Nelson, 202
New Ross (Ireland), 202
Newcastle (co. Down), 830
Newport (Mon.), 480, 753
Norton, 598
Perth, 944
Poplar, 676
Power Station Engineers' Salaries, 636
Preference Test Case, 34
Provisional Order Extensions, 753
Radcliffe (Lancs.), 868
Rawmarsh, 324
Reading, 364
Redditch, 982
Reigate, 830
Richmond-on-Thames, 124, 402, 792
Rotherham, 240, 636, 715, 792
Royton, 868
Ruthin, 830, 982
St. Pancras (London), 324, 982
Salford, 324
Scunthorpe, 598
Sewage Works, Electricity,282
Sheffield, 124, 442, 636, 676
Slaithwaite, 520
South London, Linking-up, 202, 520
South Shields, 982
South Wales, Linking-up in, 240, 160, 676
Southampton, 868
Southend-on-Sea, 124
Southport, 792
Southwark, 715
Southwell, 715
Stafford, 364, 480, 715
Staffordshire, Linking-up, 752
Stepney (London), 480
Stoke-on-Trent, 715, 753
Stowmarket, 598
Stretford, 76, 598
Sunderland, 830
Surbiton, 520
Swansea, 636
Swindon, 202
Tanfield, 753
Tottenham, 480
Tunbridge Wells, 598
Tynemouth, 34
Wages, Electricians', 1020
Wallasey, 442, 868
Walsall, 124, 944, 1021
West Ham, 34
Wigan, 944
Willesden, 324, 636, 1021
Winchester, 480
Windermere, 753
Winsley Sanatorium, 983
Wolverhampton, 364, 442, 944
Women Labour in Electricity Works, 202
Woolwich, 480
Worcester, 520, 676
Worksop, 598
Wortley, 676
Wrexham, 598
Yorkshire Provisional Orders, 34, 160

TRACTION.

Aberdeen, 481, 944
Accrington, 125
Ashton-under-Lyne, 365
Australian Elec. Tramways, 963
Bath, 831
Belfast, 161, 637, 753, 831, 868
Bexley, 792
Birkenhead, 443
Birmingham, 365, 481, 599
Blackburn, 443
Bessington Steam Tramway 443
Bolton, 677, 831, 906, 944
Bootle, 443
Bournemouth, 76
Bradford, 35, 76
Bradford-Keighley Tramways, 677
Brighton, 521, 559, 677
Brighton, Hove and District Railless Traction Act, 1911, 868
Burnley, 599, 637, 753
Burton, 753
Burton-on-Trent, 792
Cardiff, 481, 944
Coal Distribution by Tramcar, 599
Coventry, 76, 868
Croydon, 125, 521
Darlington, 161, 637, 792
Dartford Tramcar Sheds Destroyed, 753
Darwen, 35, 521
Dearne Valley Light Railway, 282
Dewsbury, 125
Dover, 831, 868, 906, 983
Dublin and Lucan Electric Railway, 241
Dudley, 125
Dundee, 125
Dunfermline-Rosyth Tramway, 831
East Ham, 203, 792
Edgware and Hampstead Railway, 481
Edinburgh, 203, 983, 1021
Electric Railway in Warfare, 559
Germany, Elec. Vehicles, 203
Glasgow, 125, 282, 365, 443, 481, 559, 715, 753, 793
Halifax, 125, 637, 753
Hampstead, 241
Huddersfield, 35, 677, 715
Hull, 324, 521, 599, 983
Ipswich, 868
Isle of Thanet Tramways, 831
Keighley, 403
Kingston-on-Thames, 35
Leeds, 754, 793
Leicester, 521
Leyton, 365
Lincoln, 599
Liverpool, 637
L.C.C. Tramways, 125, 282, 324, 637
London County Council, 203
Londonderry, 637
London Electric Railway,125, 365
Maidstone, 161
Manchester, 161, 203, 443, 559, 677, 868
Metropolitan Assoc. of Elec. Tramway Managers, 161
Metropolitan District Railway, 481
Metropolitan Railway, 365
Metropolitan Tramway Service, 76
Middlesex, 203, 443
Morecambe, 1021
Motormen and Military Service, 906
Nelson, 754
Newcastle-on-Tyne, 983, 1021
Newport (Mon.), 125, 403, 906
Northampton, 599
Norwich Elec. Tramways, 76
Nottingham Tramways, 443, 715
Nuneaton, 521
Overhead Line Material Standardisation, 793
Perth, 35, 793
Petrograd Underground Railway Scheme, 521
P.O. Tube Railway, 754
Portsmouth, 831
Rail, Tram., Famine, 283
Rawtenstall, 983
Rothesay, 831
Salford, 76
Shanghai Railless Traction, 325
Sheerness, 559
Sheffield, 125, 241, 481
Southend, 637, 677, 868
Southport, 161, 481
Stoke-on-Trent, 76, 481, 559
Strikes, Tramway and Omnibus, 283
Swansea, 161, 754
Train Lighting in India, 1021
Tramway Employés' Wages, 241, 283, 403, 443, 481, 521, 793, 869, 906
Tramway Fares, Cheap, 521
Tramway Transfer, 443
Tramway Workers' Policy, 325
Tube Railway and Omnibus Fares, 906
Tynemouth, 715
U.S.A. Elec. Railway Mobilisation, 203
U.S.A. Electric Vehicles, 324
Vancouver, 365
Vehicle, Elec., Progress, 521, 753
Wallasey, 35, 983
Walsall, 125, 599, 945
Walthamstow, 35, 599
West Ham, 521, 1021
Western Valleys (Mon.) Railless Traction, 125
Weymouth, 637, 754
Willesden – Watford Elec. Rly., 76
Wolverhampton, 125, 241, 677, 906
Women Tramcar Conductors, 559, 945
Women Tramcar Drivers, 161, 283
Women Tramway Workers' Bonus, 125
Yarmouth, 983
York, Electric Omnibuses, 241

LIGHTING.

Aberdeen Power Contract, 637
America, Elec. Light Economy, 983
Birmingham, 1021
Blantyre, 983
Bristol, 202
Burton, 792
Burton-on-Trent, 365
Cardiff, 1021
Carmarthen, 124
Cheam, 520
Clayton-le-Moors (Lancs.), 241
Crickhowell, 983
Finchley, 35
Glyn-Neath (Wales), 906
Harrogate, 1021
Hospital Ship Equipment, 481
Islington, 559
Lincoln, 241
Lye (Staffs.), 944
Montrose, 125
Railway Carriage Lighting, 35
Restrictions, Lighting, 906
Salford, 983
Scarborough, 792
Stair Lighting, 983
St. Austell, 365, 715
Walthamstow, 715
Westminster, 202, 559
York, 35, 76

POWER.

Aberdeen, 124, 944, 1021
Announcers, Elec., at Dutch Auctions, 792
Battleships, Elec. Propulsion, 365
Board of Trade Elec. Power Committee, 240
Bray (Ireland), 676
Burton-on-Trent, 124
Canadian Elec. Mining Plant, 637
Canal Haulage in New York, 402
Coal Cutters, Elec., in Australia, 637
Cooking, Elec., in Asylums, 202
Cranes, Elec., in Tin-Plate Works, 443
Dockyards, Electricity, 830
Economy Exhibition, 676
Electric Power Supply, 715
Factories, Elec. Driving, 520
Farmwork, Canadian, Electricity in, 637
Fuel Economy in United States, 831
Furnace, Elec., Development, 202, 933
Furnace, Elec., Progress in Canada, 598
Furnaces, Elec., in U.S.A., 125
Furnaces, Elec. Steel, 520
Germany, Elec. Supply, 831
Gold Mining, Electricity, 161, 241
Grain Elevator Facilities in U.S.A., 792
Greaves-Etchells Furnace, 983
Greenock, 402
Indian Collieries, Electricity, 830
Ireland Hydro-Elec. Power, 944
Italian Hydro-Elec. Scheme, 1021
Linotype Pots, Elec., 637
Llandilo, 983
Local Authorities and Elec. Power Supply, 203
Madras Electric Power, 366
Mining, Electricity in, 35, 830
New South Wales Elec. Mining Rules, 983
Niagara Elec. Power, 906
Nitrates from the Air, 520
Peat, Irish, Utilisation, 241
Russian Collieries, Elec. Power, 161
Russian Water Power, 520
Salford, 76
S. Yorkshire Power Station, 831
Spain, 443
Swiss Hydro-Elec. Power for Germany, 1021
Textile Mill Electrification, 481
Tin Mines, Electricity, 480
Transmission Line over River, 598
Turbine Order, 402
Vehicles, Elec., Manufacture of, 402
Zinc, Electrolytic Production, 241, 676

HYDRO-ELECTRIC.

Bombay, Hydro-Electric Power, 364
Canadian Hydro-Electric Progress, 160, 364, 636
French Hydro-Electric Scheme, 402
Germany, Water-Power Utilisation, 558
Italian Hydro-Electric Undertakings, 282
Italian Water-Power, 364, 402
Morocco Water-Power, 282
New England, 804
New Zealand Hydro-Electric Development, 558, 636
Norway, Hydro-Electric Power, 558
Ontario Power Undertaking, 402
Quebec, 48
Russian Water-Power, 161
Spain, 802
Swiss Water-Power Legislation, 364
Tasmanian Hydro-Electric Power, 160, 762
Toronto, 880
U.S.A. Water-Power, 160

IMPERIAL.

African Patents, Designs and Trade Marks, 126, 907
Australasia, 35, 77, 126, 161, 403, 480, 527, 559, 754, 793, 869, 945
British Columbia, 831
British Guiana Bauxite, 638
Canada, 35, 241, 403, 721, 793, 869, 907
Canadian Electrically-operated Metallurgical Works, 35
Canadian Manganese, 831
India, 126, 161, 403, 559, 831
Johannesburg, 241
Montreal Elec. Pumping Scheme, 754
New Zealand Market for Electrical Plant, 241
N.S.W. Electrical Employers' Association, 241
Ontario Power Scandal, 869
S. Africa, 638, 907, 951, 1021
Straits Settlements, 721
Sydney, 1021

FOREIGN.

Argentina, 35, 77, 209, 242, 365, 481, 559, 638, 870, 907
Berlin Electricity Works, 481
Bolivia, 677, 907
Bolivia, Smelting, 559
Brazil, 77, 481, 721, 1021
Chili, 365, 559, 870
Chili, Taxation of Travellers, 242
China, 638, 907
Colombia, 907
Commerce, Italian, French, and Spanish, 283
Corea, 677
Cuba, 403
France, Water Power, 36
French Export Restrictions, 35
Guatemala, 242
Italian Imports, 161
Italy, 77, 832
Italy, Aluminium Manufacture, 559
Japan, 403
Japanese Railways and Telegraphs, 283
Madrid Underground Railway, 77, 283
Maranhao (Brazil), 77
Mexican Tax on Elec. Energy, 907
Mexico, 754
Morocco, 162, 403
Netherlands Prohibition of Exports of Metals, 162
Niagara Falls, 832
Norway, 162
Norwegian Mining Properties, 403
Paris, 35
Petrograd, 754
Portugal, 638, 677
Russia, 36, 77, 242, 677, 721, 832, 907
Russian Exhibition, 242
Russian Year Book, 242
Salvador, 677
Shanghai Municipal Electricity Works, 283
Spain, Platinum, 870
Sweden, 36
Swedish Elec. Furnaces, 870
Swedish Prohibition of Exports, 162, 365, 677
Switzerland, 209, 870
Switzerland, Aluminium, 559
Uruguay, 481
U.S.A. Elec. Railway Material, 1012
U.S.A. Government and German-owned Patents, 638
U.S.A. Patent Legislation, 907
U.S.A. Standard Voltages, 907
U.S.A. Taxation of Electrical Energy, 403
U.S.A. Trade with China, 36
Venezuela, 559

MISCELLANEOUS.

Agriculture, Electricity in, 559, 599
Association of Station Engineers, Proposed, 946
Automotive Electric Association, 638
B.E.A.M.A. Membership, 638
Birmingham University, 716
Board of Trade Elec. Power Committee, 284, 325
Book, Forthcoming, 482
Books, New, 638, 983
Bordeaux Samples Fair, 983
Borough Polytechnic Institute, 36
Brass Swarf Order, 984
Brazilian Radio-Telegraph Station, 715
British Companies in Belgium; Liquidation, 204
British Engineers' Association, 754
British Industries Fair, 870
British Mines, Interest in, 242
British Westinghouse Employés' War Relief Fund, 908
Burmese Wolfram, 870
Cable, Theft, 78
Canadian Industries, 404
Certificates, Leaving, 1022
Channel Tunnel, 560
China, Exports to, 162, 404
Coal Economies, 404
Coal Economy in France, 443
Coal, House, Retail Prices, 984
Coal, Household, Distribution Order, 1022
Coal Prices, 559, 946
Coal Supply Facilities, 36
Coke Supplies, 325
Colliery Electrical Apparatus, Interference, 677
Contracts with Enemies, 325
Controlled Establishments, 77
Cornish Wolfram, 908
Customs Decisions, 126, 404, 870
Diesel Engine Users' Association, 325
Digging Machine, Electric, 715
Dilution Proposals, 481
Directory, Official, 559
Disabled Soldiers, Training of, 366
Documents, in Duplicate, Postage, 404
Dye Controller, 482
Education Reform, 36
Egyptian Enemy Businesses, 404
Electric Culture, 36
Electrical Fittings, Theft, 677
Electrical Trades, Dilution, 365
Electrician, Woman, 983
Electricity Supply Tables, 325
Electro-Medical Treatment, 404
Employment, After-War, 162
Enemy Firms Wound Up, 77, 126, 162, 242, 325, 366, 404, 443, 521, 677, 754
Engineering Industry After the War, 404
Engineers and Industrial Councils, 716
Engineers and Official Jargon, 325
Engineers' Strike, 325
Entertainment of Wounded Soldiers, 716
Excess Profit Duty, 560
Exports, 908
Exports from Foreign Countries, 443
Exports, Prohibited and Restricted, 36, 242, 284, 404, 832, 870
Exports, Restricted, Priority Certificates, 366
Fatality, 832
Federation of British Industries, 1022
Fires, 366, 908
First Aid in Metal Factories, 755
Football Match, Charity, 242
French War Taxation, 560
Fuel, Olive Cake, 984
Furnaces, Elec., 870
German Economiest, 908, 983
Gold Mining, Electricity in, 325
Goods Traffic on Railways, 204
Home Industries, New, 443
Hospital Fund, E.C.C. Workpeople's, 946
Hull Corporation Employés, 325
Imports and Exports, 77, 285, 908, 1022
Imports, Prohibited and Restricted, 36, 162, 242, 285, 1022
Industrial Unrest, Causes, 599
Inquests, 284, 560, 755, 946
Institution of Petroleum Technologists, 162
Insurance, Employment, 833
Insurance, Unemployment, 162, 204, 242, 285, 326, 482, 521, 638, 947
Interned Men, Trades, 984
Irish Peat, Utilisation, 326
Iron Ore Mines Control, 677
King's Northern Tour, 325
Labour Supply, National, 946
Liverpool University, 36
Loans, Local, Interest on, 36
London Chamber of Commerce, 242
London Coal Supply, 677
Machine Gun, Electrically-operated, 284
Masonic, 366
Metals and Research, 560
Miners' Federation, 677
Mines, Nationalisation, 755
Ministry of Munitions' Appointments, 946
National Revenue, 36
Newcastle-on-Tyne Signal Companies, 870
Nottingham and Derbyshire Tramways Bill, 443
Occupations, Protected, 204
Parcels, Labels, 36
Paris National Fair, 204
Patent Applications by Foreigners, 126
Patents, Application on Behalf of Alien Enemies, 126
Patents, Foreign, 126
Poster Restrictions, 242
Presentations, 77, 755
Prices, Advance, 677
"Printers' Pie, 1917," 284
Prisoners of War Fund, Cardiff, 36
Production Committee, 599
Radio-Telegraph Notes, 366
Railway Rates, 285
Rate Aid by Trading Departments, 677
Registration of Business Names, 78
Registration of Directors Names, 870
Research Work and Co-operation, 126
Reserve Funds, Intereston, 36
Resuscitation after Electric Shock, 404
Royal Assent, 366, 870
Rubber Share Handbook, 908
S. African Enemy Firms, 126
Shell Holders, 126
Soap, Liquid, 946
Steel, Elec., 870
Street Lighting Contract, 560
Strikes, 716, 755
Swedish Exports Prohibited, 794
Switching, Elec. Light, Free Examinations, 983
Switching, Elec. Light, Problems, 204
Switzerland, Exports to, 404
Telegraphic Addresses, 404
Theft, 1022
Trade After the War, 755
Trade, British, with Canada and Newfoundland, 365
Trade Union Congress, 908, 946
Trading with the Enemy, 36, 126, 285, 560, 833, 871
Trevithick Memorial, 638
Tribunal Cases, 204, 242, 285, 326, 404, 443, 482, 599, 716, 755, 793, 833, 1022
Tyne Engineers' Wages, 36
University College (London), 599
U.S.A. Liberty Loan, Elec. Employés Support, 599
U.S.A. Telegraphs and Telephones, 242
Vegetable Growing by Elec. Company's Employees,1021
Wage Awards, 285
Wages, Electrician's, 242
Wages, Engineering, 162, 404, 443, 521, 638, 793, 870, 1021
Wages, Miners', 870
Wages, Municipal Employés, 908
Wages, Munition Workers', 870
Wages, Scottish Electrical,599
Wages, Tramway Workers, 326
Wages, Wiremen's, 285, 560, 716, 754
War Bonuses, Municipalities, 908
Warfare, Electrical Engineering, 521
Waste Metal Trade Association, 126
Wholesale Traders' Association, 162
Wills, 833
Wireless Apparatus, Secret, 482
X-Ray Hospital Equipment, 404, 599

Digitized by Google

Companies' (Joint-Stock) Meetings, Reports, Dividends, Statutory Returns, &c.

Adelaide Elec. Supply, 288, 872
Airdrie & Coatbridge Tramways, 164
Alderley & Wilmslow Elec. Supply, 128, 164
Aldershot Gas, Water & Lighting, 39, 758
Allen (Edgar) & Co., 564
Altrincham Elec. Supply, 367, 445
Aluminium Corporation, 562
American Telephone & Telegraph, 79
Anchor Cable, 407
Anglo-American Telegraph, 40, 327, 680
Anglo-Argentine Tramways, 367
Anglo-Portuguese Telephone, 484
Arbroath Elec. Light & Power, 601
Argentine Tramways & Power, 79
Armstrong (Sir W. G.) Whitworth, 288, 986
Arrol-Johnston, 485
Auckland Elec. Tramway, 166
Automatic Telephone Mfg., 564
Avery, W. & T., 642
Babcock & Wilcox, 244
Banbury & District Elec. Supply, 407
Barnsley & District Elec. Traction, 164, 485
Bath Elec. Tramway, 244
Bell Telephone of Canada, 164, 564
Bests' Safety Lamps, 166
Birmingham District Power & Traction, 445
Birmingham Elec. Accessories Mfg., 80, 166
Blackpool & Fleetwood Tramroad, 796
Bombay Elec. Supply & Tramways, 80, 244
Bournemouth & Poole Elec. Supply, 680
Brazilian Traction, Light & Power, 164, 486, 641, 910
Brilliant Arc Lamp & Engineering, 80, 328, 564
Brisbane Elec. Tramways Investment, 407
Bristol Tramways & Carriage, 758
British Aluminium, 39, 986
British Columbia Elec. Rly., 642
British Elec. Tanning Synd., 986
British Elec. Traction, 368, 408, 524
British Elec. Transformer, 39
British Ever Ready, 246, 327
British Insulated & Helsby Cables, 564, 910, 948, 986
British Thomson-Houston, 679, 717
British Trade Corporation, 524
British Westinghouse Elec. & Mfg., 165, 205, 288, 327
Bromley (Kent) Elec. Light & Power, 128, 948
Brompton & Kensington Elec. Supply, 39, 796
Brooker, T., 328
Brotherton Tubes & Conduits, 986
Browett, Lindley, 563
Brown, Boveri, 796, 1024
Brunner, Mond, 486
Brush Elec. Engineering, 206, 244
Buenos Ayres Lacroze Tramways, 368
Burma Corporation, 757
Calcutta Elec. Supply Corporation, 246, 288, 446, 564, 758, 834
Calcutta Tramways, 246, 368, 485
Callender's Cable & Construction, 327, 407
Canadian General Elec., 165, 486, 910
Castner Kellner Alkali, 368
Central London Railway, 680
Chadburn's (Ship) Telegraph, 564
Charing Cross, West End & City Elec. Supply, 718
Chatham & District Light Rlys., 796
Chelsea Elec. Supply, 79, 718
Chili Telephone, 601, 679
China & Japan Telephone & Elec., 485
Chloride Elec. Storage, 328, 948
Cia de Electricidad de la Provincia de Buenos Ayres, 79, 796
City & South London Railway, 680
City of Brisbane Elec. Light, 245
City of Buenos Ayres Tramways, 718
City of London Elec. Lighting, 910
City of Sao Paulo Improvements & Freehold Land, 485
City of Santos Improvements, 246, 288
Clevedon, Portishead & District Elec. Supply, 288
Clyde Valley Elec. Power, 128, 165, 910
Colombo Electric Tramays & Lighting, 368
Companies to be Struck off the Register, 872
Consolidated Elec., 563, 758
Consolidated Gas, Elec. Light & Power, of Baltimore, 986
Cork Elec. Tramways & Lighting, 245
Cornelis, Leon, 328
Cornwall Elec. Power, 128
County of Dorset Elec. Supply, 986
County of London Elec. Supply, 872
Craigpark Elec. Cable, 245
Creed, 166, 369, 642
Crompton, 680, 757
Crossley Bros., 834
Cuba Submarine Telegraph, 165, 244
Davis & Timmins, 910
Delhi Elec. Tramways & Lighting, 408
Derby Lamp Works, 166
Direct Spanish Telegraph, 38, 986
Direct United States Cable, 128, 165, 205
Dorman Long, 757
Doulton, 408
Dublin & Lucan Elec. Railway, 80
Dumbarton Burgh & County Tramways, 948, 986
Dundee, Broughty Ferry & County Tramways, 948, 986
Eastern Extension Australasia & China Telegraph, 166, 486, 564, 986
Eastern Telegraph, 40, 166, 206, 524, 680, 986
Ebbw Vale Steel, Iron & Coal, 717
Edison Accumulators, 445
Edison Swan Elec., 80
Edmundsons' Elec. Corporation, 601, 680
Electric & General Investment, 524, 562
Electric Construction, 327, 407
Electric Holdings, 910
Electric Light & Power Supply Corporation (Sydney), 757
Electric Supply Corporation, 601
Electric Supply of Victoria, 166
Electrical Contracts & Maintenance, 328, 642
Electrical Engineers' Amalgamation, 718
Electrical Installations, 80
Electrical Utilities, 166, 680
Electro-Bleach & By-Products, 368, 408, 834
Enfield Elec. Cable Mfg., 246, 564
Enterprise Mfg., 796
Evered, 165
Faraday & Son, 564
Farnham Gas & Elec., 39
Fife Tramway, Light & Power, 796
Folkestone Elec. Supply, 948
General Elec., 327, 601, 641
Globe Telegraph & Trust, 524, 562
Glover, W. T., 128, 165
Great Northern Telegraph, 165, 408, 446
Greenock & Port Glasgow Tramways, 165
Greenwood & Batley, 680
Hadfields, Ltd., 39
Hart Accumulator, 80
Havana Elec. Rly. Light & Power, 602
Hawkes, O. C., 39, 564
Heenan & Froude, 486
Henley's, W. T., Telegraph Works, 38, 796
Holsworthy Gas & Elec. Supply, 368
Hong Kong Elec., 757, 758
Huelva Gas & Elec., 80
Imperial Tramways, 563, 602
India Rubber, Gutta Percha & Telegraph Works, 564
Indian Elec. Supply & Traction, 245
Indo-European Telegraph, 128, 164, 718
International Nickel, 563
Isle of Wight Elec. Light & Power, 39
Jacobs, W. A. & R. J., 246
Johnson & Phillips, 165, 206
Johnson (Richard), Clapham & Morris, 246
Kalgoorlie Elec. Power & Lighting Corporation, 166, 288, 368
Kalgoorlie Elec. Tramways, 796
Kaministiquia Power, 680
Keith (James) & Blackman, 486
Kensington & Knightsbridge Elec. Lighting, 758
Kidderminster & Stourport Elec. Tramway, 288
Lanarkshire Tramways, 796
Lancashire Dynamo & Motor, 796
Lancashire Elec. Engineering, 165, 910, 986
Lancashire Power Construction, 642, 718
Launceston & District Elec. Supply, 39
Lewes & District Elec. Supply, 288, 328
Lima Light, Power & Tramways, 166, 485
Lisbon Elec. Tramways, 368, 485
Liverpool District Lighting, 39
Liverpool Overhead Railway, 680
Llanelly & District Elec. Lighting & Traction, 39
London & Lancashire Fire Insurance, 245
London & Suburban Traction, 408, 485, 758
London Elec. Railway, 680
London Elec. Supply Corporation, 910
London United Tramways, 408, 435, 564, 718
Madras Elec. Supply Corporation, 446, 602
Madras Elec. Tramways, 948
Mander, 796
Manganese Bronze & Brass, 872
Manila Elec. Railroad & Lighting Corpn., 446, 986
Mansfield & District Tramways, 796
Marconi International Marine Communication, 524, 602, 718, 910
Marconi's Wireless Telegraph, 718, 796
Marconi Wireless Telegraph of America, 165
Mather & Platt, 642
Melbourne Elec. Supply, 166, 246, 872
Memoranda, 40, 80, 128, 166, 206, 246, 288, 328
Merthyr Elec. Traction & Lighting, 327
Metropolitan Carriage, Wagon and Finance, 446, 524
Metropolitan District Rly., 680
Metropolitan Elec. Supply, 642
Metropolitan Elec. Tramways, 408
Metropolitan Railway, 718, 758
Midland Elec. Corporation for Power Distribution, 128
Minehead Elec. Supply, 40
Mirrlees, Bickerton & Day, 327
Mond Nickel, 680, 758
Monte Video Telephone, 128
Montreal Light, Heat & Power, 564
Montreal Tramways, 758
Nairobi Elec. Power & Lighting Corpn., 680
National Boiler & General Insurance, 758
National Elec. Supply, 564
National Gas Engine, 758
Newcastle-on-Tyne Elec. Supply, 910
New Era Signs, 40
New General Traction, 485
Newmarket Elec. Light, 40
North of Scotland Elec. Light & Power Co., 245
North London Railway, 718
North Melbourne Elec. Tramways & Lighting, 642
North Metropolitan Elec. Power Supply, 446
Northern Counties Electricity, 408
Northern General Transport, 165
Oldham, Ashton & Hyde Elec. Tramway, 128, 758
Oriental Telephone & Electric, 245, 327
Oxford Elec., 872
Para Elec. Railways & Lighting, 796
Para Elec. Works, 166
Peel-Conner Telephone Works, 288
Penarth Elec. Lighting, 368
Pernambuco Tramways & Power, 680, 758
Peterborough Elec. Traction, 165, 485
Petters, Ltd., 563
Phonopore Construction, 564
Potteries Elec. Traction, 328
Pritchett & Gold & E.P.S., 80, 206
Provincial Tramways, 446
Pullen Engineering, 642
Ramsgate & District Elec. Supply, 246
Rangoon Elec. Tramways & Supply, 485, 563
Ransomes & Rapier, 80
Ransomes, Sims & Jefferies, 642
Reyrolle (A.), 368
Rhondda Tramways, 408
Richardsons, Westgarth, 485
River Plate Electricity, 165
Rotherham Tramways, 165
St. James' & Pall Mall Elec. Light, 680
Salisbury Elec. Light & Supply, 80
Sao Paulo Tramway, Light & Power, 166
Secar, Scott, 986
Shanghai Elec. Construction, 246, 288
Shawinigan Water & Power, 165
Sheerness & District Elec. Power & Traction, 563
Shropshire, Worcestershire & Staffordshire Elec. Power, 246
Singapore Elec. Tramways, 486, 563
Slough & Datchet Elec. Supply, 40
Smith, F. W., 986
S. American Light & Power, 680
S. Brazilian Railways, 680
S. Metropolitan Elec. Tramways & Lighting, 446
S. Staffordshire Tramways (Lessee), 328
S. Wales Elec. Power Distribution, 80, 289, 446
S. Wales Transport, 408
Southern Brazil Elec., 486, 563
Southport Tramways, 165
Stewarts & Lloyds, 834
Stone (J.), 563
Stratford-on-Avon Electricity, 408
Submarine Cables' Trust, 40, 166, 206, 288, 367
Suffolk Elec. Supply, 524, 796
Swansea Improvements & Tramway, 368
Taunton & District Elec. Traction, 368
Taylor (Wm.) Elec. Lamp, 834
Telegraph Construction & Maintenance, 564
Telephone of Egypt, 166
Toronto Railway, 80, 368, 446
Tramways & Light Railways Estates, 80, 446
Treburlard Wolfram & Tin, 910
Trowbridge Elec. Supply, 718
Tyne Electric Steel Foundries, 642
Tynemouth & District Elec. Traction, 165
Tyneside Elec. Development, 834
Tyneside Tramways & Tramroads, 872
Tudor Accumulator, 758
Turner (Stuart), 834
Underground Elec. Rlys. of London, 680
United Alkali, 680, 872
United Elec. Tramways of Montevideo, 524, 563
United River Plate Telephone, 368, 408, 484
Urban Elec. Supply, 40
Vickers, 40, 128, 758, 796
Victoria Falls & Transvaal Power, 80, 524, 948, 1024
W. African Telegraph, 602, 679
W. Coast of America Telegraph, 564
W. India & Panama Telegraph, 246, 287
W. London & Provincial Elec. Supply, 328
Wakelin, A. J., 910
Waste, Heat & Gas Elec. Generating Stations, 758
Waygood-Otis, 486, 564
Weekes, L., 486
Western Telegraph, 328
Western Union Telegraph, 246, 564
Westminster Elec. Supply Corpn., 758
White (J. G.), 524
White, Jacoby, 796, 986
Willans & Robinson, 128
Winnipeg Elec. Railway, 486
Woking Elec. Supply, 166
Wolverhampton District Elec. Tramways, 368
Wright & Wood, 986
Yorkshire Elec. Power, 718
Yorkshire (W. Riding) Elec. Tramways, 446
Yorkshire (Woollen District) Elec. Tramways, 128

Companies, Joint-Stock (New Electrical, &c.), Registered.

Aabacas Engineering Supply, 246
A.F.S. (Ltd.), 166
Alfred Herbert (Russia), 642
Amalgamated Traders, 40
Apex Elec. Accumulator Synd., 486
Arcilla Aluminium Co., 834
Armstrong, R., & Co., 166
Atwell Foundries, 642
Automatic & Elec. Furnaces, 948
Baker (Geo. W.), 486
Barnsley (John) & Sons, 486
Blackwall Engineering and Welding Works, 564
British and Allies Electrical Agency, 246
British Barimar-Thermit Welding, 486
British Glass Wool Co., 564
British Lighting & Ignition Co., 368
British Magnetos, 328
British Metallurgic Co. (Birmingham), 166
British Testing Apparatus Assoc., 680
Brooke Engineering Works, 166
Burton, Griffiths & Co., 368
Camden Engineering Co., 986
Carpenter, C. A., 642
Cathodes, 486
Chambers Engineering Co. (S. America), 986
Chase (A.) & Co., 834
Chemical Engineering Corpn., 834
Christie (R.) & Dickinson, 564
Clarke (Clement) & Co., 246
Clements, Jeakes & Co., 948
Cosmos Lamp Works, 758
C.S.B. Electric Bleaching, 328
Dinning & Cooke, 166
Dominion Export Co., 564
E. B. Magnetos, 486
"Eclipse" Carborundum & Electrite Co., 80
Electric Holdings, 486
E.M.P. Engineering, 680
Engineering Accessories, 166
Engineering Components, 986
Enterprise Mfg. Co., 758
Etablissements de Dion Bouton Soc. Anon., 758
Express Lift Co., 246
Falconbridge, C. E., 486
Farringdon Propeller & Engineering, 166
Grace Brothers (India), 246
Grimsby Elec. Vehicle, 834
Hatton Model Engineering, 40
High-speed Machinery Co., 796
Holland, Griffiths & Co., 80
Hooton & Ellesmere Port District Elec. Supply [Co., 564
Irish Arc Welding, 328
James & Shakespeare, 564
James Bridge Copper Works, 872
Keay (Thomas C.), (Ltd.), 758
Korting Bros., 758
K.W.P. Engineering, 680
Leon Cornelis, 246
Linden, V. D., and Co., 40
Lingford, Gardiner & Co., 246
Lochside Engineering, 642
Lodge Fittings Co., 80
Marconi International Code, 834
Marine Metal, 642
Meredith & Co., 758
Modern Electric Welding, 246
Motor Gear & Engineering, 680
National Smelting Co., 166
National Union of Manufacturers, 680
Naylor (J. H.), 796
Nicholson & Crockett, 80
Nottingham Electro-Plating Co., 40
Potter, G. N., 486
Piggott Electrical Co., 758
Portable Elec. Motors, 872
Precision Gauges, 564
Railway Phonopores, 246
Ransome (Tipton) (Ltd.), 758
Rapid Distillation & Power Co., 328
Rapid Elec. Arc-Welding and Engineering (Ireland), 986
Renew Elec. Lamp, 486
Rivers Engineering, 246
Rotary Ignition, 680
Rotasphere Co., 986
Russell Bros. (Walsall), 328
Russian Industries, 166
Sainsbury, A. W., 166
Sheppey Motor Transport, 486
Silent Guides, 328
Soc. anon des Ateliers de Constructions Mecaniques, Escher Wyss & Cie, 328
Southport Elec. Supply, 486
Stokes Castings, 986
Supersigns, 486
Surrey Engineering Co., 80
Taylor (S. T.) & Sons, 796
Thames Electric Co., 246
Thermophone Co., 328
Thrutchley, Percival & Co., 166
Tullite, 486
Tungsten Products, 948
U.S. Light & Heat Corpn., 564
Veritys (Founders), 486
Victoria Chemical Co., 40
Voltalite, 758
Walker (R.) & Son (Manchester), 486
Watercraft Detachable Power Installations, 948
Wholesale Battery, 986
Wilson-Maenlin Co., 80

Digitized by Google

CALIFORNIA

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,029, [Vol. LXXIX.] FRIDAY, APRIL 6, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES	9
Arrangements for the Week	11
Machine-Switching Telephone Gear. By F. R. McBerty. Illustrated.—*Concluded*	12
Technical Education. By F. M. Denton, A.C.G.I.	14
The Decimal System of Coinage, Weights and Measures	16
High *versus* Low Antennæ in Wireless Telegraphy and Telephony. By E. Bennett	18
Fluorescence and Phosphorescence and Their Use to Produce Luminous Effects	20
The Rochdale Corporation Generating System. Illustrated	21
THE EDUCATION OF APPRENTICES	22
REVIEWS	25
Single-Phase Power Production. By E. F. W. Alexanderson and G. H. Hill	26
A Large Electric Cooking Plant. Illustrated	28
Protection of Transformer Neutrals Against Destructive Transient Disturbances. By Max H. Collbohm	29
Diesel Engine Users' Association	29
CORRESPONDENCE	29
Educational	29
PARLIAMENTARY INTELLIGENCE	30
LEGAL INTELLIGENCE	30
Patent Record	30
Volunteer Notices	30
COMMERCIAL AND INDUSTRIAL SECTION	33
Electricity Supply	34
Tenders Invited and Accepted	37
Financial Matters	38

NOTES.

Nominations to the I.E.E. Council.

The following nominations have been issued by the present Council, and are subject to additional nominations by the members:—

PRESIDENT.

C. H. Wordingham.

VICE-PRESIDENTS.

(*Two vacancies.*)

Dr. A. Russell. R. A. Chattock.
W. B. Woodhouse. R. T. Smith.

HONORARY TREASURER.

J. E. Kingsbury.

ORDINARY MEMBERS OF COUNCIL.

(*Six vacancies.*)

L. B. Atkinson.	*A. P. Trotter.*	H. H. Harrison.
W. A. Chamen.	*B. Welbourn.*	Prof. T. Mather, F.R.S.
J. S. Highfield.	J. O. Callender.	G. H. Nisbett.
Lt.-Col. A. L. Le Rossignol, C.B.	F. W. Crawter.	W. Ll. Preece.
	J. Devonshire.	H. Faraday Proctor.
Sir W. Slingo.	H. Dickinson.	G. S. Ram.
Lt.-Col. H. C. Sparks, D.S.O., M.C.	J. Hunter Gray.	W. R. Rawlings.

The names printed in italics are the nominations for the vacancies which will occur. The hon. treasurer retires annually, and is eligible for immediate re-election.

FROM this list it will be seen that Mr. C. P. SPARKS is not continuing as President, but is to be succeeded by Mr. C. H. WORDINGHAM, who for many years has been responsible for the electrical side of the Admiralty—a branch of Government work which is becoming increasingly important as time goes on. We do not doubt that this choice will be favourably received. Mr. W. B. WOODHOUSE is nominated as a new Vice-President, and Dr. RUSSELL is already serving in that capacity. With regard to ordinary Members of Council, there are eight nominations, from which a selection of six must be made, and of these nominees Mr. CHAMEN and Sir WILLIAM SLINGO are already serving. Manufacturing interests are represented by Mr. ATKINSON and Mr. WELBOURN, and electricity supply by Mr. HIGHFIELD. Our military activities are reflected in, and at the same time new blood is introduced by, the nominations of Lieut.-Col. LE ROSSIGNOL and Lieut.-Col. H. C. SPARKS, brother of the President. The former, as the Officer Commanding the London Electrical Engineers, has done much to render this unit efficient; and the latter, who went to the front as a sergeant in the London Scottish, has had a distinguished military career. Lastly, we are glad to see that Mr. A. P. TROTTER is at length nominated once more.

The Decimal System.

LAST week a lecture was delivered by Mr. HARRY ALLCOCK before the Institution of Civil Engineers on "The Decimal System of Coinage, Weights and Measures." The large audience which was present was a testimonial to the importance of the subject at the present time. This has also been evident by the letters in our correspondence columns during the last few weeks. At the beginning of his lecture Mr. ALLCOCK gave a short epitome of the history of the movement. As will be seen from the account of the lecture which we give elsewhere, attempts were made as early as 1824, and there have been frequent attempts ever since on the part of Chambers of Commerce and other associations, to displace our present methods. Those who are accustomed to travelling in foreign countries have no doubt realised the great simplification due to the metric system. Coming to our own profession, we may ask how many electrical engineers work in terms of horse-power after they have once become accustomed to the kilowatt? This experience is reflected in the support given by the Council of the Institution of Electrical Engineers, who have sent to the Committee of the Board of Trade appointed to consider the question, a resolution supporting the metric system, and asking that it shall be made compulsory after a reasonable period.

THE chief objection seems to be to the centimetre, as against the inch. In mechanical engineering we have, for example, standardised our screw threads in accordance with the inch, and it is sometimes said that the millimetre is not a suitable unit of length for practical purposes, being too small for some purposes and not small enough for others. It would be interesting to know how far this is found to be a practical objection in foreign countries. Some of the objections put forward at the discussion last week did not seem to us to be serious. For example, Mr. J. A. F. ASPINALL stated that it would cost 5s. per wagon on railways to change the tare weight, because each wagon would have to be sent to be weighed and the new figure would have to be painted on in place of the old figure. This procedure surely would not be necessary; if the tare weight is already there it is a simple matter to convert it. But by far the most pressing need at the moment is the question of decimal coinage, as our present coinage is probably very harmful to our export trade. As to the precise coins, these may well be left to the consideration of experts. At first sight it is difficult to understand why a system of weights and measures which would do away with so much waste of time, not merely for our school children but for grown-up persons also, has not been adopted

Digitized by Google

by Parliament, more particularly when it has been so persistently pressed forward by those most affected. The explanation, however, is perfectly simple. Changes of this kind are advocated generally by those who know something of the subject. On the other hand, when the question comes before Parliament it is decided by the whole body of members, about three-quarters of whom know nothing about the advantages and disadvantages of the system. The majority, therefore, see only the disadvantage of disturbing the present state of affairs, and consequently the measure is thrown out. Reforms of this kind will never make rapid headway in this country until such legislation is handled only by Parliamentary Committees of men who know something about the subject.

Fluorescence and Phosphorescence.

Fluorescent and phosphorescent effects form a fascinating field for study which has received a great deal of attention during recent years, although much of the most interesting information on the subject does not find its way into print. In the course of a discussion opened by Mr. F. Harrison Glew at the last meeting of the Illuminating Engineering Society, a number of interesting experiments were shown, and some information was forthcoming regarding the behaviour of phosphorescent substances in the form of luminous paint. A distinction is to be drawn between the ordinary "Balmain's paint" and the self-luminous paint which is continuously excited to fluorescence by the action of radium. The latter variety has found many useful applications during the war, but the effect of the former is at present too transient for it to be used with effect except in somewhat special circumstances. Progress in this direction seems to be closely associated with methods of measuring the light attained. This is by no means an easy problem, and it appears that in the past chemists and physicists working in this field have been content with somewhat crude methods. Now, however, the necessary refinements are being introduced, and doubtless interesting data on the brightness and "life" of these materials will be forthcoming after the war. Apart from its interest from the purely chemical and physical side the subject appears now to be gradually emerging to a more practical stage, and it would not be surprising if substantial progress towards practical applications were made during the next few years.

Educational Reform.

We are glad to note that the Departmental Committee on Juvenile Education in Relation to Employment after the War has issued a final report, recommending drastic changes in our methods of dealing educationally with children after the age of 14. The foolishness of allowing children to stop their education at so early an age is recognised, and it is suggested that they shall attend at least eight hours a week at day continuation classes between the ages of 14 and 18. The proposed continuation classes would give a general and not a technical education, but they "may with advantage from the very beginning have something of a vocational bias," and between 16 and 18 a greater amount of specialisation will probably be introduced. It is to be hoped that this awakening will not merely terminate with the deliberations of the Committee, as is so often the case when subjects are referred to Committees and Royal Commissions.

Automatic Telephony.

In the comprehensive Paper read by Mr. F. R. McBerty before the Institution of Electrical Engineers there is a section dealing with the question of maintenance. To those who take a general interest in such matters it has always seemed a question of vital importance whether the maintenance of what appears to the casual observer to be a delicate system would not overbalance the advantages to be gained by automatic operation. In fact, we have at times heard that the cost of maintenance was altogether too heavy to be satisfactory. We are, therefore, glad to learn from Mr. McBerty that the expenditure in wages is the main item of maintenance, and that the cost of materials and renewals is practically negligible; in fact, the author states that the cost of maintenance is by no means a serious matter and that the rate of deterioration may be assumed to be equal to that of a manual central battery equipment. This is certainly most satisfactory. There is only one minor point. Why does Mr. McBerty call it "machine-switching," by which term the average engineer pictures something akin to remote control in a power station, instead of automatic telephony with which we are all familiar? For the reader who wishes to unearth this Paper in an ordinary index a year or two hence, unnecessary trouble is provided.

Electrical Traders' Benevolent Institution.—The annual general meeting will be held at the Institution of Civil Engineers, Great George-street, London, S.W., at 2.30 p.m. on 16th inst., when Mr. A. A. Campbell Swinton will take the chair.

British Association.—It is announced that owing to the restriction of railway travelling and other circumstances arising out of the war, no meeting of the British Association will be held this year. Bournemouth had been selected as the meeting place. This will be the first time since 1831 that the annual meeting has been omitted. Reports will probably be received at a special meeting of the General Committee.

Incorporated Municipal Electrical Association.—The annual convention of this Association will be held on June 21 and 22 at the Institution of Civil Engineers, London. On Thursday, June 21, Mr. F. M. Long will deliver his Presidential Address. This will be followed by a Paper on "Individual Interests in Municipal Enterprise," by Mr. J. Horace Bowden. In the afternoon Mr. J. A. Robertson will read a Paper on "Fuel Economy." Friday, June 22, will be devoted to formal business.

Electric Traction in Chicago.—We note that the Chicago Traction and Subway Commission has issued a report, proposing an expenditure of nearly £20,000,000 within the next nine years for the electrification and extension of suburban railways. The initial nine years' programme involve the construction of 11 single-track miles of subway, six miles for rapid transit and five miles for surface cars; 64½ miles (single track) of elevated lines; 150 miles of new surface lines; and the improvement of 111 miles of existing tracks. By the year 1950 it is estimated Chicago will have a population of 50,000,000 and will possess 58 miles of subway and 525 miles of surface lines.

Telegraphy.—When the last statistics of the Internationa Bureau of the Telegraphic Union were issued, the United Kingdom had 11,061 low-speed instruments in use, and 670 quadruplex, 795 Wheatstone, and 22 Baudot high-speed instruments; France, with 12,714 low-speed instruments, had 1,155 sectors on the Baudot system; Germany, with 12,455 low-speed instruments, had 30 Baudot, 27 Wheatstone, 1 Murray and 16 Siemens high-speed instruments; Italy, with 15,514 of the former, had 19 Wheatstone, 152 Baudot, and 4 Rowland sets; and Russia, with 9,796 of the former, had 121 Wheatstone, 115 Baudot, and 3 Murray high-speed instruments. Other countries showed far less development in high-speed telegraphy.

The Testing of Cast Iron.—At a recent meeting of the South Staffordshire Iron & Steel Institute Mr. F. J. Cook delivered a Paper on "The Mechanical Testing of Cast Iron" He remarked that the tests usually imposed are mechanical, but chemical tests are also sometimes required. At present, he said, the whole subject is in a state of chaos, and the drawing up of a standard series of rules for testing is urgently needed.

Digitized by Google

In America better progress in this direction has been made, with beneficial results to the industry. One obstacle hitherto has been the expense involved in installing the necessary plant An important field for study in connection with cast iron is the processes of crystallisation that take place in various materials, and the effect of small impurities.

Radiotelegraphy.—The "Electrical World" protests against restrictions on wireless telegraphy in peace times. Progress in America has, it claims, been particularly rapid owing to the fact that the art has not, in the States, been constituted a Government monopoly. Even in Europe the progress made has been due to individuals and organisations unhampered by Government restrictions. The International Convention of London has, it declares. already hindered the industrial development of the system in the States, owing to the limited range of wave-lengths to which civilian experimenters are restricted. Complaint is further made that a bill now before Congress will give the military authorities free entrance in commercial radiography and also increase their powers of regulation and restriction.

Electric Melting of Non-Ferrous Metals.—According to a contribution by Mr. A. Stansfield to the "Brass World," electric melting has not yet been widely applied to non-ferrous metals, but has considerable future possibilities. Induction furnaces, apparently, can have only a limited application to non-ferrous metals on account of their relatively high conductivity. For the economic melting of copper, brass and other metals the arc furnace appears to be most efficient, but there may be a serious loss through volatilisation, and the temperature is less easily controlled than in resistance furnaces. On the whole, the Héroult steel furnace appears most suitable for melting copper, while of the arc furnaces the Rennerfelt type, which utilises three graphite electrodes, one vertical and two horizontal, appears the most promising. The supply is two-phase, the vertical electrode acting as the common return.

Galalith.—According to "Engineering," the material known as galalith is a German-made insulating material which resembles horn and celluloid, and consists essentially of casein and formaldehyde. The chief manufacturers are the Internationale Galalith Gesselschaft of Hamburg. Galalith is prepared by heating skimmed milk with caustic alkali; from the clarified solution the casein is precipitated by means of acid and filtered. The water is removed by compression and by drying; the latter process has to be very slow and takes several weeks. The resulting dry casein plates are saturated with formaldehyde and dried again. The final product is of a yellow-white colour and translucent, and makes an excellent insulator, which may be shaped cold after having been softened by the aid of hot water. It has no odour, and is less inflammable than celluloid: but it is not quite transparent, and cannot be prepared in the thin films in which celluloid is utilised. The sp. gr. is about 1·32, and the hardness 2·5 on the Mohr scale.

OBITUARY.

Arthur Brooker.—A correspondent sends us some notes of the career of Mr. Arthur Brooker, whose death we recorded in our last issue.

Mr. Brooker joined the telegraph department of the Post Office Service in May, 1878. He soon became an ardent student of the Telegraphists School of Science, which was established at the Central Telegraph Office in 1876, securing many successes in physics and mathematics and in several technical subjects. In 1889 he became an instructor in the school in mathematics and laboratory practice, and the following year he was made chief instructor. He was also on the staff of the People's Palace and the Currie School of Engineering as instructor in electrical engineering. His scientific attainments procured for him rapid promotion in the Post Office service. He was largely responsible for the development of the present highly specialised testing branch, where the enormous supplies of apparatus and material are tested and proved on scientific bases which are generally acknowledged by manufacturers as affording the best and fairest standards, and have been adopted by very many foreign and colonial administrations. It was, however, his association in the production of Slingo and Brooker's "Electrical Engineering" in 1890 which brought his name more prominently before the public. The book was the first of its kind, it struck quite new ground, it was written from beginning to end with the requirements and capacity of a particular individual student, and he must have been fairly typical, for some 40,000 copies of the book have been disposed of, and its circulation has spread to every part of the world where the Anglo-Saxon tongue is understood. The sale was phenomenal, but perhaps the class who took to it most enthusiastically was the marine engineer. Every vessel as it was equipped with the electric light was also provided with its Slingo and Brooker. After the publication of the book the authors entered into journalism, and contributed largely to the pages of the "Electrical Review," one of the most important contributions being a series of articles on "Storms and Telegrams," which appeared in the beginning of 1891, and which were translated and reproduced in the "Journal Telegraphique." In 1898 Arthur Brooker severed his connection with the Post Office, and became works manager of the Peel Works of the General Electric Co., where he spent seven years in organising the factory and devoting himself to the wholesale manufacture of telegraph and telephone apparatus, of which he was able to bring down the cost very materially, and thereby to extend the operations of the firm. In 1906 he joined the British Insulated & Helsby Cables (Ltd.) as assistant to Mr Dane Sinclair, and on the formation of the Automatic Telephone Mfg. Co. in 1912 he became its general manager, a position he retained until shortly before his untimely death as the result of a nervous breakdown. He leaves a widow to mourn his loss, a loss which one and all must realise more and more as time passes and his absence becomes more realised.

Prof. A. Battelli.—The death occurred on Dec. 11 of Prof. Angelo Battelli, professor of physics at Pisa University and chief editor of the "Nuovo Cimento."

Prof. Battelli, who was born in 1862, was the author of a number of text-books on physics and electricity, including works on radio-activity and on electrolytic dissociation. He made various researches in electricity and in general physics, commencing with thermo-electricity; later on he carried out an extended series of investigations on the critical point of density of saturated vapours and of liquids at the maximum vapour pressure, specific heats, &c. In 1898 he engaged in an investigation of oscillatory discharges and the attendant phenomena.

W. H. Halliwell.—The death is announced of Mr. W. H. Halliwell, acting general manager to the Lobito, Benguella & Catumbella Electric Light & Power Co., which occurred at Lobito on the 17th ult., owing to fever.

Deaths on Active Service.—The following deaths on active service are reported:—

Lieut. (Acting Capt.) W. L. Harris, M.C., Scots Fusiliers, now reported to have been killed on July 30 last, was educated at the Royal Technical College, Glasgow, and afterwards served an apprenticeship with the Fairfield Shipbuilding & Engineering Co. He was 24 years of age.

Sec.-Lieut. N. H. Ward, Middlesex Regt., aged 19, who died of wounds on March 8, was formerly a student at the Manchester School of Technology.

Lieut. Fred. Raven, R.E., who has died of wounds, was formerly engaged in the mechanical department of an Indian railway. He was a son of Sir Vincent Raven, chief mechanical engineer of the North Eastern Railway and acting chief superintendent of Woolwich Arsenal.

Lieut. F. C. Clements, R.E., eldest son of Mr. F. W. Clements, manager of the Melbourne Electric Supply Co., has died of wounds received on Jan. 6.

Lieut. M. R. H. Agnew Allen, R.F.C., 25 years of age, was accidentally killed while flying on March 21. He was the only son of Mr. R. W. H. Allen, and had passed as a pupil through all the departments of the works of Messrs. W. H. Allen, Son & Co.

PERSONAL.

Mrs. J. S. Raworth and family desire to express their thanks to those who have so kindly sympathised with them in their great bereavement. The number of letters received is so great that they cannot at the moment be acknowledged individually, but it is hoped to do so in the future.

Mr. F. H. C. Tarver, who has been superintendent of the Western Telegraph Co. in Buenos Ayres, for three years, left for Rio de Janeiro on Feb. 25 to take charge of the company's establishment in that city. At Buenos Ayres, Mr. Geo. R. Gibbs, who has had 38 years of cable service, succeeds Mr. Tarver.

Mr. Hooper, Superintendent of Indian Government Telegraphs, has been transferred to Rangoon, where he will relieve Mr. M. M. Crawford, who has taken up the position of assistant to the Chief Engineer of Telegraphs, Calcutta.

War Casualty.—Lieut. (acting Capt.) E. Douglas Coe, R.G.A., who has been in the Army since the commencement of the war, and has recently been wounded, was formerly engaged in the Blackburn municipal electricity department.

ARRANGEMENTS FOR THE WEEK.

THURSDAY, April 12th.

The Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, S.W. Discussion on "Wayleaves," with introductory Paper by Mr. C. Vernier.

1st LONDON ELECTRICAL ENGINEERS

For Notices *see* p. 30.

Digitized by Google

MACHINE-SWITCHING TELEPHONE GEAR.*

BY F. R. MCBERTY.

(*Concluded from page* 748, *Vol. LXXVIII.*)

Summary.—The Author reviews comprehensively the subject of automatic telephony. After some general considerations, computation of traffic is dealt with and a comparison is made between observed results and computed chances. The advantages of automatic telephony are shown and in conclusion results are given for the maintenance of machine switches.

Traffic between Manual and Machine-switching Systems.—The particular exchange equipment described is in the single large office of the area; conversion of the area to automatic working takes place completely with the cutting over of the office. When the machine-switching equipment is in one office of a multi-office area, special provision is required for passing calls from the manual to the automatic equipment and from the automatic to manual equipments, without impairing the telephonic service or reducing the efficiency of operation of the automatic equipment.

For receiving traffic from a manual office to lines in a machine-switching equipment, semi-automatic positions are furnished in which the junctions terminate from the manual office. These junctions may, as desired, be on the ring-down or the order-wire basis.

The service at the incoming semi-automatic terminal of the junction is surprisingly accurate and prompt; the calls are disposed of with such swiftness as to reduce the drag of the "B" operator upon the "A" operator while permitting the carrying of a substantially increased load by the "B" operator.

Passing traffic from a machine-switching office (whether semi-automatic or full-automatic) to a manual office is performed with the aid of a number indicating device before the incoming junction operator in the manual office, which reproduces before the operator visually the number stored in the registers by the semi-automatic operator or by the subscriber.

Telephone Service in Machine-switching Systems.—The benefits derivable from the substitution of machines for operators and manual-switching apparatus are of three principal sorts: improvements in service, economies and freedom in development.

The promptness of switching in the full automatic system leaves little to be desired by the user. The ringing of the bell at the wanted station begins practically as soon as the calling party completes dialling the number. In systems with operators, the delay which ordinarily impresses the subscribers is that in reaching the operator to give his number; and the quality of service is judged by the percentage of occasional long delays, as well as by the average time of response. The standard for service in manual exchanges generally accepted has already been referred to—the average response for the number is 3·5 seconds after the subscriber takes the telephone with no more than 5 per cent. delays exceeding 10 seconds.

Table I. shows the times for answers measured from taking the telephone (or calling) to the answering operator's response:—

Table I.—*Answering times, average.*

	Seconds.
Manual central battery, standard	3·5
Manual central battery, heavy load, "M"	4·5
Semi-automatic system, "I"	2·1
Semi-automatic system, "J"	2·2

Another measure is the time from initiating the call to the beginning of ringing the bell at the wanted station. Within this period there is no delay which is not directly dependent upon the operator and the apparatus except the drag of the subscriber in giving his order, which ordinarily is not a large factor.

Time for initiating call to ringing bell of called station.

	Seconds (av.)
Manual C.B. exchange, "M," best performance	10·3
Manual C.B. exchange, "M," heavy load	12·0
Manual C.B. 100 per cent. junction calls	18·5
Semi-automatic, "I"	10·3
Semi-automatic, "J"	10·5
Full automatic, "H"	8·5

Data for direct comparison of the time of connecting for the same subscriber's lines by manual and by machine switches is at hand for only one office, I, located in France. The replaced equipment was a magneto board; the replacing equipment a Western Electric semi-automatic machine system. The measured times run from the moment of the operator's answer—the insertion of the plug in the one case, the passing of the call to the telephone in the other—to the beginning of ringing. This data is presented in Fig. 5 in the form of two curves, showing the times required for completing different percentages of connections. In the machine equipment the average time is about half that formerly experienced, and 95 per cent. of the connections are made in one-fourth the former time, the maximum time being only one-fifth of the former maximum.

The shorter time noted in the above table for the full automatic system is due to the omission of the time of waiting for the operator. Otherwise the time for getting connection in a self-contained office is not largely different in manual and in machine-switching systems. In multi-office areas, however, with a considerable percentage of junction calls, working through second operators adds largely to the time occupied in manual switching, but adds nothing to that in machine switching.

A third improvement in service of marked value, but obscure origin, is that before referred to as an increase in the availability of the subscriber's lines. The duration of a connection is noticeably less in machine-switching systems, as seen in Table II.

Table II.—*Duration of Connection.*

	Seconds.
Manual magneto, accepted average	180
Manual magneto, office "I"	175
Manual C.B., accepted average	120
Full automatic, Strowger	83
Full automatic, "H"	112
Semi-automatic, "I" calling line	102
" " called line	97
Semi-automatic, "J"	60

It is notable that at office I where accurate observations were made of duration before and after the installation, the change brought

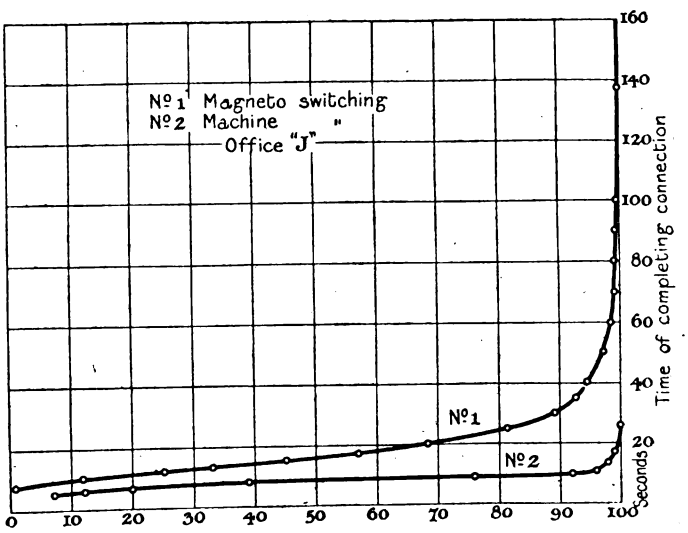


Fig. 5.—Time for Making Connection Expressed in Percentages of Connections in Different Periods.

the holding time down from 175 seconds to 102 seconds—or, if the occupied times of the pair of lines be taken, from a total of 332 seconds to 199 seconds, a reduction amounting to 40 per cent., and resulting in a more than a proportional increase in the availability of the line and decrease in the percentage of busy calls.

The more obvious economies offered by machine-switching are in operating and supervising forces and in plant. The possible net savings in operating are still subjects of controversy, while the savings in plant which might be made are still somewhat speculative.

The handling time of the operator per connection is a very significant though not an entirely satisfactory measure of probable operator's loads and costs of operating, for the reason that it is definitely measurable and comparable in different systems. The busy-hour load is, however, fairly indicated by dividing the seconds per hour by the average seconds of handling time per call; the discrepancies produced by that process are not so great in the case of semi-automatic as in manual switching. The two main influences which restrict the raising of loads in manual working—the increasing delay to the subscriber and the fatigue of the operator—are greatly reduced in automatic working.

The fatigue of the operator is very noticeably less in machine-switching systems. Accepted manual practice has favoured keeping an operator occupied about 60 per cent. of the hour, with occasional short periods of 75 per cent. With such loads the operator is

* Abstract of a Paper read last night before the Institution of Electrical Engineers.

Digitized by Google

Table III.—*Maintenance Labour.*

Exchange	A	B	C	D	E	F	G	H	I	J	K
In service	1905	1910	1910	1910	1911	1912	1909	1914	1915	1915	1915
Type	Full	Full	Full	Full	Full	Semi	Semi	Full	Semi	Semi	Semi
Lines	13,500	2,000	5,000	750	2,300	3,150	450	700	960	780	6,500
Call-rate	—	4·5	4·5	3	10	12	22	—	2	10	3
Error per cent.	5·4	—	5·0	17	5·3	—	0·25	—	—	0·01	0·37
Man-hours per line per year	6·7	6·3	3·2	12·6	11·5	5·4	6·9	6·1	5·5	2	5·2

physically and mentally busy. In semi-mechanical operating, an operator may be kept occupied normally 75 per cent. or 80 per cent. of the hour, with higher percentages on occasion, and with such loads is working easily.

In a table given in the original Paper, which illustrates the complicated and somewhat unsatisfactory nature of comparisons of operator's loads, a few significant facts are salient. An operator at a manual central-battery board with no trunking can give fairly prompt service without undue fatigue under a load of 230 calls per busy hour, and can carry a load of 400 calls with exceptional fatigue and a notable impairment of service. Such an operator can give more prompt service with ease through a mechanical switching system under a load of 450 or more busy hour calls of like average character and can carry 600 or even 700 calls in exceptional cases without noticeable impairment of service or troublesome fatigue. Junction calls reduce the load materially in manual systems, but not at all in mechanical switching.

Maintenance of Machine Switches.—As in the earlier history of the conversion of central office equipment from the magneto to the central-battery system, so in the conversion of central battery to machine-switching systems, the difficulties and expenditures actually experienced turn out to be less important than anticipated, and show a substantial diminution as the result of progressive improvement in manufacture and in practice. The early automatic exchanges required the attention of men in such numbers and of such skill to keep the equipments in good working order that their wages largely or quite counterbalanced the savings in operators. Experience with modern equipments demonstrates that the maintenance force need be hardly more numerous or more skilful than that required for manual equipments of equal size; while the faults requiring maintenance are of such a nature as to warrant the expectation of still further reductions in staff.

The expenditure in wages constitutes the main item of maintenance expenditure; those for materials and replacing parts are practically negligible.

The labour of maintaining certain typical automatic exchanges is shown in Table III, expressed in man-hours per line per year. These examples have been selected as typical from amongst a considerable number because of the fairly accurate and complete data available with respect to them.

The year is estimated at 313 days to bring all examples to equality with certain equipments in which there is no maintenance on Sunday—excepting in the case of office H, calculated for 12 months from data of one month. The number of lines given is that of lines actually in operation. In all cases, except offices G, H and I, the numbers of man-hours cover the time of maintaining the switches only, excluding time spent on power plant, distributing frames and manual switchboards. The times given for exchanges G and I include the maintenance of the power plant and manual portions of the equipment, while that given for office H includes the work on manual toll switchboards but not on power plants.

The errors noted for exchanges A, C, D, E and G were observed by standard service tests from sub-stations; those for offices H, I, J and K were observed by tests and observation at the main distributing frame. Offices A to F inclusive are ratchet-driven equipments, while offices G to K inclusive are power-driven. Offices A, B, C, G and K were operated by telephone companies, while offices D, E, F, H, I and J are operated by Postal Administrations.

In offices of relatively small size the amount and cost of labour is largely affected by the need or preference for continuous attendance. Offices A to F, and K, are attended continuously through 24 hours, offices A, B, C and K by men in three shifts, offices D, E and F by men in two shifts. Office G was operated for 12 hours per day only, with continuous attendance during that time; office I operates and is attended from 7 a.m. to 12 p.m.; office H operates through the 24-hour period, attended only from 8 a.m. to 5 p.m., with no attendance on Sundays; office J operates throughout 24 hours with attendance during 12 hours.

A special study was made at office G to determine the effect of reducing the hours of attendance. For a period of 11 days, during which 83,000 connections were recorded, all maintenance of the equipment was withheld, with the single exception of removing a fuse from one switch to put it out of operation. The equipment gave satisfactory service throughout the period. For an equal number of connections just prior to the test the percentage of errors (failures to obtain proper connections) was 0·27 per cent.; at the end of the test the percentage of error had risen to 0·57 per cent. In a later test the maintenance and repair of the equipment was suspended for a period of six weeks; attention was confined to recording the errors and removing the fuses from switches marked as frequently producing errors. During this test the percentage of error did not change substantially, but at the end of the period of six weeks 12 per cent. of the selectors had been temporarily withdrawn from operation for cleaning or repair. The switching service was satisfactory throughout.

These instances indicate that with apparatus of good construction the quantity of labour can be largely reduced by withdrawing attendance during slack hours, nights and Sundays.

A minimum attendance probably can be reached by employing one man in a single shift of eight hours during the busy portion of the day. For a 1,000-line exchange this would result in 2·5 man-hours per line per year. Studies made in exchanges G to K indicate that the time of the attendant would be occupied to only a very small extent in inspecting, testing and repairing the switching-machines.

A tabulated analysis of faults reported, identified and corrected is given.

In exchanges H, I and J no failure has been observed of contact between the bronze collector springs and commutator rings, leaf springs and brushes, or brushes and terminals. The line terminals and brushes require no cleaning or attention. The woven ribbon cable for the multiple connection at the rear of the arcs in the exchanges collectively has required 12 repairs, the cases being broken wires and loose bits of solder. The driving power has caused practically no trouble. The total value of parts replaced in all these exchanges is well within £5.

The difficulty of obtaining men of sufficient skill and training for maintaining an automatic equipment often has been unduly emphasised. The exchanges A to C, G and K have been maintained in the main by men trained in the factories and in the installation of the equipment; those in charge of exchanges F, H, I and J, and in certain others of a like character, have been taken from the Administration's forces ordinarily employed in the maintenance of manual central-battery equipments selected with somwehat more care than usual, and with a certain amount of instruction and experience during the periods of installation and initial operation of the plants under the supervision of the installing engineer.

The foregoing studies distinctly indicate that a machine-switching equipment of either of the available types, of modern construction and of moderate or large size, can be kept in good operating condition with an expenditure of labour not exceeding 5 or 6 man-hours per line per year, and that the expectation may be entertained of reducing the labour in fairly large equipments to one-half that amount or less.

Depreciation of Machine-Switching Apparatus.—The actual depreciation—wear, breakage and deterioration—in a machine-switching equipment is not heavy, and eventually may be found to be less even for the present types than the rate of depreciation commonly assumed for manual equipments. The customary rate of depreciation would naturally be applied for the sorts of apparatus well known in manual practice. As to the switching machinery sufficient experience has accrued to warrant the expectation of a rate of actual deterioration in no case greater but possibly less.

Although exact comparative data are not available, it would appear that the repairs in machine-switching systems will be fewer and less expensive than the repairs to cords alone in manual equipments.

In view of these facts, it is the opinion of the author that an actual rate of deterioration for a machine-switching equipment may be assumed conservatively to be equal to that of a manual central-battery equipment.

An element which is important in estimating depreciation as a factor in studies of annual charge is the probability of displacement by improved apparatus. This is always a difficult factor to evaluate, but in the present circumstances a partisan of machine switching might find warrant for assigning to it a larger value for manual than for automatic switches.

Digitized by Google

TECHNICAL EDUCATION.

BY F. M. DENTON, A.C.G.I.

Since the outbreak of war the subject of technical education has been widely discussed. It is a subject disturbing to our national conscience. We have come to believe that the great commercial progress of Germany during the past 30 years has resulted largely from her application of science to industry, an application made possible by careful attention to the instruction of her people in scientific things. We try to stifle the thought that had our own care for scientific instruction been as great as Germany's the war would never have happened—since Germany's relative position as a world power would then have failed to warrant her embarkation, with any hope of success, upon such an enterprise—by putting our attention upon the improvement of scientific instruction after the war.

The object of this article, the writer of which has had opportunities of observing, not only as a student and as an engineer, but also as a teacher of engineering, the conditions of technical education in Germany and in the United States, as well as in England, during the past 18 years, is, first, to outline the trend of the proposals for the improvement of technical education which seem to find favour at the present moment in England, then to criticise these proposals and, finally, to make some suggestions.

Amongst recent contributions to the discussion of technical education great importance seems to have been attached to the address by Viscount Haldane on "Education After the War with Special Reference to Technical Instruction," and the Paper by Sir A. Trevor Dawson on "Education After the War with Special Reference to Engineering Instruction," both given before a General Meeting of the Association of Technical Institutions on Oct. 20, 1916. In fact, judging by the warm reception given both to the address and to the Paper, by the highly representative body before whom they were submitted, it may reasonably be concluded that the proposals made by the two speakers were typical of the proposals generally finding favour with the representatives of our technical institutions. Moreover, the statements made, the points of view taken and the schemes outlined were so closely in accord with those put forward in the recent publication "Eclipse and Empire," which is being read with eager approval by so many, that it may be doubted whether any truer outline of the general trend of thought at the present time on the subject of technical instruction could well be found than is contained in the address and Paper just cited.

Viscount Haldane dwelt first upon the importance of basing education upon large ideas. Much was heard about the controversy between the "humanities" and "science." To the man of large ideas there could be no antagonism between these two great branches of learning; the one should complement the other, and each should be so taught that it must complement the other. It was wrong to think that the human and spiritual sides of a man's nature could be developed only by the study of history, literature and languages, or that these could, by the man of science, be neglected. Education should be carried out in a large spirit, so as to embrace both these great branches of learning.

Education and business could not be put apart. Success in business came through new or great *ideas*, and these came through thought, stimulated by education.

Numerous instances were given in which our own failure to apply scientific knowledge to business handicapped us in commerce, whilst, on the other hand, the application of science by other nations gave to these an important advantage.

We must be more ready to realise the value of thought. The recent work of Bertrand Russell and others, in connection with the mathematical subject of relativity, was cited as an instance of the value of thought.

Dealing with our systems of education, Viscount Haldane urged the importance of a broader education in the secondary schools and discouraged all attempts at specialisation. Secondary school education in Germany had recently come to grief because it allowed specialisation.

It was a deplorable fact that 90 per cent. of the youth of this country received no further education after reaching the age of 14! A scheme was needed by which employers of boys between 14 and 17 years of age should be compelled to allow these boys to attend day-time continuation classes.

The Paper by Sir A. Trevor Dawson, of the firm of Vickers, followed immediately upon Viscount Haldane's address, and, like it, dealt first with the importance of the "humanities in combination with "science," explaining that the "humanities" should be so taught as to give to the student a knowledge of men. "The two great features in education, the ideal and the utilitarian, are antagonistic, unless properly controlled, and it is for the educationist to hold fast to both, to make each merge into the other, to ensure that each shall serve the other."

"The whole scheme of education from the elementary school upwards requires reforming." There was too much instruction and too little education.

Evening schools were doing good work, but the boys were often too tired by the day's work to be able to benefit by the classes. "At the Vicker's works this view is recognised, and, in addition to other facilities, the apprentices have the privilege of going into the works one hour later in the mornings following the evenings when they have been at the classes." More than this was desirable, but it should be general and done under State arrangement. Sir Trevor Dawson, having further explained his view of the importance to an engineer of the knowledge gained by contact with men, and particularly with workmen in the shops, outlined a scheme for the education of engineers, which he considered would "work a revolution in the engineering industries, and would put them into a position to face the severest competition that can arise in any part of the world." The scheme consisted in a modified apprenticeship system. At an age to be determined by "educationists"—an age which, if the scheme were to be practicable, one could only conclude must be about 14—a boy would enter a factory as an apprentice. One half of each day would be spent in the factory, the other half in school. And in order that this division of time should not too greatly disorganise the work of the factory, the boys should work in pairs, one boy taking his shift in the factory whilst the other took his in the classroom. In this way the young engineer would, very early, be brought into contact with engineering work and workmen, whilst, in addition, he "would be stimulated in his study by the alternation of work and of school life."

"If, at the end of the first or second year, it were discovered that the youth had not taken advantage of his privilege, he would be passed into the shops to continue and complete an ordinary apprenticeship." . . . "Where the boy at the end of the second year continued to excel he would be permitted to review completely his prospects in life, with a view of definitely choosing a profession." The knowledge obtained during the two years would be valuable in any profession.

Those boys who passed, in this way, successfully through four or five years, would (at State expense in case of need) enter upon a three years' course of training at a technical school or university.

Further details of Sir Trevor Dawson's proposed scheme are available in the reprints of his Paper, copies of which may be obtained from the Honorary Secretary of the Association of Technical Institutions, Municipal Technical School, Bolton.

Consideration of these two addresses leads first to the question of the importance of the "humanities" in the education of an engineer. The expression "the humanities" generally means "classical and polite literature," but both Viscount Haldane and Sir Trevor Dawson appeared to attach to it a wider meaning, using it to embrace all those branches of learning, such as history, art and modern languages, which give a man knowledge of human nature and enable him to understand his neighbours.

Digitized by Google

There can hardly be any doubt as to the importance to an engineer, the term engineer being used to embrace all those whose work is the application of science to industry, of a knowledge of men. To some men such knowledge comes without effort, without deliberate study. In the commercial world such men are recognised by their rapid rise to positions of responsibility and control. A few years ago the secret of success of such men was reckoned a mystery, but to-day, at any rate in America, the secret is out and the big commercial firms have begun to search diligently for men with a practical understanding of their neighbours, a knowledge of "applied humanities." It was obvious from Sir Trevor Dawson's words that the intention was to draw a clear distinction between the "applied humanities" and the practically useless humanities such as the dead languages, but one had the feeling, on listening to Viscount Haldane, that a man who, in spite of a wide education both in "pure" science and in the "pure humanities," had himself so remarkably failed to read the hearts of those at whose feet he loved to sit in the pride of self-claimed spiritual sonship, could possess no real understanding of the bearing of the humanities upon practical life.

An important direction in which must come reform, not only in our secondary schools, in which, more especially, attention is given to the humanities, but also in the elementary schools, is that of the manner of teaching such subjects as history and languages. These should be taught always with a view to their bearing upon the lives of the people whom they concern, so that, for instance, history, instead of leaving on the student's memory an impression of dates and names and isolated discoveries, should draw for him a picture of the development of a people along spiritual, mental and material lines, marking especially those events which seem to have had important bearing upon the people's progress. Such reform demands two revolutionary conditions: first, that the teachers shall be men chosen because they themselves have a wide knowledge not alone of their subjects but also of men, and next that these teachers be given freedom as to their methods of teaching. It will be impossible to attract or to retain a sufficient number of men with such qualifications as teaching will then demand, unless the present scale of salaries be greatly increased.

Viscount Haldane's plea for a greater realisation of the value of thought lost much of its force through the unfortunate mention of the name of Bertrand Russell. For, whether rightly or wrongly, many of us have formed the opinion that Bertrand Russell is a man of distorted vision, who, though undoubtedly a seer in mathematics, is blind in matters of everyday life. Nevertheless, the choice of Bertrand Russell's name was in one way an apt one. In any broad scheme of education the needs chiefly to be considered are those of the *average* man. We must not, however, forget how much of every nation's progress has, in the past, depended and must surely in the future, in spite of all educational reforms, continue to depend, upon the work of extraordinary individuals. Such men have often been gifted with peculiar powers of concentration which have demanded conditions of education and of life inconsistent with the usual conventional schemes. A broad scheme of education must not overlook the occurrence and inestimable importance of such men.

On the question of specialisation, Viscount Haldane's position coincides with that of most of our technical teachers. With such a wide range of realities before him, and so few years in which to attack them, it is obviously foolish that a boy who may have to become an engineer should spend time upon mere memory exercises like the ordinary study of the dead languages to the exclusion of thought-stimulating work like the study of scientific phenomena; whilst, on the other hand, experience has already shown that too close concentration upon science during the formative period of a boy's life endangers the acquirement of that breadth of outlook without which his usefulness in the world must fail of full development.

Those of us who have to teach engineering to students coming straight from secondary schools throughout the kingdom realise probably better than anyone how greatly many a student's progress at college and his future career are handicapped by lack of preparation at the secondary school in the elements of mechanics, heat, light and chemistry.

Sir Trevor Dawson's Paper shows the keen realisation on the part of a noted engineer, who lays no claim to an expert knowledge of education, of the shortcomings of an educational system under which not only is there no compulsory provision of education after the age of 14, but, further, as is shown by statistics, 90 per cent. of the children actually receive no education after the age of 14.

The solution proposed for this difficulty by Sir Trevor Dawson is interesting, though, in principle, by no means new. In America similar schemes have for some time been in use, but instead of alternate half-days the boys spend alternate weeks in school and shop. The boys work in pairs, one boy in the shop whilst the other is in school, and the works output is thus found equivalent to that of one boy spending his whole time in the shop. Similar success as regards output is not met with in those schemes involving shorter shifts. The question arises, however, whether, in spite of its lower efficiency from the point of view of workshop output, Sir Trevor Dawson's scheme might not have the more than compensating advantage of greater educational efficiency. Such a long interval as a week would break the thread of the average boy's studies and would discourage him, whereas a few hours' work in the shops each day would serve, to some extent, as recreation. It would, however, be essential that the boy should get home early, in order to think over and write up the school work of the morning.

Probably the great difficulty would lie in the fact that, in order to be effective, Sir Trevor Dawson's scheme would have to be made compulsory.

Granted that such a scheme would be of value to the nation as a whole, it would be unjust that the cost of it should be borne by one part only of the nation—namely, by the engineering manufacturers. Sir Trevor Dawson foresees this difficulty, and suggests that the Treasury should solve it.

This question of cost underlies and controls all possible schemes of education, and it is time the State faced it. Compulsory education must be extended and must be paid for by the State, for there neither is nor ever is likely to be any logical connection between the number of a man's sons and the amount of his income. If, then, the education of her sons is a thing the nation must purchase it behoves her to insist on the best. Some form of half-time apprenticeship may be ready to hand, and may seem expedient, but is it the best?

Is it really best for a boy who later is to become an engineer to enter the shops at 14 and try to cram into four or five years two or three years of manual labour in addition to study and recreation? Has it not been sufficiently proved that study and recreation alone demand this same period of years? The years spent at a secondary school are among the hardest of a boy's life, and to cram into them a long course of manual labour would often be disastrous. Physically a boy at this age is unfit for close work in the shops; he needs exercise and fresh air. Mentally, though immature, he is keen and receptive.

If the State must bear the cost of the boy's education, let it do so under a liberal and effective scheme, each boy being educated and maintained between the ages of 14 and 18 at a secondary school and from 18 to 21 at a technical school. The outlay would be great, but the investment good.

Such a scheme could be realised only through a united effort on the part of the nation, and the signs are not at the moment propitious for the success of such an effort. The spirit of united effort so essential to progress is lacking. Great Britain is full of little firms, intent on remaining independent, and content so long as they can remain solvent. This is deplorable, but, after all, natural. Years ago such little independent firms were the only firms. The little firms of to-day are but following precedent. Moreover, we must face the elementary truth that each man's first concern is his own happiness, and when, having obtained, by setting up business in a small way, a moderate degree of happiness, he sees the continuation of these conditions fairly assured, he is

Digitized by Google

loth to change. In a country like America the conditions are different. There is no precedent for little independent firms; everything is newly planted, rapidly growing; there is no assured happiness even of a vegetable sort in remaining small and independent—there is, on the contrary, assured failure.

It is foolish to think that the average Englishman, even though he may be less energetic whilst in England in the application of science or the development of manufacture, is by nature less progressive than the average American. So soon as he begins to live in America the Englishman exhibits the traits appropriate to American conditions.

Whilst, therefore, it is right that we should deplore and try to remedy our lack of the spirit of progress by united effort, remembering that complacency is a deadly thing, it is unwise to discourage ourselves by imagining mental or moral shortcomings. Mentally and morally we are second to no nation in the world. This fact is emphasised by our possession—and it is a unique one—of that peculiar trait by which, as a nation, we are apt to belittle our own greatness and to be blind to the extent, variety and resources of our own empire.

The spirit of industrial enterprise involuntarily awakened in the man who finds himself in contact with the obvious newness, vastness and unlimited resources of America, must, in the venerable and more circumscribed surroundings of England, be deliberately aroused. If only we would train ourselves to realise that we are at the head of an empire newer, vaster and of even greater resources than the States, the spirit of united effort would be awakened as though automatically. Then, at last, we should be ready to embark upon a broad and liberal scheme of education.

The United States have already approached the realisation of such a scheme of education. They have approached it *officially*—*actually*, they have attained it. In many a technical school in America it is possible for a boy with no resources at all to maintain himself, pay all his fees and finally graduate as an engineer. This is made possible, not by official grants from the State, but by the involuntary grants provided by a country whose conditions of life are so broad and liberal that by light duties, such, for instance, as selling ice cream at a drug store, a boy may, in his spare hours earn enough money to carry him through his college course.

Unfortunately we have not yet awakened, and it may be that during the period of awakening we may find it expedient to employ some half-time makeshift scheme. The really urgent thing is that we may embark at once upon *some* scheme a little less short-sighted and a little less disastrous than the present.

Few schemes could be so full of faults as is our present scheme of evening schools. We are righteously indignant at the thought of sweated labour, and it is time we began to realise that these evening schools, of which we are so proud, by which through our bountiful generosity the industrial classes may acquire technical education at no cost to themselves, are really sweating factories. That man is a sweater who allows his workmen to sacrifice health and strength, things for which he neither can make nor attempts to make adequate payment, in order that he himself may get rich; and that State is a sweater which allows its young men to sacrifice health and strength in order that, in addition to the normal tribute, a good day's work, which every man owes to his country, there may be added, without cost to the State, the priceless gifts of trained minds.

There are few things so sad and so brave in our country to-day as the efforts of the thousands of boys throughout the country who struggle on from year to year, often sleepless, foodless and restless; crowding into each long day, already filled with manual labour, three hours of mental effort. Only those who have taught these boys from year to year know the sadness of it; know what a small percentage of those attending the earlier years can ever reach the final qualifying year. Statistics seldom show this. The report that so many millions of "student-hours" have been spent leaves the impression that so many thousand trained engineers have been produced. Nothing could be more deceptive. *There is no connection at all between student-hours and trained engineers.*

Never in our history has there been such urgent need for earnest consideration of the problem of education as there is to-day. We have before us in the German nation an astounding proof of the effectiveness of scientific training, organised and applied, in advancing a nation's commercial welfare and giving wealth and power. In spite of all those personal shortcomings of the typical German, such as aggressiveness, coarseness, a low estimate of woman, slowness to command trust or affection—shortcomings which, though remarkably absent in individual cases, are none the less certainly characteristic of the average German—organised education has worked wonders.

Yet the German system of education has many obvious faults, and with these before us and a modest though sound realisation of the Briton's advantage in possessing a natural gift for the "applied humanities," we have every reason to attack the problem of education with gladness and enthusiasm.

Let us discountenance such pettifogging things as half-time schemes of apprenticeship, and be openly ashamed of our evening "sweating" systems, let us shake up our little comfortable men, and, above all, let us look at the map and begin to realise our empire. In this way we shall hasten the time when the nation will be ready for a united effort and will demand a liberal scheme of free education and maintenance, extending through the secondary schools right on to the universities and technical colleges.

THE DECIMAL SYSTEM OF COINAGE, WEIGHTS AND MEASURES.

At the Institution of Civil Engineers, London, on the 27th ult., Mr. Harry Allcock delivered a lecture on the above subject before members of the Institutions of Civil, Mechanical and Electrical Engineers, the Institution of Naval Architects and the Iron and Steel Institute.

In the course of his lecture Mr. Allcock said there were 103 countries employing monetary units having 32 different values as the basis of their respective systems, and their monetary units he classified as follows: (1) 20 countries with unit of the order of £1, (2) 20 with unit of the order of a gold dollar=50d., (3) 8 with unit of the order of a silver dollar=28d., (4) 12 with unit of the order of a florin =18·25d., (5) 9 with unit of the order of a rupee=16d., (6) 8 with unit of the order of a mark or krone=10·13d., (7) 21 with unit of the order of a franc=9·10d. Apart from the British Empire, practically all other countries employed the decimal system, the coin of least value being one-hundredth part of the value of the monetary unit, with subsidiary coins having values of 2, 5, 10, 20, or 25 and 50 times the value of the smallest coin. Nickel bronze alloy, containing 25 per cent. nickel and 75 per cent. copper, was used much more than pure nickel. Financial transactions, such as payment of dividends, interest, &c., were based on a rate per cent. and not per 20 or per 240, which made it obvious that the use of the decimal system would save time and labour, and with the decimal system cash entries would consist of two instead of three columns, and additions and subtractions would be based on simple instead of compound arithmetic. The Lancashire cotton trade daily prices of raw cotton were now in hundredths instead of sixty-fourths of a penny as formerly, and the change greatly facilitated business.

The lecturer then gave a record of the attempts made in this country to secure the compulsory adoption of the decimal system, including those made by Lord Wrottesley in 1824, by the Commissioners for the Restoration of Weights and Measures in 1841, by a Parliamentary Select Committee in 1853, by the citizens of London in 1856, by Mr. Ashton Dilke in 1881, and by Lord Belhaven in 1904. Since 1907 over 400 resolutions had been passed by chambers of commerce, local authorities, professional institutions, trade associations, &c., in favour of the decimal system, but it remained for the war to awaken the nation to the necessity of our adopting the reform. He thought it was agreed that it would be desirable to retain the British sovereign, if possible. The florin was one-tenth of the sovereign, and if we divided the florin into 100 cents instead of 96 farthings, the decimal chain was complete.

Digitized by Google

He suggested that the coins should be: Gold—sovereign and half-sovereign; silver—florin, shilling, quarter (=6d.); nickel—10 cts. (=2·4d.), 5 cts. (=1·2d.); bronze—4 cts. (=0·96d.), 2 cts. (=0·48d.), 1 ct. (=0·24d.). The value of the present bronze coins would be depreciated 4 per cent., but surely that was not a sufficiently powerful consideration to debar us from enjoying the benefits of decimal coinage. If the face value of the present penny were retained entirely new coins representing 10d., 100d., &c., would be necessary, and the pound could not survive. Those who advocated the shilling unit as preferable to the florin were correct when they claimed that a man would accept 38·50 shillings more readily than 19·25 florins as the equivalent of his wages of 38s. 6d., but that would only be a difficulty for a few weeks, while the permanent advantages all rested with the florin. Owing to our having grown accustomed to expressing values in pounds, the florin might be considered too small a unit, but those of most other countries were smaller. The following examples showed how various amounts would be expressed: 18s. 11½d. would be 9·48 florins, £843. 14s. 10d.=8,437·42 florins, £58,500,000=585,000,000 florins. Decimal points of a pound could be used instead, but three figures would then be necessary to express values less than 2·4d., which would appear to be a disadvantage. Another alternative would be to retain our three columns for cash entries and head them, "£, Fl. (florins), cts.," or, preferably, "£, Fl., mils," representing pounds, tenths of pounds, and thousandths of pounds. As values were now fluctuating this would be a convenient opportunity for introducing the change, especially as millions of our people were now gaining knowledge of our Allies' decimal coinage. The Association of Chambers of Commerce recently passed a resolution in favour of the reform, and asked the Government to urge the Australian and South African Governments to adopt it concurrently.

With regard to weights and measures, Sir Wm. Preece said in 1903 we employed 154 different measures of length, and Sir Hy. Norman stated in 1907 that there were over 200 different weights and measures used in the British corn trade. The pound, yard, gallon, &c., could be retained as foundations for a decimal system. In his report of June, 1916, Dr. S. W. Stratton, Director of the Bureau of Standards, Washington, stated that the metric system, was obligatory in 34 countries having a population of 437,330,000 and optional in 11 countries having a population of 727,233,000, while 26 countries adhered to the international metric treaty. The last group had a population of 683,523,000. There was in some quarters a tendency to recommend the decimalisation of the present British units. A House of Commons Committee in 1862 reported that it would involve almost as much difficulty to create a special decimal system of our own as simply to adopt the metric system in common with other nations, and if we created a special system we would probably have to change it again in a few years as commerce and intercourse between nations increased. International trade had increased more than was dreamed of at that time. The sooner we accepted the fact that the adoption of the metric system was forced upon us the less would be the difficulties incidental to the change. Mr. A. J. Balfour said in 1895 the judgment of the whole civilised world had decided that the metric was the only rational system. No country ever abandoned the metric system after its adoption. The United States and Russia were always quoted by the rapidly dwindling body of last-ditch opponents of the adoption of the metric system in support of the argument that the metric system could not become universal while those two large nations stand aloof. Dr. Stratton said in the above-mentioned report no manufacturer unwilling to attempt to meet the requirements of foreign trade should be allowed to retard the development of foreign trade by his inertia or indifference to the metric system. If that were true of the United States, whose export trade was a minor issue compared with its home trade, what must be said of us whose very existence depended on our ability to maintain and expand our export trade? Whether we or the United States were the first to adopt the metric system the other would rapidly follow, and it was incumbent upon us to make the first move. Russia was a comparatively undeveloped country, but so far as she participated in manufacturing she employed the metric system to a very large extent. The Russo-British Chamber of Commerce informed him that no British firm would find the slightest difficulty in using the metric system for their trade relations with Russia. The British Weights and Measures Act of 1878 professedly authorised, but practically prohibited, the use of the metric system, as it prohibited a trader from having in his possession metric weights or measures. Subsequent legislation permitted the use of the system, but fell short of making its use compulsory. In January last the British Engineers' Association obtained the opinion of its members as to compulsion. The results were 90 per cent. in favour of decimal coinage, 87 per cent. voted for metric weights, 86 per cent. for metric dry and liquid measures, and 83 per cent. for metric linear measures. The Decimal Association, who recently attempted through a firm of publicity agents to obtain the views of 25,000 British firms, obtained 3,036 replies: 2,994 were in favour of decimal coinage and metric weights and measures. The fear that the adoption of the metric system would mean the immediate scrapping of existing patterns, tools, &c., was unfounded, as the new draft bill being prepared by the Association of Chambers of Commerce contained a clause providing that nothing in the bill should affect the manufacture or use of any machinery, &c., made by measures other than metric, so that each manufacturer could fix the length of his own transition period. The main committee of the Engineering Standards Committee had decided to issue cheap copies of their specifications in foreign languages, which involved printing metric equivalents side by side with the British dimensions. This brought us nearer the day when we should design our goods on the metric basis.

The lecturer quoted a reference by Lord Kelvin to the waste of time involved in the use of our present weights and measures, and Prof. Aldred F. Barker's expression of opinion that the change to the metric system would be easy. A commission of German cotton spinning organisations representing 96 per cent. of the 12 million spindles in the empire decided to recommend their Government to introduce the metric system of numbering yarns. With regard to the compromise by which our masters in classics agreed that more science should be taught in schools provided the time allowed for classics should not be reduced, the abandonment of our obsolete system of coinage, weights and measures would free valuable time for that purpose.

DISCUSSION.

Sir Guildford Molesworth said he had been the means of bringing about the adoption of the decimal system in Ceylon. At first everybody else there was against it, from the Governor downwards. He formed a decimal association, and gradually converted opinion in favour of the proposal. No difficulty was experienced in applying the new system, and it was found in practice to be simple and to facilitate book-keeping. The Secretary of the Public Works Department of Ceylon wrote and informed him that six weeks after the change the people ceased to talk about it. Mr. Sharpe, a high official of the Government of India, also wrote that he had never heard of any trouble in connection with the working of the system in Ceylon. By the Weights and Measures Act of 1871 the Government of India adopted the metric system. They first introduced the kilog-seer (=2 lb.). There was no difficulty in carrying out the change, but Lord Mayo declined to put forward the notification which would make it legal, so that the thing had been a dead letter. They changed the pounds, shillings and pence to rupees and cents. There was no difficulty in comparing with the English coinage, reckoned in florins and cents.

Mr. O. Bury said many of the lecturer's arguments were obvious to members of that Institution. Mr. Allcock had also told them of the many unsuccessful attempts to get a bill through. In 1895 there was no evidence against the proposal, yet it came to nought. Lord Belhaven's Committee in 1904 reported entirely in favour of the metric system, yet the bill was thrown out. Why was it that the matter never got any further? Was it because we made money too easily, and would not bestir ourselves to make changes? He spent 16 years in South America, where he got close acquaintance with the disadvantages of our present weights and measures. It was necessary to make the change, and quickly. Knowledge of the language used in South America and the adoption of the metric system were important in connection with trade with South America. A permanent chair of Spanish had been started in London, and the language could now be learnt with the greatest facility. It was hoped something of the sort would follow in the case of Portuguese to enable us to get a grip on the trade of Brazil. He thought one of the council of that Institution should go to the Education Committee and urge that decimals should not only be taught in the elementary schools, but learnt. He also suggested that a vote of the members of the Institution should be taken as to whether they were in favour of the adoption of the metric system.

Mr. C. P. Sparks stated that the Council of the Institution of Electrical Engineers had sent to the Committee of the Board of Trade appointed to consider the question a resolution advocating that the metric system should be made compulsory after a reasonable period. Electrical calculations were based on the centimetre-gramme-second, and the electrical industry thus had a common language in every part of the world. It would be impossible to adopt the metric system unless it was made compulsory. Mr. Crammond's recent lecture on foreign trade had a marked bearing on the question. If our manufacturers were looking for extended overseas trade they were bound to adopt the metric system. The United Kingdom and the United States were said to be hovering on the borders of the adoption of the system. Let us be the leaders in the matter. A universal standard of measurement appeared to be within the reach of the whole world, and such a standard must be in the general interests of civilisation.

Sir Archibald Denny said he did not know whether he was the only remaining insular conservative and last ditcher. The French and other nations used the pound and the yard for the yarn count. That was a good reason why the Germans did not want to stick to those units—they wanted to upset our measure. The metric system did not seem to satisfy the Decimal Association. They wished to give us the shells and take

Digitized by Google

away the kernel. As to the answers in favour of the metric system, he was not surprised that 90 per cent. were in favour of the metric system. The questions put would lead to those answers. We already decimalised the inch or the lb. Ten was the basis of our system. It would have been better if it had been 12; then it would have come into its own. Laplace, in the time of the Revolution, said the metre was chosen because it was absolutely different from any other countries' measures. It would have been better if he had chosen a measure that was more or less universal—the fathom. The metric system involved more than weights and measures. It involved time. It involved the subdivision of the circle into grads, which had never been used, but had never been withdrawn. If we adopted the metric system, how could we be sure we should not be worried by other enthusiasts to adopt the grads and the 10-hour day. Would it not be better for the metric people to change their metre to 40 inches? Our inch was a good measure used universally by engineers.

Dr. W. C. Unwin said the decimal coinage might have considerable advantages, and he saw no great objection to adopting the kilogram; but the alteration of the unit of length would seriously affect the proceedings of the engineer. Five-eighths of the trade of the world was carried on by the United States and the British Empire. What would be the advantages if we adopted the metric system in America? It would be an advantage to metric countries if we adopted it in trade with our dominions. Science was international, and scientific data should be accessible to scientific men all over the world, but it did not follow that the metric system would be equally advantageous to engineers in the workshop. When the association for promoting the adoption of the metric system was formed in America the American Institute of Mechanical Engineers formed an association for the purpose of defending the use of the British units. America did not appear to be ripe for the change. A certain English engineer was having his catalogues translated into Russian, and was informed that the inch and the foot were used in Russia. Therefore Russia was not yet ripe for the change. In Japan, Japanese units were used in teaching engineering in Japan, and the only other system used was the English system. Only the Army used the metric system The British Standards Committee, in translating their specifications into French, Spanish and Russian, intended to place the metric units alongside the British units The English standard sections could not be changed by merely writing their metrical equivalents. The British Standards Committee recommended that certain metric standards should be adopted as English standards and printed in their specifications, and that certain new work should also be worked out purely on the metric system. Certain standard sections of rails and rolled sections were published and distributed to different steel-making firms in Germany, and before the war one could obtain in Germany nearly all the English sections rolled in Germany.

Mr. J. A. F. Aspinall (general manager of L. & Y. Railway) said when he looked into the matter from the workshop point of view he found that Papers read by Sellars, of Philadelphia, in 1874 and 1880, expressed the opinion that the metric system was not suited to the work of the mechanical engineer's shop. That was the definite opinion of a man who might be compared to our own Whitworth. He (Mr. Aspinall) asked a number of members of his staff to report as to how the metric system would affect their different departments. He found a large sum would have to be spent on the initial cost of the change. Wagons would have to be retared. The work of weighing them and painting out old and painting in new figures on 1,600,000 wagons in this country would probably cost £400,000. Every engineer would feel the cost of the change, and the railway companies would have to alter weighing machines, gas and water meters, &c. A single bill could not settle everything, and if New Zealand, Australia and Canada did not elect to change we should have a dual system in this country. The question whether our internal trade or our export trade was the more important must in the end decide the question

Mr. H. W. Ravenshaw referred to the existing mixed system of making drawings, some in millimetres, some in inches and some in both. He had received recently a drawing of a pump. The pump was in millimetres and tenths of a millimetre, the bolts at one end in inches and at the other in millimetres, the pipe flanges were in inches, the pipe flange thicknesses in millimetres, and the scale was one-third full size. A report for the Home Office by important professors on electric bells in mines not long ago stuck to C.G.S. units until it came to the pull on the magnets, which was given in ounces. If we decided to use millimetres the nearest millimetre should be given, and if necessary in a contract one could give in parenthesis the "Whitworth" or "4 in. pipe flange." He had bought a gauge which was used by clock makers and opera glass makers. It was called the douzaine gauge, which was the 12th part of the French inch, which was one 11th larger than our inch.

Mr. S. Barton said he wished as an Australian to say the Australians did not stand in the way of the proposed reform. The Australian Premiers asked the British Premier to do something in the business, because the Australians were tired of the old measures, which wasted children's time and kept them ignorant of science. Sellars, Whitney and half a dozen other tool makers in America opposed Dr. Stanton's campaign for the metric system because they wanted to get work for their tools and plant, which they thought would be scrapped if the metric system was adopted. They had, in decency, to say they abominated the metric system.

Prof. A. Lupton deprecated the idea of compulsion, and said scientific men were free to adopt the metric system if they liked. Why should not the engineers have the option? If the system had great advantages, the intelligence of the engineers would induce them to adopt it. He helped in 1907 to throw out the compulsory metric system.

Mr. E. A. W. Phillips said everything could not be worked by decimals. It was very difficult to use vulgar fractions of over one-eighth in the metric system, and it was not international, being based on the Paris meridian. The only international earth line was the earth's polar axis, of which our inch was a 500 millionth part. There was a great lack of knowledge of the British system, which was already metric. Our metre was descended from the old Belgic yard, the oldest measure in Europe; our rod, pole or perch was 5 metres, our furlong 200 metres. The proposed new penny would cause prices to be put up 20 per cent., as shopkeepers would not take as a penny a coin of 4 per cent. less value.

Mr. O. P. Monckton said the Japanese navy were about to use the metric system as well as the army. A comparator had been made to send to Russia for use in connection with the metric system, but it had not been sent on account of the outbreak of the war.

Dr. D. G. B. Hunter said if our customers preferred the metric system, why should we not adopt it? The metre, whether rightly or wrongly, was adopted by the majority of the trading world, and the metric system seemed to be the only one which would help us as a trading nation.

Mr. C. T. A. Hanson said the time spent by children in learning tables could be better spent in learning science, mathematics and arithmetic. They had four different systems of measurement in Russia, and they were going to adopt the metric system.

Mr. Allcock, in reply to the discussion, said if Ceylon forgot there was a change in their system in six weeks we ought not to take so long. The electrical engineers, who had begun comparatively late, were able to choose their system, and had chosen the best. If Sir Archibald Denny went so far as to agree with decimals he hoped he would go the "whole hog." Dr. Unwin did not object to decimal coinage, but had some objection to metric length dimensions. In America the only people opposed to the metric system were the mechanical engineers. With regard to the trouble and expense of changing, referred to by Mr. Aspinall, the longer it was left the greater would be the confusion. Our export trade must be more important than our home trade in future if we were to survive. Mr. Ravenshaw's reference to mixed systems was splendid advocacy in favour of the adoption of one system, and that must be the metric. Unless the metric system was made compulsory we should not get out of our present difficulty of having two systems. The Chinese Legation had informed him that China was considering the early compulsory adoption of the metric system.

HIGH *VERSUS* LOW ANTENNÆ IN WIRELESS TELEGRAPHY AND TELEPHONY.*

BY E. BENNETT.

The author first makes a critical examination as to whether the usual practice in wireless telegraphy of mounting high above the ground the extended capacity areas employed is necessary or not.

The first part of the Paper deals theoretically with the electrostatic field at a great distance from an extended charged sheet, and then with the more involved problem of a similar sheet charged to a periodically varying potential.

From the mathematical discussion it follows that if a system of charges moves in space in a known manner, the electric displacement **D** and the magnetic force **H** at any point in space may be derived from the retarded displacement potential φ and the retarded vector potential **A** by the equations

$$\mathbf{D} = \text{grad. } \varphi - \frac{1}{s^2}\frac{d}{dt}\mathbf{A} \qquad (s = \text{velocity of light}),$$

$$\mathbf{H} = \text{curl. } \mathbf{A}$$

and equations are given from which the retarded potentials φ and A can be computed. These relations are then applied to a concrete case as an example, and expressions are obtained for the forces at great distances from the radiator.

The later portions of the Paper then continue the investigation from the practical point of view, and the expressions already derived are utilised to provide the answer to the main question of how the magnitude of the disturbance which is set up in the medium at a distant point is affected by the height of the capacity area of the radiating station.

The expressions for the electric force, for the magnetic force and for the rate at which energy streams past the distant point all contain a certain factor, Qh_o, which is the product of the charge Q on the capacity area multiplied by the maximum height of the capacity area, and the rate at which energy streams past the distant point is proportional to the square of this product; so that by writing CE for Q we can replace Qh_o by its equivalent, Ch_oE. Now the maximum voltage which may be applied between the capacity area and earth is limited by such considerations as the failure of the insulators and the ionisation loss around the wires. This voltage is substantially independent of the capacity C and the elevation h_o, although the limiting voltage may possibly be somewhat lower for a radiator having the capacity area at a great elevation (150 metres) than for one having it at a moderate elevation owing to the greater mechanical difficulties in insulating an extended area at a great elevation.

* Abstract of a Paper in "Bulletin" No. 810 of the University of Wisconsin, Engineering Series. Vol. VIII., No. 4.

Digitized by Google

It thus follows that if two different antennæ of extended area are operated at the same voltage and frequency then the magnitudes of the electric forces—or of the magnetic forces—at the same distance from the two antennæ are proportional to the values of the (Ch) products of the two antennæ. For this reason the product Ch is called by the author the *Radiation figure of merit* of the antenna. For a capacity area of radius large compared with the elevation the radiation figure of merit of the antenna is independent of the height of the capacity area. On the other hand, if the radius is small in comparison with the height of the capacity area the radiation figure of merit is directly proportional to the elevation h. Between those extreme conditions, the figure of merit of an antenna of given area increases with the elevation of the capacity area, but at a lower rate than the first power of the elevation.

Having arrived at this result, the author proceeds briefly to consider the feasibility of mounting at a low elevation the capacity areas in wireless telegraph stations.

For the purpose of comparison, a low antenna consisting of a flat circular capacity area of radius 165 metres is assumed, this capacity area being mounted 10 metres above the ground; and as typical high antenna that of the U.S. Government wireless station at Arlington is taken.

The capacity area of the Arlington station consists of three approximately horizontal wire harps suspended at an elevation of about 150 metres. The capacity of this antenna as determined by measurement is reported to be 0·0094 mfd The antenna cannot, however, be regarded as the equivalent of a radiating area at an elevation of 150 metres and having a capacity of the above-given value, for various effects have to be allowed for, such as (1) those due to the fact that part of the capacity of 0·0094 mfd. is through the insulators to the steel towers, and (2) the fact that the 0·0094 mfd. includes the capacity due to displacement from the lower portions of the antenna tail to ground. Making allowance for these effects, the author estimates that the capacity is reduced to such an extent that the radiating power of the Arlington antenna is not in reality greater than that of a capacity area at an elevation of 150 metres and having a capacity of 0·005 mfd. The radiation figure of merit of the Arlington antenna is, therefore, estimated to be $0{\cdot}005 \times 150 = 0{\cdot}75$ mfd.-metres.

Now the capacity to earth of a low antenna consisting of a circular sheet of 165 metres radius mounted at an elevation of 60 metres is approximately 0·0125 mfd., and its figure of merit 0·75 mfd.-metres. This low-elevation radiator when operated at the same voltage and frequency as the Arlington antenna may, therefore, be expected to set up at distant points a field of the same intensity as the Arlington antenna. Moreover, from what has gone before, this sheet of 165 metres radius, if mounted at a height of 5 or 10 metres above the ground, will set up the same field as if mounted at the height of 60 metres.

The effect of mounting the capacity area at the lower elevation of 10 metres is to increase its capacity to 0·075 mfd. Now this is only 40 per cent. less than the capacity of the compressed air condensers used in the primary oscillation circuit of the Arlington station; and since the low antenna can quite easily be insulated for operating voltages far in excess of the voltages usually applied to the condensers (30 kv. to 50 kv.) it is possible in this way, by using capacity areas at low elevations, to store in the antenna circuit more energy than is generally stored in the condensers of the primary circuits of high-power wireless stations. This makes it feasible to dispense with the coupled circuits which are at present used in spark systems of wireless telegraphy, and to obtain slightly damped oscillations from a simple oscillating circuit comprising an extended capacity area, an inductance and a spark-gap.

The constants of such an antenna mounted at 10 metres above the ground are given in Table I.

Table I.

Constants of an Antenna 10 metres in Height.	
Radius of capacity area	165 metres.
Height of capacity area	10 metres
Capacity of area to earth	0·075 mfd.
Assumed Operating Conditions.	
Voltage at moment of discharge	100 peak kilovolts.
Frequency of oscillation	80,000 cycles per sec.
For the above Voltage and Frequency.	
Energy stored	375 joules.
Power input at 1,000 sparks per second	375 kw.
Peak value of antenna current	3,800 amperes.
Critical resistance of osillatory circuit	53 ohms.
Initial rate of radiation	80 kw.
Radiation resistance	0·011 ohm.
Log. decrement per cycle due to radiation of energy	0·0013
Linear decrement per cycle due to radiation of energy	0·13 per cent.

It will be seen that the decrement due to the radiation of energy is extremely low; the decrease in the voltage or current due to radiation losses is only 0·13 of 1 per cent. per cycle. In addition to the radiation loss there are other losses which have to be taken into consideration—namely, the I^2R loss in the conductors, the ionisation losses in the air around the conductors and the losses in the spark-gap. The resistance of the conductors to the 80,000-cycle currents can readily be made less than 0·01 ohm, and the ionisation losses made negligibly small. The equivalent resistance of the spark will be of the order of 0·1 ohm (between 0·05 and 0·15 ohm). If the equivalent resistance of the spark is estimated at 0·1 ohm, the total damping resistance is 0·12 ohm. This resistance will cause a decrement of only 1·4 per cent. per cycle. The current and rate of radiation in Table I. are calculated for a peak voltage of 100 kv. This is considerably in excess of the voltages which have hitherto been used with rotary spark-gaps; and there may be some uncertainty as to the performance of a rotary spark-gap at this voltage.

The Low Antenna for Receiving Purposes.—Up to this point the author has only discussed the low antenna as a radiator of electric waves. He now deals with the question whether the effectiveness of an extended antenna as an absorber or receiver of electromagnetic energy is independent (within the limits previously stated) of its height above the ground.

Now, the resistance of a receiving station consists of (1) the useful resistance R_1—that is, the equivalent resistance of the devices which consume a part of the received energy and are actuated thereby; (2) the unavoidable ohmic resistance R_2 of the antenna conductors and ground connections; (3) the radiation resistance R_3 of the antenna.

The value of (2) can be made smaller than that of (3), and, of two stations operating at the same frequency, the station having the higher resistance would, in general, have the higher value of (2) resistance. The radiation resistance R_3 is obtained from the expression $R_3 = 160\pi^2 h_1^2 f^2/s^2$ ohms, and is, therefore, proportional to the square of the height of the capacity area.

The author then compares the ultimate values to which the current and voltage build up, and the rate at which they build up to these values, in two receiving stations in which the only resistance is that formed of items (2) and (3) already mentioned. Station A is supposed to have the capacity area mounted at a height h_1 and station B at the height nh_1, the antenna being of the same area in the two stations. The constants of the two circuits will then be as shown in Table II.

Table II.—*Relative Constants of Low and High Antennæ.*

	Station A.		Station B.
Height of capacity area	h_1	.....	nh_1
Induced voltage	E	.....	nE
Capacity	C	.....	C/n
Inductance	L	.....	nL
Radiation resistance	R	.....	n^2R
Final current (peak)	E/R	.....	E/nR
Final condenser voltage (peak)	$E/RC\omega$	.....	$E/RC\omega$
Final energy stored, $\frac{1}{2}LI^2$	$LE^2/2R^2$	.....	$LE^2/2nR^2$
or $\frac{1}{2}CE^2$	$E^2/2R^2C\omega^2$	.....	$E^2/2R^2nC\omega^2$
Final rate of radiation	E^2/R	.....	E^2/R
Time constant	$2L/R$	.....	$2L/nR$

It is seen that the receiving properties of the two antennæ correspond with their respective radiating properties. The current in the low antenna builds up to n times the current in the high; both build up to the same condenser voltage, therefore the low antenna stores n times as much energy as the high, and has a time constant n times as long as that of the high antenna. The final rate of radiation is the same for both stations; that is, both antennæ ultimately abstract energy at the same rate from the passing electromagnetic waves, but the high antenna abstracts energy as a greater rate during the initial stages (first few swings) of the oscillation. The high antenna will, therefore, respond much more readily to highly damped waves than will the low antenna. This means, of course, that when receiving undamped or slightly damped waves the high antenna will be subject to greater interference from atmospheric disturbances than will the low antenna. To reduce this interference in the case of stations with high antenna additional capacity is used in the "interference preventer" circuits. In other words, the low antenna is to be regarded as the equivalent of a high antenna and "interference preventer" combined.

If, now, the two stations under comparison contain receiving devices, the maximum amount of power is expended in these devices if the resistance R_1 of the utilising devices is made equal to the resistance R_0. With the resistance R_1 so proportioned, the final rate at which energy is abstracted from the passing waves by the antenna is half as great as it would be if the utilising devices were left out of the circuit. Of the energy so abstracted, one-half is expended in the utilising devices and one-half is re-radiated. So

Digitized by Google

that in the case of both the high and the low antenna the maximum rate at which energy can be expended in the utilising devices is approximately equal to one-quarter of the final rate of radiation with the utilising devices cut out of the circuit. And since this rate of radiation is, as previously shown, the same for stations A and B, the conclusions already drawn as to the relative receiving properties of the two stations are not altered by the insertion of utilising devices with properly proportioned resistances.

If the station whose constants are given in Table I. is used to emit damped waves, and if a similar station is employed for receiving, then the maximum amount of power will be expended in the utilising devices if their equivalent resistance is approximately 0·02 ohm. With such a resistance, and with a distance of 5,000 km. between the two stations and no absorption losses in transmission, the computed final values of the power received, current, &c., at the receiving station are as given in Table III.

Table III.—*Computed Value of Received Power with Similar Sending and Receiving Stations.*

Height of capacity areas	10 metres.
Capacity of antenna to earth	0·075 mfd.
Distance between stations	5,000 km.
Assumed Sending Conditions :	
Voltage	100 peak kv.
Current	3,800 peak amps.
Frequency	80,000 cycles per sec.
Rate of radiation	80 kw.
Receiving Station :	
Radiation plus wire and earth resistance	0·02 ohm.
Resistance of utilising devices	0·02 ohm.
Induced voltage	0·0076 peak volts.
Final condenser voltage	5·0 peak volts.
Final current	0·19 peak amps.
Final expenditure in utilising devices	0·00035 watt.
Inductance	53 microhenrys.
Time constant	0·0026 second.
Time constant	210 cycles.

In conclusion, the advantages or merits of low *versus* high antennæ for high power stations are briefly contrasted as shown below:—

Low antenna.	High antenna.
Lower first cost (except where cost of land per acre is very high).	Smaller antenna current. This may be of considerable advantage where are generators or high-frequency alternators are used.
Power condensers are unnecessary.	A smaller number of insulators will be required; less likelihood of interruption due to insulator failures.
Single frequency of oscillation.	
Apparently possible to obtain a smaller decrement than where power condensers are necessary.	
Less likelihood of damage by lightning.	
Probably less interference by "atmospherics."	

FLUORESCENCE AND PHOSPHORESCENCE AND THEIR USE TO PRODUCE LUMINOUS EFFECTS.

A discussion on the above subject took place at the last meeting of the Illuminating Engineering Society on Feb. 22, the Chair being taken by Mr. F. J. Cheshire (Director of Optical Munitions and Glassware Supply, Ministry of Munitions of War).

The discussion was opened by Mr. F. Harrison Glew, who referred to several well known examples of phosphorescence. The glow of phosphorous in the dark is due to slow oxidation and the light of the fire-fly, and of various marine forms of life, is believed to have a chemical origin. Luminous effects can also be produced by the oxidation of pyrogallic acid and various organic materials. "Luminescence" is applied generally to indicate the production of light by other agencies than heat. The above are examples of chemi-luminescence." "Tribo-luminescence" is exhibited in the luminous effects produced by rubbing certain crystals (quartz, sugar, fluorspar, &c.). When the luminous effect persists after the cessation of the stimulating force it is called "phosphorescence." Luminescence which occurs only during the period of stimulation is often called "fluorescence." Fluorescence might be excited by the action of visible or ultra-violet rays or the radiation from an X-Ray tube. According to Stokes's Law such effects involve a transformation to energy of a lower order than that of the excitant. A good instance of such degradation of energy is the fluorescence of the rhodamine reflector used with mercury vapour lamps, the red light thus produced being a transformation of the violet and ultra-violet rays from the mercury vapour.

Materials which, after exposure to daylight, continue to glow in the dark have been known for many years. Crystals of calcium sulphide phosphoresce blue, zinc sulphide green. Immediately after exposure to a strong exciting force the glow may be quite intense, but dies away very rapidly and becomes relatively feeble after a few hours. To illustrate the momentary high luminosity produced Mr. Glew exhibited a small cylinder coated with zinc sulphide. This was rotated at 10,000 revs. per minute and illuminated, on the side remote from the audience, by the light from an arc between tungsten electrodes (very rich in ultra-violet light). The side of the cylinder facing the audience appeared a vivid green, visible even when the lights in the room were turned on, and with a brightness of several foot-candles.

However the transitory quality of such effects at present limited the practical applications of phosphorescent substances. An important development was the production of so-called "self-luminous" paints, which consisted of zinc sulphide with a small admixture of radio-active constituents. Fluorescence was excited by the alpha rays emitted by the radium. As radium only wastes away at a rate which would diminish the intensity of these rays to half in 1,000 years the brightness would remain practically constant but for the deterioration of the zinc sulphide and the gradual darkening of the enclosing glass or the varnish used with it. The actual luminosity attained is roughly proportional to the amount of radio-active material used, but the desirable brightness is limited by considerations of expense and by the fact that greater bombardment leads to rapid deterioration of the zinc sulphide. A diminution in brightness of 50 per cent. in the course of one year is not unusual, but in one sample containing as much as 75 mgrm. of radium bromide per gramme of zinc sulphide, the brightness diminished to half in 24 hours. It is, therefore, very important to determine the order of brightness necessary for different purposes and not to exceed this value.

As regards the darkening effect of radium on glass, porcelain and similar materials, this appears to be a purely surface phenomenon. In some cases it is possible, by heating the material, to cause it to phosphoresce, this release of the stored up radium energy causing the discoloration to disappear.

Mr. J. S. Dow, who followed, emphasised the relation between the application of such feebly luminous substances and the behaviour of the eye at weak illumination. In some cases the phosphorescent material could only be seen with a dark-adapted eye, and, when the glow had reached its feebler stage, only by averted vision. Owing to the chromatic aberration of the eye a disc of calcium sulphide, giving blue and violet light, appeared to "spread" and its edges became indistinct at a distance of a few feet; the same was true, in a less degree, of zinc sulphide. While, therefore, the light from such substances was useful for near work—for example, the green light from luminescent zinc sulphide was good for painting dials, &c.—it was less satisfactory for distant conditions where it would be useful if a moderately strong yellow or orange phosphorescence could be produced.

The phosphorescence of "luminous buttons" made of calcium sulphide and excited by any ordinary means wore off rapidly; he had found that an hour after close exposure to a 50-watt lamp a button 1½ inches in diameter could only be just seen by oblique vision from across the room. The ordinary illumination in the corners of a room was hardly sufficient to excite a useful brightness in zinc or calcium sulphide and at present the application of these substances for coating switches indoors was therefore limited. It had been suggested that the cost of using self-luminous paint for the purpose was not prohibitive, but at present there were more urgent uses for such material.

Ordinary luminous paint (not self-luminous) might have useful applications for coating large areas, in very dark places where there was practically no artificial light, if available in larger quantity. As regards the self-luminous paints he had found that freshly prepared 0·2 material had a brightness of the same order as a white surface illuminated by full moonlight (about 0·02 ft.-candles).

Mr. A. Blok explained some of the physiological difficulties which were inherent in the photometry of luminous paints. Relative results could be obtained with care, though in the case of small samples much patience was needed; absolute data could only be stated very approximately, owing to the peculiar colour and low luminosity. Mr. Blok described several photometric methods, involving the comparison of luminescing zinc sulphide with the light of a glow lamp shielded by signal green glass. In one method the luminous material was viewed as a luminous island with the surface illuminated through the green-screened glow lamp as a background. In another, devised by Mr. Clinton and Mr. Dow in association with him, the sample was viewed through a small aperture in a white screen inclined at 45° to the direction from which light from the glow lamp was received.

In view of the value of such photometric methods in obtaining life-tests and in determining in the laboratory the effect of small changes in

Digitized by Google

composition of self-luminous paints their more general application might have important results.

Mr. C. C. Paterson described the method of testing self-luminous compounds used at the National Physical Laboratory. In judging dials the painted dial was placed midway between two metal stencils, which were duplicates of the dial tested and had figures of the same size cut in them. Behind these two comparison dials was a translucent material which received light from a glow lamp screened with green glass. The light from the glow lamp was adjusted until the cut figures, illuminated from behind, appeared as bright as the corresponding painted figures on the centre dial. At the National Physical Laboratory they were also using an apparatus involving a small aperture in the photometric screen, substantially the same as that described by Mr. Blok.

Mr. A. J. Landau showed a series of experiments illustrating the excitation of fluorescence in various colours by the rays from a spark between iron electrodes. A picture of a church-window in which a great variety of blended colours was excited, made a striking impression. The speaker also exhibited a 10s. note, the corners of which had been impregnated with special materials. By natural or artificial light this was indistinguishable from an ordinary untreated note, but under the rays from the iron-spark white and green fluorescence occurred. This device might be useful as a precaution against counterfeits.

The Chairman, in closing the discussion, expressed his satisfaction that this important subject was receiving the attention of the Society. The help of the scientific societies had been of very great assistance during the war in dealing with these and other elusive optical problems.

THE ROCHDALE CORPORATION GENERATING SYSTEM.

To cope with a rapidly increased demand in their area, the Rochdale Corporation have recently completed important extensions to their existing power house, bringing the total kilowatts of turbo-generating plant to 9,000. Prior to these extensions there existed three 1,000 kw. "Witton" turbo-generators driven by Howden turbines, the power being generated at 5,800 to 6,600 volts three-phase, the generating sets running at 3,000 revs. per min. The new additions take the form of two 3,000 kw. "Witton" turbo-alternators coupled to Howden turbines, the sets running at the high speed of 3,000 revs. per min. The Howden turbines are of the pure impulse type, designed to give their output of 3,000 kw. at a high efficiency with a liberal margin of overload. The casing and diaphragms are divided on the horizontal centre line, the first three stages being arranged for partial admission and the later stages for

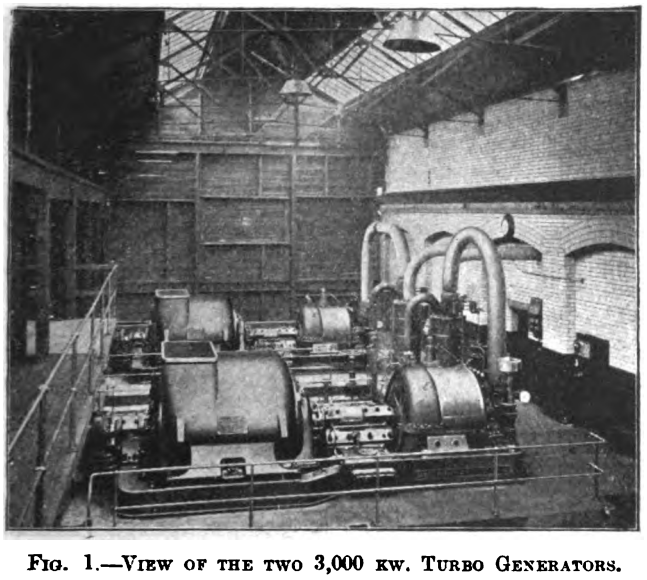


Fig. 1.—View of the two 3,000 kw. Turbo Generators.

all-round admission. The discs are constructed of special Siemens-Martin steel forgings accurately balanced. The rim of each disc is provided with an inverted T shaped slot to receive the blades and spacers, the gateway at which these are introduced being subsequently closed up by a patent process. The running clearances of the plates in both the axial and radial directions are approximately $\frac{1}{8}$ in.

As will be observed from the illustrations, continuous bedplates are provided to take the turbines and alternators. The oil tank is situated in the middle section of the bedplate, and is equipped with a cooling arrangement which maintains the oil in circulation, and also the bearings, at a very moderate temperature. A powerful governor is provided, and is driven by worm-gear from the turbine shaft. By means of an oil relay acting on the throttle valve the governor controls the speed within very close limits, approximately 1 per cent. variation from full load to no load. The "Witton" alternators are of the General Electric Co.'s latest construction, having solid steel rotors with machined slots, into which the exciting conductors are laid, the mouths of the slots being subsequently closed by metallic wedges.

In the turbo-generators, as is usual in "Witton" machines, great care has been taken of the ventilating arrangements, separate cooling draughts of air being drawn in through wet air filters by fans carried on the rotor shaft for cooling the rotor and the stator respectively. The windings are strongly braced, giving adequate protection against short-circuits. These machines are interesting samples of literal ratings, as proved by the fact that both generators are frequently run by the Corporation with a load of 4,000 kw. for 12 hours on end without showing any sign of overheating either in the stator or in the rotor.

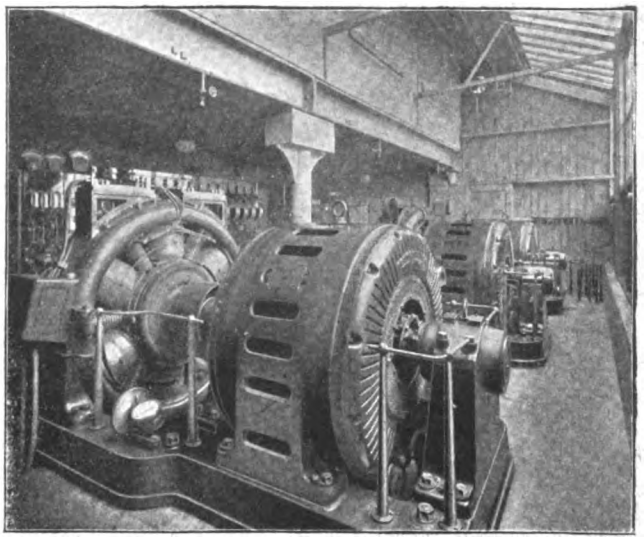


Fig. 2.—Motor Generator Sets.

The station also includes two 500-kw. motor-generators for supplying the local continuous-current requirements, the town mains being supplied at a pressure of 240-0-240 volts on the three-wire system, although the machines can be utilised to supply power to the tramway at a pressure of 500 to 550 volts through a change-over switch. These motor-generator sets are depicted in Fig. 2, and run at a speed of 500 revs. per min., the motors being of the synchronous type.

The Rochdale Corporation have a number of outlying sub-stations for supplying various works, and a typical example of these is that which furnishes the power supply for Messrs. Robinson's, the well-known wood-working machine manufacturers. This sub-station contains three "Witton" synchronous motor-generators running at a speed of 750 revs. per min. These motor-generators are to be seen in Fig. 2.

The electrical generating plant for this installation was supplied by the General Electric Co. (Ltd.), of Witton, Birmingham, Messrs. James Howden & Co., (Ltd.), of Glasgow, being the main contractors and manufacturers of the steam turbines.

We are indebted to Mr. F. H. Rudd, A.M.I.E.E., the acting borough electrical engineer, for permission to take the photographs and to publish this description.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from The Electrician Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

The "Metal Industry" Handbook and Directory, No. 6, 1917. (London: Louis Cassier Co., Ltd.)

"Year Book of the American Institute of Electrical Engineers," 1917, New York: The American Institute of Electrical Engineers.)

"Manual of Reinforced Concrete," by Charles F. Marsh, M.Inst.C.E., and William Dunn, F.R.I.B.A. 3rd edition. (London: Constable & Co., Ltd.) Pp. xvi.+475. 10s. 6d. net.

"Atoms," by Jean Perrin. Authorised translation from the fourth revised edition by D. Ll. Hammick. (London: Constable & Co., Ltd.) Pp. xiv.+211. 6s. net.

"The Principles of Electric Wave Telegraphy and Telephony," by Dr. J. A. Fleming, F.R.S. (London: Longmans, Green & Co.) Pp. xvi.+911. 30s. net. 3rd edition.

Digitized by Google

The Electrician.
FRIDAY, APRIL 6th, 1917.
Editorial and Publishing Offices:—
1, 2 & 3, SALISBURY COURT, FLEET STREET, LONDON, E.C. 4.
Telephone: City 4698-9. *Telegrams:* "Electrician Newspaper London."

SPECIAL NOTICE.

Last week's number of "THE ELECTRICIAN" completed Vol. LXXVIII. With next week's number will be issued the Index to the Volume.

THE EDUCATION OF APPRENTICES.

Employers of labour and others are paying a good deal of attention to the question of training of apprentices and of those who are qualifying for higher appointments in the works. It is well that it should be so. Not without regret many have witnessed the passing of the old apprenticeship system. So highly developed have workshop processes become, and so largely does the machine now do the work which at one time was done by skilled craftsmen, that there is no excuse for an employer paying youngsters low rates of wages on the ground that the said youngsters are being taught their trades. The fact that there has been a very considerable increase in the number of well-paid engineering artisans during the past 15 months indicates that anyone of normal intelligence, with little or no preliminary training, can be profitably employed in the engineering and allied trades on work which, prior to the war, was thought to call for a degree of skill only to be acquired by years of practice.

It is for employers of labour to determine what inducements will have to be offered to boys and, we hope, girls to persuade them to engage in the artisan side of engineering and to work for a low wage. Of the many possible inducements, in our opinion among the most attractive are shorter hours of employment, frequent changes of occupation and a broad scheme of education. All these form part of the bigger subject of welfare work. It is only intended to deal briefly with the question of education and to hold over for the time being a consideration of the other two inducements.

There are those who would make it compulsory for employers to give their young employés facilities during shop hours for acquiring what many call technical education. In the past such technical education has, for the most part, consisted of a heterogeneous mass of subjects such as electrical engineering, machine drawing, *practical* mathematics, mechanics and the like. To teach such subjects as these to the rising generation of engineering artisans is waste of time in probably nine cases out of ten, for not more than 10 per cent. of our engineering artisans will ever have any occasion to use such knowledge in their work. Were it in our power so to do we would make it illegal for well-meaning though badly advised employers and education committees to engage in any such schemes. As it is we protest against the expenditure of public money on schemes which cannot by any chance bring about a successful result.

Assuming that the boy who desires to become an "engineer" leaves school at, say, 14 years of age. Notwithstanding all arguments to the contrary, we are convinced that this is a good age for a boy to leave school. He enters the works of a broad-minded employer who believes in the eight-hour day and who is anxious to do his best for the boy. There are many such employers waiting for a lead. They realise that since most boys and girls have to leave school at an early age and therefore at a time when they know very little about anything, these juveniles must, under existing conditions, become ignorant men and women having pride in nothing they do and incapable of understanding the things which are going on around them. To guard against this, which, we would say, is not the peculiar characteristic of those having to leave school at an age when the children of the well-to-do are just beginning their schooling, the enlightened employer decides that the youngsters whom he employs shall be trained. Being a humane man he recognises that a boy cannot be expected to fill the unforgiving minute for him for 48 hours per week, and attend the night school afterwards, as well as get 10 hours' rest to be ready for the next day's work, so he decides that the boys working for him shall be taught the things which matter during shop hours.

From experience the employer knows that the average boy deliberately wastes several hours per day, besides making himself a nuisance to the men in the shop. He arranges, therefore, to cut down the time actually spent in the works by slightly less than one-third, or, say, 15 hours per week. During these 15 hours, which correspond to three hours per day, classes are held and attendance is compulsory. To begin with the subjects taught have no direct bearing on engineering. They form a continuation of some of the subjects taught in the elementary schools and, in addition, particular emphasis is placed on the English language and on the duty of man to his neighbour and to himself. As the training advances an attempt is made to teach the principles of government. Certain of the boys are taken by their instructor to the meetings of the local council and to the police court. Permission is sought to visit the workhouse in order to show how the poor laws are administered.

The employer endeavours to have the boy so trained that he can think things out for himself. Social problems, politics and economics are discussed on non-party lines. Questions relating to home and foreign trade are introduced; good books are read; emphasis is given to the principal events in the history of their own country (at the elementary school they have learned as much as is good for them to know about the kings and queens), and some of the stirring passages in the history of other countries are dealt with. Morning, noon and night, year after year, the lesson is taught that of all the things man can turn his hand to, noble fruitful labour is the greatest.

The young fellows now approaching 18 years of age, begin to realise that by working alone they can accomplish nothing, and that co-operation enables them to live. Their instructor, who was at first little better than a policeman in the classroom, is now their friend, and he drives home the moral of the pinmaker, with utmost industry, making 20 pins per day, and of the 10 pinmakers working in concert making upwards of 48,000 pins per day. He now begins to teach something of the trade on which they are engaged, dealing with each item and giving examples of the practice of other countries.

As yet none of the boys have been allowed to attend technical classes. The attempt has been made to teach them how to think, and to teach them the things likely to be most useful to 90 per cent. of them, at an age when they learn most easily. It were surely better to do this than endeavour to teach so-called engineering and science to those who write their own names with difficulty, and whose knowledge of mathematics is limited to the making of mistakes in arithmetic. After such a course it will probably pay to allow one boy in 10 to attend full-time day classes at a technical college, and in many cases it will be found that those likely to benefit are not the most useful craftsmen.

By the time they reach 18 years of age most of the boys will know whether they are likely to make headway in the trade at which they have been working part time for four years. If there are good reasons for believing that a boy has been unfortunate in his choice of a trade it should be

Digitized by Google

possible for him to change, and in no case would a boy be the worse for having spent a number of years in the works before starting on another line of business.

Elsewhere will be found an article by Mr. F. M. Denton, in which particulars are given of Sir A. Trevor Dawson's proposed scheme for the training of engineers. In this scheme boys enter the works at 14 years of age, and spend half the time in the shops and half the time in the class room, the boys working in pairs to simplify the management of the works. Like Sir Trevor, we believe that such a scheme would work a revolution in the engineering industries, and would put them into a position to face the severest competition that can arise. Few men have better opportunities than he of putting such a scheme to the test and of making it a success.

We look forward to the time when the evening schools, which Mr. Denton rightly calls sweating factories, will be either closed or burnt down. There are few things, says Mr. Denton, so sad and so brave in our country to-day as the efforts of the thousands of boys who struggle on from year to year, often sleepless, foodless and restless; crowding into each long day, already filled with manual labour, three hours of mental effort. As one of the boys referred to, and as a teacher of such boys for over 20 years, we know a little about the sadness and difficulty of acquiring an engineering training in this barbaric country which many of us call home.

REVIEWS.

Eight Lectures on Theoretical Physics. By Max Planck. Translated by A. P. Wills. (New York: Columbia University Press.) Pp. ix.+130. $1.

In 1909 Prof. Planck delivered a course of lectures at Columbia University on "The Present System of Theoretical Physics." These lectures, duly published in Berlin in 1909, have now been translated into English by Prof. Wills. The author's deservedly high standing in the world of physics and mathematics make his criticisms well worth studying, and several of his suggestions will be found most helpful. To the English reader (the reviewer does not include those who dwell north of the Tweed), however, the elaborate philosphical investigations will not prove inviting, and he will find difficulty in following the mathematical reasoning in several places.

In the first lecture when discussing "reversibility and irreversibility," the author points out that in the early days the fundamental ideas of physics were taken from the sense perceptions of man. Nowadays the sense perceptions are almost excluded from physics. For example, tone in acoustics and colour in optics are now defined by a vibration number or wave-length, and temperature in the theory of heat is defined by the volume change of a thermometric substance or by a scale based on the second law of thermodynamics. It will be noticed that the sense perceptions of sound, light and heat are not used in these definitions.

It is sometimes stated that the importance of the second law lies in the fact that water flows down hill, electricity flows from a point of higher to a point of lower potential, &c. This is quite erroneous. Water can flow upwards, as in a spring, and electricity sometimes flows from points of lower to points of higher potential, as, for instance, during the oscillatory discharge of a condenser.

Planck bases the second law of thermodynamics on the fact that it is impossible to construct a motor which only involves the raising of a load, and the cooling of a reservoir. The second law is that there are processes in nature which in no possible way can be made completely reversible. In these cases the entropy of the system tends continually to increase. With each irreversible process the world takes a step forward the traces of which can never be obliterated. Planck believes that in the physics of the future the first and most important division of all physical processes will be into reversible and irreversible.

In the second lecture the thermodynamic states of equilibrium in dilute solutions are discussed, and a well-merited tribute of praise is given to the work of John Willard Gibbs. The atomic theory of matter is next described, and a clear description of the modern theory is given, stress being laid on the assumptions made in proving the usual formulæ. The calculation made of the entropy of an ideal monatomic gas is an excellent illustration of the value of mathematics in physical investigations. It is rightly pointed out that when we pass from stable atoms to the unstable atoms of radioactive substances we can no longer employ the kinetic theory of gases. In the fifth and sixth lectures the electrodynamical and the statistical theories of heat radiation are discussed. The theorems in heat radiation are well known, and it is most valuable to have this simple exposition of them by their author. So rapidly, however, has the theory of heat radiation developed in recent years that the author's treatment must now be seriously modified.

In the last two lectures the principles of least action and the principles of relativity are discussed. By applying the principle of least action the author deduces the Maxwellian field equations. This is a notable advance in the theory of an atomic ether. Having completely eliminated the ether the principle of relativity is then framed as a basis for investigation. With the exception of a few misprints, J. J. Thompson for J. J. Thomson, Galilee for Galileo, &c., the printing has been well done, and investigators will find the broad margins useful for notes.

A. Russell.

A Manual of Practical Physics. By H. E. Hadley, B.Sc. (London: Macmillan & Co.) Pp. viii.+265. Price 3s.

This work has been written with a view to the requirements of candidates for the pass intermediate examinations of the various British universities, and although the reasonable size and moderate price do not allow it to be claimed that the book is quite exhaustive as far as such examinations are concerned, yet the student who has performed the experiments described and who understands the principles taught by them should be able to undertake any ordinary practical exercises in elementary physics.

The volume is divided into 18 chapters, grouped into six sections dealing with General Physics (96 pp.), Heat (47 pp.), Light (28 pp.), Magnetism (12 pp.), Static Electricity (16 pp.) and Voltaic Electricity (35 pp.) respectively. In all, 166 experiments are described, illustrated by 153 diagrams and graphs, which are exceptionally clear and instructive. It may not be necessary for those students of intermediate standard who have already taken a preliminary course in physics to carry out all the above experiments, as a number of exercises dealing with the more elementary measurements are included in order to make the course described complete in itself. Some of the experiments are preceded by a brief reference to the theory, where experience has taught that a special danger exists that the practical work may be approached with ill-defined notions of the principles involved.

As a guidance to the style of recording observations, a number of the experiments are followed by tabulated data and deductions obtained in actual laboratory work.

The apparatus required for the performance of the experiments described in the course is generally of the simplest possible character, and is such as would be found in any laboratory; indeed, a considerable amount of it could readily be put together by a student of ordinary ability.

At the end of the volume is given a collection of 138 numerical and experimental exercises, many of which are taken from examination papers. Answers to the numerical questions are included, and the practical exercises will serve as a test whether the student clearly understands the principles taught in the text.

Tables of standard wire gauge and of maximum pressures of water vapour, and a very useful and complete index, conclude a volume which may be thoroughly recommended as a great assistance to those students for whom the course has been prepared.

B. W. C.

Digitized by Google

SINGLE-PHASE POWER PRODUCTION.*

BY E. F. W. ALEXANDERSON AND G. H. HILL.

Summary.—It is pointed out that the production of single-phase power should not interfere with the general scheme of centralisation of power, and means are suggested for producing single-phase power without limiting the usefulness of the station. Both the mode of operation and the theory of phase converters are discussed with reference to their adaptability for producing single-phase power from polyphase circuits.

In view of the universal use by power companies of polyphase generation and transmission of electric power for general purposes, the production and delivery of single-phase power must be considered as a special problem. The ideas of consolidation and co-operation and standardisation of electrical supply have recently been given serious attention.

Differences in voltage cannot be avoided, but to equalise this does not entail great loss of efficiency or undesirable features.

Differences in frequency are more serious, and the decision as to the most desirable frequency for general use has resulted in adopting a variety of frequencies in different localities. We (in the U.S.A.) now look upon 60 cycles as standard. There are, however, many excellent systems and stations using 25-cycle power, and the reasons for adopting 25 cycles were good and sufficient when they were established. Yet they could be duplicated to-day with 60-cycle apparatus for less than the original cost, and with a distinct gain in general economic usefulness and value.

Single-phase power may be obtained by—

1. Separate generating and distribution systems for single-phase and polyphase load.
2. Polyphase generation and distribution of single-phase load between the phases so that in effect the load becomes a polyphase load.
3. Polyphase generation and transmission with motor-generator sets at sub-stations.
4. Mixed single-phase and polyphase load furnished by the same distribution system in combination with methods for correcting the unbalancing effect of the single-phase load.

The first method comes under the head of special and abnormal development. It has the further disadvantage, as regards the generator, of increased size, weight and lower efficiency as compared with polyphase generators. Single-phase generators have been built only for 25 cycles or lower, and to a limited extent for special purposes. This method seems to offer the least promise of general usefulness.

The second method has the advantage of the polyphase alternator. It is generally used for incandescent lighting distribution and for power and heating where the unit of energy capacity is small and adapted to division between the phases, so as to result in very little, if any, unbalancing. It has been proposed and used to a limited extent for heavy single-phase loads, but the difficulty of preserving even an approximate balance between phases makes this method insufficient for large power requirements. It has the further disadvantage of requiring generators of the same frequency as that which the load demands.

The third method has the advantage of entire freedom as to generator and transmission, and permits a single-phase load of any frequency or power-factor to be drawn from any standard polyphase system without disturbing the balance or regulation. It provides means, moreover, of improving the power factor of the system by synchronous motors, and from the power system standpoint is the most desirable of all methods when large unit amounts of single-phase power are demanded. It is the only method of producing low frequency single-phase power from a 60-cycle system. The only objection that is made to this method is the cost of motor-generator sets and the cost of attendance.

The first cost of equipment, it is true, is greater than static transformers alone, but this is balanced to some degree by lower costs at the power station and in the transmission line. The cost of attendance is frequently made negligible by so locating the sub-stations that the attendant may have other duties, and by introducing automatic devices to start and switch the motor and generator.

This disadvantage, moreover, largely disappears when, as usually happens, a system of single-phase generation is connected to other systems through motor-generator sets for interchange of power.

No. 4 is in general respects the same as No. 2, with the addition of a relatively new development known as the "phase converter," which preserves the balance of the system even when large blocks of single-phase power are taken from the system. Its use greatly extends the possibility of connecting single-phase loads directly to a polyphase system, provided the frequency does not have to be changed.

* Abstract of a Paper read before the American Institute of Electrical Engineers.

Theory of Phase Conversion.

The earliest known form of phase conversion is splitting the phase by induction and capacity. In this case the energy of one phase is stored for a fraction of a cycle and released again so as to make the same energy active in another phase. All methods of phase conversion, therefore, involve the storage of energy, even the phase conversion of wattless currents.

The method of storing energy in inductances and condensers is very convenient for high-frequency currents, but has not up to the present found much practical application for low-frequency power current. There is, therefore, for phase conversion on a large scale, only one type of apparatus that can be considered, namely, a rotating machine which stores the energy in the mechanical inertia of the rotor.

The following three methods of looking at the problem may be helpful :—

1. Phase Converter Considered as a Motor-Generator.

The phase converter is built as a quarter-phase induction motor or synchronous motor with a squirrel-cage; one phase is a motor phase and the other phase is a generator phase. The input of the motor phase is equal to the output from the generator phase, not only in the average value of the power flow, but in the instantaneous value of energy flow which is delivered and returned during the same half cycle. The only difference between the energy flow in the two phase windings of the converter is that the momentary values of current, volts and energy are delayed ¼ cycle in one winding in relation to the other. The squirrel-cage is the medium for the transfer of energy, and the mechanical mass of the rotor provides the energy storage. Various means can be provided for producing the desired energy flow, and will lead to different types of phase converters. Broadly, the result of these means must be the desired flow of currents through the windings, and, therefore, the means must consist in providing the necessary E.M.F.s to cause these currents to flow through the windings.

One method is to use an auxiliary generator which impresses the desired E.M.F. on the windings. Another method is to connect the windings of the converter with reference to the source of power and the load in such a way that the E.M.F.s are furnished automatically by the source of power.

The first method leads to the phase converter connected in shunt to the line and is the type that has been adopted in the phase balancer stations of the Philadelphia Electric Company; this type may be referred to as the shunt converter. The function of the shunt converter is to transfer energy from one phase to another in a polyphase system so as to neutralise the effect of single-phase load drawn from the same system in another place. The second method of producing the desired flow of current in the system leads to the series converter. In this type of converter the single-phase circuit is in series with one phase of the converter. The function of the series converter is not to correct for a single phase load that has been placed on a polyphase line, but to change the single-phase load into a polyphase load before it is connected to the line.

2. The Phase Converter Considered as a Polyphase Generator.

This second point of view is more artificial than the first, but is more helpful in analysing the function of the phase converter. A single-phase current can be considered as resolved into two polyphase components with opposite phase rotation. One of these polyphase components has the same phase rotation as the power system, and constitutes a legitimate load on the power system. The other component, which has the opposite phase rotation, is the one that causes the unbalancing of voltage, heating of generators and motors connected to the system, &c. The function of the phase converter is to neutralise this component of the single-phase load which has opposite phase rotation. From these considerations it becomes evident how the phase balancing can be accomplished. This function consists in providing a machine which feeds into the system a polyphase current which has opposite phase rotation to the system, and is equal and opposite to the component of the single-phase load we wish to neutralise. It is now evident how the phase balancer ought to be constructed. The converter should be a polyphase machine, not necessarily synchronous, but preferably so in

Digitized by Google

order not to draw lagging current from the system, and means are to be provided for forcing a current to flow through the windings of the phase machine which has opposite phase rotation to the system. The currents of opposite phase rotation are to be regulated in magnitude and phase corresponding to the single-phase load. One convenient way of producing such adjustable polyphase currents is to provide a polyphase generator with its field controlled by suitable regulators. These considerations lead to the design of the shunt converter with direct connected balancer and regulators, such as used by the Philadelphia Electric Company. The set consists of a main converter and an auxiliary balancing machine which is controlled by automatic regulators. The main converter is mechanically connected to a generator which is called a balancer. The function of this balancer is to circulate polyphase currents of the desired phase and magnitude in the windings of the converter. This auxiliary generator is small compared to the converter because its output is used only to overcome the losses and inductive drop in the windings of the main converter.

3. The Phase Converter Considered as a Transformer.

This point of view is also more artificial than the first one, but it is helpful in understanding and analysing the functions of the series converter. The two stator windings of the phase converter are considered as the primary and secondary of a transformer. The squirrel-cage rotor is a medium for transferring the current from the primary to the secondary, and the characteristics of the phase converter as a transformer differs from the ordinary transformer only by the fact that the time phase of the secondary is ¼ cycle from the time phase of the primary. This displacement of time phase is due to the time required for the squirrel-cage to rotate through the angle corresponding to the location of the primary and secondary windings of the stator. The function of the series converter is easiest explained in connection with a quarter-phase system, but it is obvious that it can be used in a three-phase system by the use of a Scott transformer connection. The object in the use of the converter is to distribute the single-phase load equally in the two phases of the quarter-phase system. The ratio of current transformation is for all practical purposes constant at all loads at which the transformer can be used. The voltage drop on the secondary side is the sum of the impedance drop in the primary and secondary winding. In the case of the phase converter the impedance drop includes the drop in the squirrel-cage, which is the transfer medium. The change of a single-phase load into polyphase load is automatic and results in a *perfect distribution of current in the two phases at all loads.* The voltage delivered to the single-phase circuit has a slight drop with increasing load, and has characteristics with reference to current and power-factor as would be obtained by placing an impedance in series with the single-phase circuit equal to the impedance of the windings of the converter.

Applications of Phase Converter.

In regard to efficiency and size the phase converter can be considered as being in the same class as the synchronous condenser. The fact that the machines can be designed so that they are useful as synchronous condensers and phase converters simultaneously is worth consideration in the application of the methods of phase conversion, as several methods of application are possible. In the first place, it is possible to place the phase converters either in the power house or at any desired place of the distribution system. Synchronous condensers may be needed on distribution systems for the sake of counteracting low power-factor, and such synchronous condensers can if desired be designed so that they can in addition be used as phase balancers in order to make it possible to draw single-phase load from the same system. If, on the other hand, the main load is synchronous converters with unity or leading power-factor it may be more practical to locate the phase balancers in the power stations. The single-phase load is usually of low power factor and the lagging current of the single-phase system may be furnished either to the single-phase distribution system by single-phase synchronous condensers or may be furnished in the power house by polyphase machinery after the whole k.v.a. of the single-phase load has been converted to polyphase. In the latter case the phase converter can be used for power-factor correction as well as phase conversion, but it must then be large enough to convert the whole single-phase k.v.a. at a low power-factor and furnish polyphase current to correct for this power-factor; whereas in the other case where the single-phase power-factor is corrected for by synchronous condensers the phase converter needs to convert only the power component of the single-phase load. The choice between these methods of conversion will depend upon local conditions of expediency.

The shunt converter is of particular value in those cases where it is expected that single-phase load may be drawn from different phases of a polyphase system. In such cases unbalancing of the single-phase load will be partly neutralised, and it will be necessary to convert only the difference between the single-phase loads. There are, on the other hand, cases where the series phase converter can be used to best advantage. These are cases where it is desired to convert the single-phase load at the point where it is connected to the polyphase system. The series converter here has the advantage of simplicity, as the arrangement is automatic and no auxiliary generator or voltage regulator is needed. In cases where a single electric welding machine or a single arc furnace is to be fed from a polyphase system the series converter should be recommended.

The methods that may be employed in order to equip a power system so that it can take on mixed single-phase and polyphase load can be classified in the following groups:—

(*a*) The use of standard polyphase generators and phase converters for correcting the unbalanced load The phase converters may be placed either in the power station or substations and may be:—

1. Shunt converters, or
2. Series converters.

(*b*) The use of special generators with squirrel-cage windings adapted for mixed single-phase and polyphase load, and an equipment of automatic apparatus to prevent the unbalancing of voltage that the single-phase load tends to produce.

(*c*) The use of standard polyphase generators and special single-phase generators connected to the same busbars with automatic means for regulating the governors and fields of the single-phase generators so that they will absorb the entire unbalancing of the current.

The choice between these three methods of balancing a power system with mixed load will depend upon local conditions and expedience. All three methods have the advantage of avoiding duplication of the transformation and distribution system. The first method involving the use of the phase converter introduces the least change in standard polyphase power systems and is adapted for cases where the polyphase load is predominant. The second method is adapted for cases where the single-phase load is predominant, and has the merit of making all the generating units available for both single and polyphase power, as the system may demand. It is thus adaptable to growth and changes in the system, to preservation of good load factor and interconnection with other power systems. The third method does not offer any particular advantages over the two others but is mentioned for the sake of completeness. Its use might be considered in cases where single-phase and polyphase generators are already in use in the same power house, and it is desired to use the polyphase distribution system for taking on single-phase load. The efficiency of all three methods may be said as a whole to be on a par. In specific cases some slight advantage may be figured out for each of the systems, but the determining factors will not be so much the inherent efficiency of the electrical apparatus as the difference in load factors and the influence of load factors on steam economy.

Japanese Foreign Electrical and Allied Trades.—Statistics have recently been published of the foreign trade of Japan during 1914 and 1915 in electrical and allied goods imported from different countries. Of a total of £1,226,500 of such goods imported to Japan in 1914, this country contributed goods worth £317,800. In 1915 the total imports were £899,100, of which £231,500 were made in Great Britain. Before the war Germany led in electrical goods sent to Japan. In 1914 the German total was £431,300. In the following year but £23,800 were of German manufacture, while the imports from the United States were £381,700. Most of the trade referred to was in goods allied to the electrical trade. Of the purely electrical trade the total imports in 1914 were £406,300 and in 1915 they were £100,700. Britain is strong in manufactured copper, in cranes, steam engines and boilers, and storage batteries. The figures show that Germany was strong in galvanised wire, line material and poles, cable, turbines, internal combustion engines, lamps and instruments. The Americans stand first in dynamo-electric machinery and measuring instruments. The present is undoubtedly an opportunity for the United States, of which full advantage will be taken.

Digitized by Google

A LARGE ELECTRIC COOKING PLANT.

The Carron Company recently completed a large electric cooking plant of a total capacity of 332·8 kw. in a munitions factory, and although we are precluded for obvious reasons from giving full details of the installation, the following particulars of some of the plant will be of interest.

In such a plant the oven plays a prominent part in the construction of the range. Fig. 1 shows a standard oven measuring 22 in. wide by 22 in. deep by 20 in. high. These ovens are constructed of cast iron, and have porcelain enamelled steel linings throughout, being double cased and heavily lagged, whilst the usual top and bottom heaters are fitted in all of them. Each oven is also fitted with a toughened glass inspection window and thermometer as an extra, in addition to the usual internal accessories.

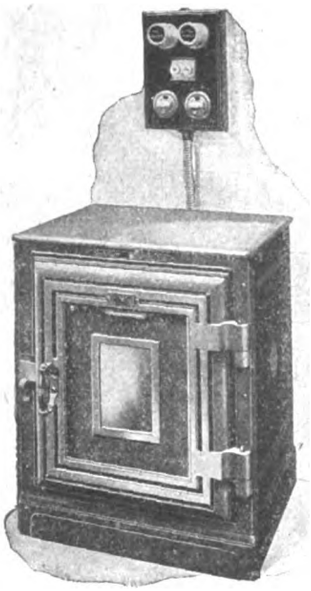


Fig. 1.—View of Standard Oven.

The ranges are usually built up of three such ovens, but sometimes of double this number, as seen in Fig. 2. The hobs on these ranges carry their standard fillings, of which there are two, each measuring 29 in. by 22½ in., and another filling under which is mounted the grill. These fillings, which are machined quite flat, each have three boiling sections, as shown in Fig. 3, of various sizes and loadings, and as the castings are very thick there is a large reservoir of heat, and the whole plate can be utilised for cooking operations, whilst, of course, the individual sections are working at a much higher temperature than the rest of the plate. We are informed that some of these have been in operation over a year for many hours at a time, with very satisfactory results. The loadings of this range are: Ovens, 5·5 kw. each; grill, 4 kw; hob fillings, 6 kw. each, making a total of 32·5 kw.

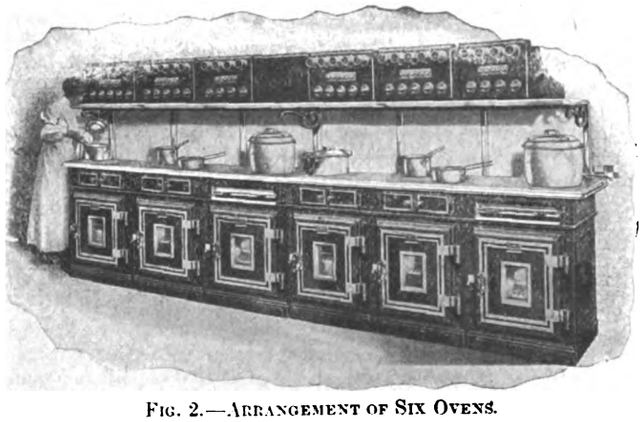


Fig. 2.—Arrangement of Six Ovens.

At the back of the hob is mounted a white porcelain enamelled splash plate, from which the brackets are fixed, carrying the switchboard which has been extended over the hob, thus making it much more convenient for the cooks to operate the switches. Each heating element is arranged for three-heat series-parallel control by means of the rotary indicating switches, which, along with the fuses and pilot lights, are mounted on the board. Also each ruby glass in the pilot lights have etched upon them the element or section corresponding to that which the switch beneath it operates. The Carron method of standard units of ovens, hob fillings, &c., lends itself admirably to extension and ready assembly on site, not overlooking the handling for transit.

There are eight hot closets, each 22 ft. overall in length, by 2 ft. 9 in. high by 2 ft. 6 in. deep. They consist of four compartments, having three divisions or shelves, all separately heated by standard interchangeable Carron elements. The linings and shelves are all of white porcelain enamelled steel sheets. Each section is rated at 5·25 kw., making a total of 21 kw. per hot closet, and the heat regulation is such that three-heat series-parallel control is obtained in each shelf. In this case the rotary indicating switches and fuses are mounted on the ends and in the centre of the equipment, the finish of which is bright stove black enamel, with hob and facings nickel-plated and polished.

The boiling table illustrated in Fig. 4 is one of five also included in the same equipment, and is designed on the same principle as the standard fillings described in the ranges, the only difference being that they are cast in one solid piece, carefully machined quite flat on the top and the element receiving surfaces underneath. These tables each measure 6 ft. long by 2ft. 6 in. high by 2 ft. deep, are arranged for seven boiling sections, which are rated at different loadings varying from 2·5 kw. to 1·2 kw., and giving a total of 17 kw. per table. All the elements are interchangeable, and are readily accessible in case of necessity. Solid 'bus bars are used for the main connections where possible, and heavy gauge nickel wire for the remainder, no loose beaded wires entering into their construction whatever. On the back of the table is mounted a 16 in. fine cast-iron skirting, and over this is mounted the control board which carries a rotary indicating switch to give three-heat series-parallel control for each section. These, along with the fuses and pilot lights, with numbered etched ruby glasses to correspond with the sections, complete the equipment of a table.

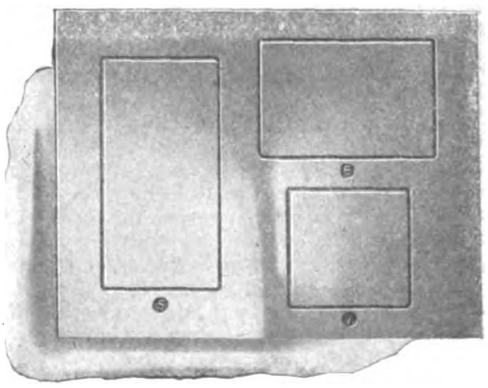


Fig. 3.—Plan View of Boiling Sections.

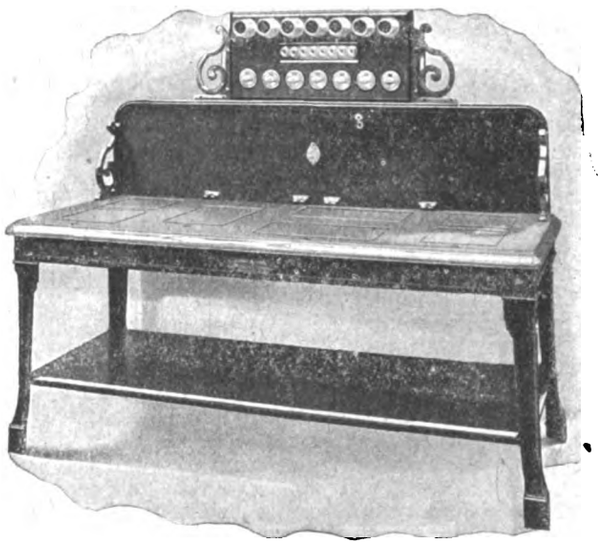


Fig. 4.—Arrangement of Boiling Table, showing Seven Boiling Sections.

There are two 6-gallon copper stock pots, each self-contained, and rated at a maximum of 5 kw. These are also wired up to the usual three-heat rotary indicating switches on a standard board.

In addition to the foregoing, a number of Carron standard independent 10 in. boiling discs are used in these kitchens, which are rated at 1·6 kw., are self-contained and have the usual heat regulation. There is also a 6 ft. hot closet similar to the larger ones, and a 3 ft. boiling table, similar to the 6 ft. illustrated, only rated at half their loading, these bringing the total loading of plant up to 332·8 kw.

The installation of this plant has been going on for over a year, and it has not yet been working at its maximum capacity, but the results so far obtained are very satisfying. We hope at some future date to be able to publish a series of interesting figures relative to this undertaking, which, when it is completed, will no doubt lead to similar developments in other factories and works now that the welfare of the employés is receiving more attention.

Digitized by Google

PROTECTION OF TRANSFORMER NEUTRALS AGAINST DESTRUCTIVE TRANSIENT DISTURBANCES.*

BY MAX H. COLLBOHM.

Summary.—The author points out the danger to which the neutral point of transformers, connected to long-distance transmission lines, are exposed through the building up of excessive potentials at this point under conditions of atmospheric lightning.

It is a well-established practice to protect the low-tension windings of a transformer through a spark gap against the excessive potentials induced upon it through capacity effects between high-tension and low-tension windings under abnormal voltage conditions on the high-voltage side. There also exists, however, a distinct danger to the high-voltage side which is not generally recognised and which cannot be guarded against by the ordinary types of arresters. This danger is evident from the following consideration :—

If during a lightning storm a discharge takes place from a cloud above a transmission line the electrostatic charge, previously induced by this cloud in equal quantities and like polarity on all three wires of a three-phase line, is suddenly set free and travels in both directions along the line. Inasmuch as for all practical purposes the three wires of the same line offer the same impedance, and as this is also true of the main power transformers on either end of the line, the speed of propagation of the released electrostatic charge, or more correctly that portion of it which has not been discharged over the insulators, is exactly alike in all three wires. Consequently, the neutral point of the transformer constitutes the reflection point for all these travelling waves. If the potential of this travelling wave after having reached the station is below the value for which the arresters have been set it will pass through the transformers, and as the charges from all three wires meet at the neutral point they build up to three times their individual potential at that place. Although the P.D. to ground of each individual charge may be below the safe electrostatic stress of the transformer winding and terminal bushing, the combined effect of the triple voltage is likely to produce disastrous results.

The writer was confronted with this condition in the operation of a system where the 66,000-volt step-down transformers showed repeatedly momentary arcing from the neutral transformer terminals to the case, a distance of 3 ft. In one instance the arc formed between the neutral lead under oil and the transformer iron.

In order to provide a discharge path for this dangerous potential a multigap arrester is to be installed at the neutral point and adjusted to discharge at 42,000 volts. A multigap arrester was chosen in place of an electrolytic arrester in order to avoid the inconvenience of providing for the necessary special arrangement and constant attendance for the regular charging of the latter.

On account of the urgent need for protection of the transformer neutral, a makeshift arrangement has been used to serve until the multigap arrester can be installed. This arrangement consists of two zinc balls 5 in. in diameter set 6 in. apart, each supported by an iron rod and connected to the neutral point and ground respectively, thus forming a relief gap for the transient excess potential. This arrangement has worked well during recent lightning storms, when discharges over this spark gap have repeatedly been observed. This proves that protection against the above-mentioned transient disturbances can be obtained by a shunted spark-gap. It is of interest to note that the spheres were originally set 12 in. apart by error, and even with this wide setting the previously mentioned discharges have been observed, indicating a P.D. of about 350,000 volts between neutral and ground.

It should be noted that the trouble occurred only on the transformer neutral in the sub-station, while no disturbances of this nature were observed in the generating station, where the metallic ground rheostat between transformer neutral and ground served to drain off these transient charges.

The danger from this source is only present in Y-connected transformers where the neutral acts as a reflection point. If delta connection is used on the high-tension side, the incoming charge divides at each corner of the delta, one-half going into one transformer and the other half going into the other transformer. The middle point of each transformer will in this case be the reflection point, but the accumulation of potential at this place will, therefore, not be greater than that of the original charge on each line wire at the transformer terminal. This statement, however, must not be taken to dispute the fact that potentials higher than that possessed by the original charge at the transformer may exist within the transformer winding, due to the piling-up of potential through reactance under high frequency or steep wave fronts. However, as experience proves that the electrostatic charges actually pass through the transformer and build up at the neutral point to destructive potentials, it appears that their wave front has become less steep, due to the impedance of the transmission line between the point of lightning discharge and the transformer station. From this consideration it would seem that lines of greater lengths should be more subject to this danger of potential rise at the neutral than those of shorter lengths, where the impedance may not be great enough to flatten out the transient wave front sufficiently to permit of its passing through the windings. In this latter case, however, danger is present from abnormal potential rises within the transformer due to reactance as mentioned before.

* Abstract of a Paper read before the Am. Inst. E. E.

DIESEL ENGINE USERS' ASSOCIATION.

At the February meeting of the Diesel Engine Users' Association a discussion took place on Mr. E. A. Evans's Paper on "Chemistry and Examination of Lubricating Oils," which had been read at the previous meeting.

A communication from Mr. T. C. THOMSEN was read, in which he referred to changes brought about by the oxidation and polymerisation of the hydro-carbons present in lubricating oils.

Mr. C. O. MILTON referred to the corrosion noted in some air compressors, which he suggested might possibly be caused by the formation of acids in compressor coils due to the "cracking" of the lubricating oil used. He quoted instances of compressors of identical design, working practically side by side and under similar conditions, wherein acid would be present in the case of one machine and not of another, the lubricant used in both being of the same brand. He asked whether the explanation might not be found in the formation from the lubricating oil of some of those unstable compounds to which Mr. Evans had referred, and, if so, what was the factor, temperature or pressure which, by attaining abnormal values in a compressor, might most conduce to the release of the same. He had noted a fact in connection with the working of an air compressor at Maidenhead which seemed to confirm this idea. The delivered air was abnormally hot, and there was strong evidence of acid formation in the coils of the higher stages. The engine was overhauled, and the opportunity was taken to fit a non-return valve on the delivery pipe. The running of the compressor was then much improved, the delivered air being quite cool, and evidence of acid formation entirely disappeared. The same brand of lubricating oil had been used throughout. He thought that it was possible that the former high temperatures were due to lack of tightness of the high-pressure valves, and that the added non-return valve has simply improved the efficiency of the delivery valves and prevented pulsating of the air at that point. It was known that leaky valves would cause or lead to overheating of the air, and that it was a difficult matter to keep compressor valves continuously tight.

Mr. GEOFFREY PORTER (President) mentioned that the decomposition or "cracking" of hydro-carbon oils under pressure at various temperatures was of great interest and importance to the Association, as the conditions required to produce the lighter oils were present in an air compressor. He would be glad if investigation could be pursued further to ascertain if any particular hydro-carbon base was more liable to favour the formation of unstable hydro-carbons during the decomposition of an oil than was another, and to determine further at what critical temperatures these unstable bodies might be formed.

CORRESPONDENCE.

DECIMAL COINAGE.

TO THE EDITORS OF THE ELECTRICIAN.

In reference to my letter of the 17th inst. which you were kind enough to print in your current issue, I have to point out that in the rule given for conversion, it is necessary first to convert the pence to the new basis of 10 to the shilling. Thus, in the example given : £3 17s. 9¼d., the pence become 7·7083 new pence and this rather unattractive amount, happily and practically is 7·70. Hence, £3 17s. 9¼d. = £7·777.

Silvertown, March 27. A. DITTMAR.

EDUCATIONAL.

Huddersfield Technical College.—The governors have decided to carry out extensions at an estimated cost of £85,000.

A department of coal-tar colour chemistry is to be established at once and the extension of the mechanical and electrical engineering, the textile and other departments is to be proceeded with after the war.

Digitized by Google

PARLIAMENTARY INTELLIGENCE.

COMPANIES (FOREIGN INTERESTS) BILL.

In the House of Lords on Thursday last, Lord Hylton moved the second reading of this Bill, the object of which is to prohibit the alteration, except with the consent of the Board of Trade, of articles of association or regulations which restrict foreign interests in companies.

Lord Wrenbury said the Bill did not go far enough. It dealt only with companies which had a share capital, whereas there were many companies which had no share capital. It applied to "foreigners," but he was not aware of any statutory definition of what a "foreigner" was; the term had no exact legal significance at all. A company included every association of persons who were bound together by some *nexus* for a common purpose, and asked what class of company the Bill was intended to cover. Was every partnership and every firm to fall within it?

The Lord Chancellor said the suggestions would receive attentive consideration when the Bill reached its next stages. The measure had reference to the case or cases where under the Trading with the Enemy Act, 1916, the Public Trustee had acquired shares which were held by or were supposed to be held for the benefit of enemy subjects, and sought to prevent those shares from going back to aliens. It had been the custom for the Public Trustee to require that the articles should provide against their going to enemy aliens, and the Bill was designed to prevent a company from making alterations which would lead to the shares getting into the hands of enemy aliens.

The Bill was read a second time.

LEGAL INTELLIGENCE.

German Telegraph Contracts Severed.

On March 29 Mr. Justice Coleridge gave judgment in the following cases:—

Eastern Extension Telegraph Co. v. Deutsch Niederlandische Telegraphen Gesellschaft and the Eastern Telegraph Co. v. same; the Eastern Telegraph Co. v. Deutsch Atlantische Telegraphen Gesellschaft, and the Europe & Azores Telegraph Co. v. the same.

On notices of motion given by plaintiff companies (British companies) asking for declaration that the several contracts and agreements existing between the plaintiff companies and the defendants (German companies) were terminated as from 11 p.m. on Aug. 4, 1914, when Great Britain declared war against Germany. No appearance was entered on behalf of any of the German companies.

Mr. Justice Coleridge gave judgment for all the plaintiffs on the terms of the notices of motion.

Liability for Accidents in Dark Streets.

At the West Riding Assizes last week Thos. Morrison sued Sheffield Corporation for damages for the loss of his left eye by reason of the neglect of the Corporation's servants.

Mr. Waugh, K.C., said that on the evening of April 20 last, as plaintiff was crossing the street, he walked into an iron tree-guard. It was intensely dark, and plaintiff's eye was gouged out.

Mr. Atkinson, K.C., contended that there was no case for the jury, for the Corporation could not be held liable for the condition of the street. In normal times the tree guards were perfectly safe, there being plenty of light to reveal their presence, and the accident was due to the removal of the light, for which his clients were not responsible. The lights were restricted by a special order of the Home Secretary.

The case was left to the jury, and after hearing evidence Mr. Justice Rowlatt asked the jury to answer two questions: (1) Was the guard dangerous in the circumstances of darkness that existed, and (2) could the Corporation, by taking reasonable measures, have neutralised the danger before the date of the accident?

The jury answered both questions in the affirmative, and awarded plaintiff £100 for loss of business, £60. 16s. 10d. for medical expenses, and £500 for the loss of the eye and pain and suffering—a total of £660. 16s. 10d.

A stay of execution was granted.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 Specifications.

13,888 Hevs. (Neuland Patents, Ltd.) Dynamo-electric machines.
Relates to a dynamo-electric machine wherein the rotating field magnet is dispensed with, and the revolving field is produced by a winding carried by either the stator or the rotor member, whereby this winding serves as a primary winding and the induced winding as a secondary winding.

14,500 Bethenod & Girardeau. Radiotelegraphy. (15/10/14.)
Comprises an oscillating circuit having a plurality of spark-gaps arranged in parallel therein, each spark-gap being connected in series with an inductance, the said inductances possessing between them as high a coefficient of mutual induction as possible, so that the charge is divided between the electrodes of the several spark-gaps.

17,615 Hay & Sullivan. Loading coils for superimposed telephone working and other purposes.

17,962 Trechmann & B.T.-H. Co. Electric switches.

1916 Specifications.

731 Marconi & Franklin. Wireless telegraph transmitters. (17/1/16.) 104,188.

732 Marconi & Entwistle. Wireless telegraph transmitters. (17/1/16.) 104,189.

2,346 Berry. Electric air purifying or conditioning apparatus (16/2/16.) 104,019.

2,347 Berry. Oil-cooled electric transformers. (16/2/16.) 104,020

2,547 Lancashire Dynamo & Motor Co. & Whitmore. Dynamo-electric machinery. (21/2/16.) 104,027

2,569 B.T.-H. Co. (G.E. Co.) Dynamo-electric machines. (21/2/16.) 104,197.
Relates to a dynamo-electric machine of the type in which a distributed winding is provided on the field magnet or stator for compensating for the armature reaction having one or more magnetic members provided with slots adapted to receive form-wound coils and another magnetic member adapted to close said slots.

2,600 Hultman. Semi-automatic telephone exchange systems. (23/2/15.) 100,113.

2,701 Mason. Ignition dynamos. (15/3/15.) 100,173.

2,745 Relay Automatic Telephone Co. & Herink. Electrical impulse responders or selectors. (23/2/16.) 104,212.

3,164 Marconi's Wireless Telegraph Co. & Ewen. Means for suspending and insulating electrical conductors. (2/3/16.) 104,228.

3,390 Waygood-Otis. (Otis Elevator Co.) Alternating-current electromagnets. (7/3/16.) 104,229.

3,474 Wijk. Overload electric switches or cut-outs. (8/3/16.) 103,733.

3,797 Salmson Mount for magneto distributors. (14/3/16.) 104,046.

3,336 Corneille & Grote. Incandescent electric lamps. (6/3/16.) 104,039.

4,430 Schulte. Tumbling machines and electroplating barrels. (25/3/16.) 104,245.

5,171 Gray & Wilkie. Elbows and like fittings for electric conduits. (7/10/16.) 104,248.

5,343 Rutherford. Electric lamp-holders. (12/4/16.) 104,070.

5,377 B.T.-H. Co. (G.E. Co.) Dynamo-electric machines. (12/4/16.) 104,250.

5,874 Switchgear & Cowans & Neep. Magnetic blow-out fuses. (25/4/16.) 104,257.

6,809 Boothroyd & Callender's Cable & Construction Co. Sealing and bonding glands for electrical junction boxes. (12/5/16.) 104,259.

8,959 Boothroyd & Callender's Cable & Construction Co. Electrical bonding boxes for use with metallic sheathed wires and the like. (26/6/16.) 104,106.

9,079 McGregor. Sparking plugs for internal combustion engines. (28/6/16.) (Cognate application, 11,099/16.) 104,107.

9,105 Simpson. Electric spark gaps. (28/6/16.) (Convention date not granted.) 100,795.

9609 Deutsche Gasluhlicht Akt.-Ges. (Auer-Ges.). Electric incandescent lamps and method of and means for producing the same. (27/9/15.) 101,622.

11,752 Crucible Steel Co. of America. Electric motor gyroscopes and means for making electrical connection therewith. (3/4/15.) (Divided application on 17,895/15.) 101,225.

12,099 Tarver. Electric dry cells. (26/8/16.) 104,298.

13,888 Rushen. (Bosch Magneto Co.) Magnetos and dynamos. (29/9/16.) 104,308.

14,068 Husebye. Method and apparatus applicable in repairng electric power transmission masts for overhead conductors. (4/10/16.) 104,131.

14,276 British Westinghouse Electric & Mfg. Co. Contacts of electric circuit interrupters. (9/10/15.) 101,796.

15,054 Anderson. Control switches for electrically-controlled apparatus for measuring liquids. (11/11/15.) 102,143.

16,065 Benjamin Electric, Ltd., & Fowler. Means for supporting electric lamps. (9/11/16.) 104,142.

16,202 Cooke. Electric contact-breakers or interrupters. (11/11/16.) 104,144.

16,861 Norrel. Apparatus for the circular grinding of the commutators of electrical machines. (24/11/16.) 104,148.

17,273 Pearson. Cells for secondary batteries. (1/12/16.) 104,320.

1917 Specifications.

249 Eastern Telegraph Co., Fraser & Appleton. Apparatus for automatically re-transmitting through successive lines telegraphic messages received from a distant station. (5/1/17.) 104,152.

314 Mason. Ignition dynamos. (15/3/15.) (Divided application on 2,701/16.) 103,300.

315 Mason. Ignition dynamos. (15/3/15.) (Divided on application 2,701/16.) 103,656.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

February 19, 1917.

2,439 B. T.-H. Co. (G. E. Co.). Temperature compensators for electric control devices.

February 20, 1917.

2,475 McLeod. Electric switches.

2,487 Peters, Hibberd & King. Electro-magnetically operated contact makers or switches.

2,488 B. T.-H. Co. (G. E. Co.) Electric motor control systems.

2,494 Simms. Armature driving spindles.

2,505 Moffett. Operation of electric or magnetic apparatus.

2,507 Hortik. Wireless telegraphy and telephony.

February 21. 1917.

2,525 Smith. Electro-magnetic levitating and transmitting apparatus.

2,558 Martin & Russell. Actuating tram points.

2,564 Benjamin Electric & Fowler. Terminal devices for electric conductors.

2,570 Pillinger & Sunderland. Automatic control of electric generating sets for ships.

2,582 Submarine Signal Co. & Evans. Electric oscillating apparatus.

2,591 Crochat. Electric driving gear for motor cars, &c. (15/12/16, France.)

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for the week:—

Officer for the Week.—Platoon Commander Hughes-Hallett.

Next for Duty.—Platoon Commander No. 1 platoon

Monday, April 9th.—Headquarters closed. Last day of Easter training at Esher. Parade Victoria, opposite No. 5 platform, 9 a.m.

Wednesday, April 11th.—Instructional class, 6.15. Platoon drill, platoon No. 2.

Thursday, April 12th.—Platoon drill, platoon Nos. 5 and 6. Signalling class. Ambulance class.

Friday, April 13th.—Technical for platoon No. 10, Regency-street. Platoon drill, platoon No. 9. Recruits' drill, 6.30.

Saturday, April 14th.—N.C.O.'s class, 2.30, under Captain Bentley and the Instructor of Musketry. Subjects: Extended order drill and musketry.

Sunday, April 15th.—Orders will be posted at headquarters.

Musketry.—For all companies, see notice at headquarters.

Note.—Unless otherwise indicated, all drills will take place at headquarters (Balderton-street, Oxford-street, W.).

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

The Effect of War on Contracts. The President of the Board of Trade has appointed a committee to consider and report on the position of British manufacturers and merchants after the war in respect of contracts entered into by them prior to the war with persons or companies in the United Kingdom or in allied or neutral countries, the fulfilment of which has been prevented or impeded by the war, and as to the measures, if any, which are necessary or desirable in this respect.

The members of the committee are Lord Buckmaster (*chairman*), Messrs. C. S. S. Guthrie, Lennox Lee, F. D. Mackinnon, K.C., Walter Raine, F. G. Rice and T. Worthington.

* * * *

Incidence of Excess Profits Tax. Many manufacturers and controlled firms are complaining of the incidence of the excess profits tax and of the treatment meted out to them by the authorities.

A good idea of the position may be gained from the statement on this point made at the recent meeting of W. T. Henley's Telegraph Works Co. The managing director (Mr. Geo. Sutton) stated that their commercial trading had nearly disappeared, and that they were making claims upon the Government in regard to depreciation and for machinery bought by them. It was matter for regret that the taxation for 1915 had not yet been settled. The Act provided that an allowance should be made against the excess profit paid by the company in respect of any machinery or plant which the company purchased for war requirements, and which the directors did not contemplate would be of any use to them when the war closed; but in their negotiations with regard to the 1915 settlement the taxing authorities suggested that certain claims which had been made on that account should be spread over a number of years. He, however, submitted that if such machinery made excess profits the first charge upon those profits should be the cost of that machinery, and that there should be no question of spreading it over a number of years. That was the directors' contention, and they would endeavour to insist on it in their negotiations with the Government. He thought the excess profits taxes were badly conceived and they were not being applied as justly as was expected when the Act was passed. He thought that the arrangement by which the company received 20 per cent. over their standard period and nothing more—except that they got some allowance, which was not fixed yet, in relation to any enlarged capital they might have—was thoroughly bad for the industries of this country.

* * * *

Rails and Scrap Iron Regulations. The Minister of Munitions has issued new orders relating to the sale of rails and of wrought-iron scrap.

The words "Relayable rails 50 lb. per yard and over £10 per ton net f.o.t. at point of purchase" have been modified, and "other second-hand rails" added to the schedule attached to the general permit of November 1st last.

To the above-mentioned price a sum not exceeding 2½ per cent. may be added in the case of sales by recognised merchants. Rails which have been purchased by a merchant and stored or sorted by him, and which are sold as relayable rails or otherwise than as heavy steel melting scrap may be sold at a price not exceeding £12 per ton net. The maximum prices for wrought-iron scrap vary from £6. 5s. to £5. 5s. per ton.

* * * *

Manufacturers' Certificates. Misunderstandings have arisen as to the meaning of the Priority Order issued by the Ministry of Munitions on March 8. The Board of Trade announce that manufacturers in the industries affected are free to carry on their ordinary commercial business as at present until they receive any orders accompanied by priority certificates A or B.

In regard to export orders, the Board of Trade do not exercise their power of certification by dealing with particular orders, but by the issue of an official Order specifying any industry in which they consider that production for export should have priority over home consumption, and also specifying the classes of orders to which priority must be given, subject to any conditions laid down and to the issue of a certificate by a Government Department or other authority controlling any necessary materials that such materials can be spared. Any official order will be general in character, and it will be unnecessary for applications to be made to the Board of Trade each time an exporter desires to secure priority.

* * * *

Development of British Minerals. A new branch of the Ministry of Munitions has been formed under Sir Lionel Phillips, Bart., as controller, to deal with the examination and development of such mineral properties other than coal or iron ore) in the United Kingdom as are considered likely to be of special value for the purposes of war.

The Ministry of Munitions has appointed the following to act as an advisory committee on the development of mineral resources: Sir Lionel Phillips, Bart. (chairman), Mr. F. J. Allen, Mr. C. W. Fielding, Mr. R. J. Frecheville, Prof. F. W. Harbord, F.I.C., Assoc.R.S.M., Mr F. Merricks, Sir Harry Ross Skinner, Dr. A. Strahan, LL.D., F.R.S. (representing the Geological Survey), Mr. Edgar Taylor, together with a representative to be nominated by the Board of Trade.

* * * *

Metric System. At the meeting of the Association of Chambers of Commerce last week a resolution was passed approving of the Executive Council's bill to introduce the metric system of weights and measures.

Mr. E. Stoney moved the resolution.

In the course of the discussion, Mr. J. M'Laren (Leeds) said that the subject was an attractive one, but from the point of view of engineers and shipbuilding it would mean the scrapping of valuable standards.

Mr. A. J. Hobson (Sheffield) said he had no objection in the abstract to the proposal, but to alter the system in the United Kingdom alone without the assent of our Dominions and the United States would be midsummer madness.

The resolution was carried by a very large majority.

* * * *

The Fireclay Industry. A meeting, promoted by the Refractory Materials Section of the Ceramic Society, was recently held at Leeds University in furtherance of the movement among manufacturers of firebricks and refractory materials to develop the industry on more scientific lines and then be in a position to meet German competition after the war.

Mr. Wm. Oates, who presided, said the West Riding was pre-eminent as a centre of refractory products, and he suggested that the Society should co-operate with the Iron and Steel Institute.

Prof. Kendall and Mr. Albert Gilligan, of the Leeds University, gave information as to the clays of northern and central Yorkshire. Prof. Kendall said that the three Ridings of Yorkshire appeared to be better endowed in the matter of clays than any other equal area in Britain.

In a paper on "The Use of Zirconia as a Refractory Material," Mr. J. A. Audley remarked that in Germany patents had been taken out for the use of zirconia in a variety of ways. As a refractory it was applied to cutting muffles, retorts and tubes, and to crucibles in which quartz was to be fused to prepare quartz glass. Calculations showed in actual maintenance cost a saving of over 50 per cent. in favour of zirconia lining compared with the ordinary refractory lining. In the calculations no allowance was made for increased production and higher efficiency. Zirconia was also used in the manufacture of ferro-zirconium, which had been employed in Germany for producing zirconium steel for armour plates, armour-piercing projectiles, bullet-proof steel, &c. Zirconium steels were particularly hard. Before the war there was practically a German monopoly of the raw zirconia ore, which was mainly dealt with under German patents. This was now available for this and other countries, provided that they could find a means for transferring it.

Prof. J. W. Cobb, head of the Coal Gas and Fuel Industries Department at Leeds University, gave a lecture on temperature measurement in clay works practice. He remarked that it was a tradition in the clay industry to depend almost exclusively upon the personal judgment and acquired skill of a fireman in the determination of the temperature in the kilns used for burning bricks, pottery and porcelain. Modern science had produced a far more effective means for that purpose in several directions, giving the possibility of much greater precision in the manufacturing operations. He explained the use of instruments now in the hands of the clay-worker for the control of temperature. Many of these were dependent upon the application of electrical principles.

* * * *

Registration of Business Names. A deputation from Manchester recently waited upon Sir Albert Stanley, M.P., President of the Board of Trade, in connection with the operation of the Registration of Business Names Act.

The deputation urged that where partners in a firm were exclusively of British nationality registration should be sufficient, and that it should not be necessary to publish the names of each of the partners on all trade catalogues, trade circulars, show cards and business letters. It was also urged that the conditions of the Act should not apply to existing stocks of such catalogues, &c.

Sir Albert Stanley said that he was not prepared to comply with the suggestions of the deputation. His reply, however, did not exclude an amending Act being introduced at a later date, but he could not give a direct hope that such an Act would be introduced. Each case would be examined on its merits, but the Act had to be interpreted as it stood, and there would not be harsh prosecutions.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Buckfastleigh.—The Urban Council have sanctioned the erection of poles and overhead mains for giving a supply of electric current to a local hospital at Bigadon.

London County Council.—On Tuesday the Finance Committee recommended and it was agreed to sanction the borrowing of £1,000 by Battersea Borough Council for a transformer for the Nine Elms sub-station, with switchgear, mains, &c.

The Highways Committee reported that as a matter of urgency the chairman of the Council opened the tenders received on March 26 for the supply of h.t. switchgear and h.t. and l.t. cables in connection with the proposed additional supply of power to Woolwich. The Council approved of this action, and also gave the chairman similar authority in the case of tenders which will be received during the Easter recess for the supply of granite sets and axle forgings for the tramways department, and transformers for the Greenwich station.

Motherwell.—The Council are recommended to dispose of some of the older units and to substitute a 2,000 kw. turbo-alternator. It is also proposed to make other alterations at a total cost of £30,000, and sanction to borrow this sum will be applied for.

Rochdale.—Mr. W. J. H. Wood in a recent report recommends the Council to spend about £20,000 on extensions of the electricity undertaking, in order to be in a position to meet the increasing requirements of consumers for electrical energy for power.

Spenborough.—Owing to the increasing demand for electrical energy, a scheme of extensions is being prepared, and application will be made to the L.G. Board for sanction to a loan.

Stoke Newington (London).—It has been decided to lay electric cables at a cost of £254 to give a supply of electrical energy to certain factories.

GENERAL.

Bootle.—The annual estimates were recently approved by the Council.

The approximate deficit for the current year on the tramways would amount to £2,822 (against £1,811 estimated) and this will be met out of reserve. The deficit did not take account of the fact that a sum of £4,689 in respect of the rental payable by Liverpool Corporation for the current year had not yet been paid. In the coming year the total expenditure is put at £10,749, an increase of £4,069, and after taking account of the rental of £4,869 the estimated loss is £5,880, plus £200 for overhead equipment renewal fund, a total of £6,080. Of this sum £2,762 will come out of reserve, and £,3818 from rates. Extensive track repairs and renewals account for the large increase in the estimate.

The net surplus on the electricity account for the present year will amount to about £3,268, though no surplus was estimated. The reserve and renewal fund accounts show a credit balance of £19,765 at the close of the year, representing 9·48 per cent. of capital, and the reserve fund had nearly reached its maximum limit.

Bradford.—On Tuesday the Council were recommended to increase the salary of the city electrical engineer (Mr. Thomas Roles) by £100 per annum, to £900, and that of the deputy electrical engineer (Mr. J. H. Shaw) by £100 per annum, to £450.

Cuddington.—A local inquiry was held recently into the applications of Wimbledon Corporation and the South Metropolitan Electric Tramways & Lighting Co. for a provisional order for this district.

Evidence in support of the company's application was given by Mr. R. B. Yardley (Surrey) and several ratepayers. For Wimbledon several witnesses were also called.

Glasgow.—Mr. Denny proposes to ask the Corporation to exercise their influence with the Dean of Guild and his Court to secure in all new buildings electric wiring of sufficient capacity to permit of the use of electric current for electric lighting, heating and cooking.

Hebden Bridge.—The Council are faced with a greatly increased demand for electric current for power, but rather than put down a further oil driven set they have decided, subject to a satisfactory agreement being arrived at, to take a bulk supply from Halifax Corporation.

Manchester.—Last week the City Council adopted the recommendations of the Electricity and Tramways Committees as to increases of officials' salaries.

Councillor Dagnall explained that the increases proposed by the Electricity Committee were all for men holding the positions of supervisors, who under Government regulations were unable to leave in order to better their circumstances. In many cases the men working under them were receiving higher wages. There were, for example, stokers who were now drawing £5 a week and upwards, while the supervisors were only receiving £200. That was not equitable.

Ald. Bowes stated that the total advances asked for by the Tramways Committee only amounted to £168. 8s. on a wages list of £100,000 a year.

The Undue Preference Test Case.—Hackney Borough Council continue to receive support in defending the action brought by the Gas Light & Coke Co. to restrain them from giving an alleged undue preference in their charges for electric current.

Last week Southend Council adopted a recommendation of the Electricity Committee to guarantee a maximum sum of £40 to Hackney Council in defending the action. In the course of the debate Ald. Martin said the Committee was satisfied that it was a most important matter, which would have a far-reaching effect on all electric supply undertakings in the country, and Councillor Scott said the Committee considered the matter so important that each member decided, if necessary, to bear his share of the surcharge.

Barnes Urban Council proposed to vote £20 as a contribution towards the expenses of defending the action, but the Lighting Committee are advised by the L.G. Board that it is unaware of any legal authority authorising the Council to make such a contribution.

Tynemouth.—The salary of the borough electrical engineer, Mr. Charles Turnbull, has been increased from £325 to £400 per annum.

West Ham.—The Borough Treasurer recently reported on the estimated deficits on the electricity and tramways departments.

In regard to the electricity undertaking provision is being made in the rate estimates for the coming year, and a provisional figure of £35,500 will be included as the anticipated deficiency for the year ended on the 31st ult., and a further sum of £4,500 for the allowance to men on active service—a total of £40,000. Owing to the large increase in the bank overdraft, together with the larger outlay on stocks and stores, it is proposed to charge the active service allowance against the current year's expenditure on the general district rate and to make provision in the estimates for 1917-18 for £4,600 under this head.

With regard to the tramways, it is necessary to make provision in the rate estimates for the ensuing year for £15,500 as the anticipated deficiency for the year to March 31 and a further sum of £16,100 for the allowance to men on active service, a total of £31,600. The effect of this deficiency and the increase in the outlay on stocks and stores would be to cause an overdraft, which is not allowed on tramways, and to obviate this it is suggested that the active service allowance (*i.e.*, £16,100) be also charged against the expenditure for the current year on the borough rate. It is also proposed to make provision in the new estimates for £17,500 as the active service allowance for 1917-18.

With regard to the question of overdraft, if deficiencies on both undertakings are continued, it will be necessary to provide—especially in the case of tramways—for increased working balances; or, to anticipate the respective results of working, one year in advance, in order that provision may be made in the rates for raising the money during the period in which the deficiencies are accumulating.

The Finance Committee has approved the borough treasurer's suggestions.

Yorkshire Provisional Orders.—The Board of Trade recently heard the objections of the Corporations of Bradford, Halifax, Leeds, Rotherham and Sheffield to the applications made by Electrical Distribution of Yorkshire (Ltd.) for provisional orders for the districts of Clayton and Queensbury, Rawdon and Wortley.

The districts are in the area of supply of the Yorkshire Electric Power Co., and the promoters propose to take a supply in bulk and distribute for lighting purposes, as they are doing in a number of other districts. The local authorities of the districts had given their consent to the company's applications. The objections of the boroughs were based on the grounds that they might at some later date desire to extend their boundaries to take in the districts, and that in such case it would be unsatisfactory if the company possessed lighting powers; and in the case of the objections of the Sheffield and Rotherham Corporations to the Wortley order that the Corporations would be in a position after the war to supply electricity to these districts, and that they would be prepared to ask the Board for the necessary lighting powers. It was pointed out on behalf of the promoters that the granting of the orders to the company was the natural course of development of supply in a power company's area, and was in accordance with the opinion expressed by the Board of Trade in their report on the Yorkshire Electric Power Bill of 1915, in which they stated that they saw no reason why the obtaining of lighting powers by the distribution company should be departed from.

On the following day the objections of certain gas companies to other applications for lighting orders by the distribution company were heard. These objections were based on the usual grounds of competition. The Board of Trade will communicate their decision in due course.

Digitized by Google

ELECTRIC TRACTION.

Bradford.—The Electricity Committee recently decided to purchase two electric (5-ton) chassis and one petrol (25 cwt.) tipping wagon for conveying coal, &c.

Darwen.—The Corporation have granted a war bonus of £25 per year to the tramways manager, Mr. Hosken.

Huddersfield.—It was announced at the Council meeting last week that the tramways undertaking continued to be prosperous, and it could easily afford a contribution of 4d. in the pound.

The payment of this amount will clear off the last instalment of the £73,041 received from the rates in the earlier years of the undertaking. For the fourth year in succession the Electricity Committee has transferred an amount equal to 1d. in the pound in relief of the rates.

Kingston-on-Thames.—The tramcar services between St. Peter's Church and Kingston-hill, and from King's-road to Ham boundary have been discontinued for the period of the war.

The Council maintain that this is a breach of the agreement between the company and the Corporation, as the company are under statutory obligations to supply services on the routes. The tramway company has suspended the services owing to the difficulty experienced in procuring material for the upkeep of the rolling stock; also in consequence of the pressure by the Ministry of Munitions to provide more frequent services on those routes which serve munition factories.

Perth.—The Council has given permission for non-commissioned officers and men of the Perthshire Volunteer Regiment engaged on observation duty to travel free on the tramways when going to and from duty.

Wallasey.—The Tramways Committee recommend an additional war bonus of 2s. per week to all male employés over 21 years of age and 1s. per week to all male employés under that age. The chief traffic inspector and the works foreman are each to have 5s. per week additional war bonus.

Walthamstow.—The Tramways Committee recommend that the salary of Mr. W. Murray, the tramways manager, be increased by £25, with a further increase of the same amount at the end of 12 months.

LIGHTING AND INDUSTRIAL POWER.

Electricity in Mining.—At the recent meeting of the Mysore Gold Mining Co. (Ltd.) it was announced that the pumping arrangements throughout the mine had been considerably modified during the year, and the company was now able to do without the services of the pumps previously operated by compressed air, they having been replaced by electrically-driven pumps. The saving in cost of upkeep and running them represented a large sum of money. The supply of electrical power via the Cauvery Falls system had been entirely satisfactory throughout the year, and that source of anxiety had been removed. A considerable amount of other machinery at the cyanide works, Tennent's Railway and at the workshops had been, and was being, converted to electrical power, the benefit of which was experienced in smoother running as well as in the reduction of running costs. There were delays in the shipment of machinery.

Finchley.—At the last meeting of the Urban Council Mr. Day moved that the arc lighting be discontinued, and that no payment be made to the Electricity Committee in respect thereof.

Mr. Day said the arc lamps were costing the Highways Committee over £1,100 a year, and were practically never lighted. Of the amount, £760 was paid to the Electricity Committee.

Mr. H. O. Syrett, chairman of the Electricity Committee, said the £760 was paid for the supply of current, maintenance of lamps, gear, switches and the special mains which had to be laid. There was a five years' contract for maintenance of lamps, the annual charge being £227. Of this amount £124 was credited last year to the Highways Committee, being the sum obtained from the maintenance firm on the ground that the lamps were not now used. In place of the 45 arc lamps they were now lighting for the Highways Committee 97 incandescent lamps. The charge for these incandescent lamps in normal times was £1 per lamp per annum, or for complete all-night lighting by incandescent lamps £4 per lamp per annum, so that the Electricity Committee was really presenting to the Highways Committee £3 per lamp per annum. After working it out, it would appear that the lamps were costing the Highways Committee only about £130, and not the £1,100 mentioned by Mr. Day, and in the £130 was included the cost to the Electr city Committee of maintaining the gear, switches and special mains, the lamps only being maintained under contract. He moved "That the arc lighting be discontinued, and that the Electricity Committee allow the Highways Committee 1d. per unit for all current saved owing to the alteration in lighting due to the War."

Mr. Syrett's motion was carried by 8 votes to 4.

Railway Carriage Lighting.—The Belfast & County Down Railway Co. is building seven new second-class carriages which are to be lighted electrically.

York.—In certain streets previously illuminated by gas the Streets and Buildings Committee will adopt electric lighting temporarily.

IMPERIAL NOTES.

Australasia.—The "Australian Mining Standard" states, in reference to Mr. J. H. Butters's proposal to employ the water power of King River (Tasmania) for generating electrical energy for supply to metallurgical works on the West Coast, that a site has been provisionally selected, 2 miles from the North Mt. Lyell railway, as suitable for the construction of a dam.

It is estimated that a dam 120 ft. high across a narrow gorge will provide a reservoir of 3½ square miles, and that it will give water power sufficient to generate 30,000 H.P. The water would be taken by a pipeline between 3 and 4 miles in length to the power station.

Victoria Park (W. Australia) Council propose to borrow £3,750 for electricity supply and other works.

The increasing load on the electric lighting plant will necessitate consideration by Subiaco (W. Australia) Council of the question of extensions.

The "Australian Mining Standard" of Jan. 18 states that two contracts (dated respectively Jan. 9 and Aug. 31, 1915) between Siemens Bros. & Co. and the Postmaster-General of the Commonwealth, have been declared enemy contracts by the Federal Attorney-General, Mr. W. M. Hughes. The contracts were for 35 differential galvanometers and 50 Morse keys; and 17½ miles two-twisted conductors flame-resisting wire.

Mr. H. W. Gepp, general manager of the Amalgamated Zinc (De Bavay's) Ltd., who recently returned to Australia from a visit to the United States, will shortly leave for Tasmania to push on the work of the Electrolytic Zinc Co. of Australasia, a separate organisation established by the company for the production of electrolytic zinc. The first unit of the plant, with a capacity of 10 or 11 tons of electrolytic zinc a day, is under construction at Risdon, near Hobart.

During the latter half of 1916 the Mount Lyell (Tasmania) Mining & Railway Co. consigned 1,351 tons of blister copper to the electrolytic works at Port Kembla for refining. The first unit of the recently installed electrically-driven compressor plant at the Mount Lyell Mine is reported to be working splendidly The company has in operation sulphur extraction plants with coal-fired reverberatory and electrically heated retort furnaces, and it is thought that the latter method of production from the raw pyrites will prove the more successful.

Canada.—It is stated that the Kenora & English River Railway Co. intend to apply for authority for the construction and working of a railway from a point on the Trans-continental Railway, in the district of Kenora (Ontario), to Winnipeg; for the construction and working of telegraph and telephones lines and other works.

Electrically-operated Metallurgical Works in Canada.—In a list recently issued by the Mines Branch of the Department of Mines (Ottawa) it is stated that electric furnaces are used to produce ferro-alloys—ferro-phosphorus and ferro-silicon; also there are 17 furnaces operating for reducing iron ores, these furnaces varying in capacity up to 6 tons. One large Canadian company is refining copper, lead and zinc electrolytically on a very considerable scale.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says that on Feb. 23 Engineer Mauro Herlitzka, representing the Anglo-Argentine Eléctrica del Sud, Andina, General de Cordoba, San Carlos de Bolivar and Eléctrica Nueve de Julio, presented a memorandum to the Argentine Minister of Agriculture on the question of fuel supply.

The memorandum stated that the companies had reckoned upon being able to obtain fuel for their generating stations and particularly petroleum from Comodoro Rivadavia. The companies had put in oil engines at several stations and had adapted their boilers for using oil fuel. Hitherto the companies had obtained petroleum from the Anglo-Mexican Co. and the West India Oil Co., obtaining from the Comodoro Rivadavia Exploitation Committee only about 50 tons per month. Owing to transport difficulties and the fact that the contracts with two of the companies above mentioned were on the eve of expiration, the companies would be obliged to suspend work at several of their stations unless it became possible for them to obtain increased supplies of Comodoro Rivadavia petroleum, of which they required 546 tons per month.

French Export Restrictions.—A French Ministerial decree was issued on March 19 which abrogates earlier decrees, in virtue of which the following amongst other articles were allowed to be exported or re-exported from France, without special authorisation, when consigned to the United Kingdom, the British Dominions, Colonies and Protectorates, &c.:—

Accumulators and accumulator plates, aluminium wares, anti-friction metal, asbestos wares, cadmium, carbide of calcium, copper, or or metal (pure or alloyed, in all forms), dynamo-electric machines, electrodes batteries, and their elements, lead, metal, pure or alloyed, pipes and other wares of all kinds, manganese (metal) in all forms, mercury (ore, metal, compounds and preparation), mica in sheets and plates, worked mica and micanite, monazite (ore of cerium, lanthanum and thorium), nickel (metal) pure or alloyed, in all forms, ores of manganese, molybdenum, titanium and vanadium, salts of chrome, copper, tin, mercury and molybdenum, tin ore and metal, tungsten metal in all forms, zinc, &c.

Paris.—It is reported that owing to the scarcity of coal, the authorities are preparing to have the streets lit by oil lamps.

Should the coal shortage become still more acute further restrictions with regard to the supply of electricity and gas to private houses may also be expected.

Digitized by Google

Russia.—The Municipal Council of Ekaterinburg propose to float a loan as soon as possible for constructing an electric tramway, the erection of electricity works, &c. Lighting is at present done by a private company, whose concession expires at an early date.

The Council of the Empire recently passed a Bill authorising the import free of duty for five years, through the mouth of the River Yenisei, of certain merchandise, including carbolic acid, all kinds of iron, tin, steel, lead, agricultural implements and movable engines.

A proposal to generate electrical energy by the water power of the Imatra Falls in Finland and to supply current to Petrograd was approved some time ago by the Russian Council of Minsiters. The construction work is estimated to cost 32 million roubles (about 1¾ million pounds).

The Council has also approved a proposal that the Finnish Treasury shall have expropriation rights over the Vallinkoski waterfalls, and arrange for the construction of hydro-electric works to supply current in Petrograd, and also for operating the Finnish railways.

Sweden.—A new company was recently formed in Stockholm, with a capital of over £1,100,000, for the manufacture of Diesel engines.

U.S.A. Trade with China.—The 1916 trade of the United States with China created a record, the total value being $111,557,000, against $72,686,000 in 1915 and $56,672,000 in 1914.

The increase in exports occurs chiefly in iron and steel manufactures. The total value of iron and steel exported in 1916 was $5,543,000, against $2,710,000 in 1915 and $2,940,000 in 1914. There were also large increases in wire, nails, tin plate, &c. Automobiles showed a slight increase, amounting to $192,000, against $120,000 in 1915, and railway cars $134,000 against $51,000. The value of the electrical machinery exported was $408,000 in 1916 against $236,000 in 1915.

Water Power in France.—The Société des Acieries de Firminy intend to utilise water-power from the Cére at Laroquebrou for the generation of electrical energy. It is estimated that about 30,000 kw. can be developed from this source.

In the Tinée Valley the Société d'Energie Electrique du Littoral Mediterranean propose to generate electrical energy by means of water lower for railway electrification and lighting and industrial purposes.

MISCELLANEOUS.

Borough Polytechnic Institute (London).—On Saturday afternoon and evening an interesting exhibition of students' work took place at this Institute.

Cardiff Prisoners of War Fund.—In support of a fund started by the Cardiff "Evening Express" for sending food to prisoners of war, the members of the electrical industry at Cardiff (with Mr. W. A. Chamen as their president) played a football match, followed by a dinner and concert, with the Bristol City Electricals on Saturday last. The Bristol team won by 5 goals to nil. Mr. Chamen announced that he believed over £200 would be realised to be handed over to the fund.

Coal Supply Facilities.—On March 30 His Majesty in Council ordered the amendment of the Defence of the Realm Regulations by the inclusion of Regulation 2AA to the following effect :—

Where, with a view to increasing the supply of coal, it appears to the Board of Trade that it is expedient that any railway or tramway or other facilities for transport from a colliery should be provided, the Board of Trade may take possession of any land and construct or maintain thereon such works as may be necessary for the purpose.

Education Reform.—The final report of the Departmental Committee on Juvenile Education in relation to employment after the war has been issued, and among the recommendations are :—

The establishment of a uniform elementary school-leaving age of 14, which entails the abolition of all exemptions (total or partial) from compulsory attendance below that age ; and

The attendance for not less than eight hours a week, or 320 hours a year, at day continuation classes between the ages of 14 and 18.

The report emphasises that both proposals are integral parts of one reform, and that juvenile education, to be effective, must be continuous and progressive. The two great causes of educational wastage are too early withdrawal from day schools and general disregard of the facilities offered by evening schools. It is also stated that "apprenticeship does not of itself give that general industrial knowledge and intelligence which will enable the worker to adapt himself to changing industrial conditions." Existing defects have been aggravated by the war. "Many children have been withdrawn at an even earlier age than usual from day schools, and the attendance at those evening schools which have not been closed show a lamentable shrinkage. There can be no doubt that many of the tendencies adversely affecting the development of character and efficiency have been accentuated. Unsuitable occupations in the distributive trades have largely been transferred from boys to girls. Parental control has been relaxed, largely through the absence of fathers of families from their homes. Wages have been exceptionally high, and, although this has led to an improved standard of living, it has also, in ill-regulated households, induced habits of foolish and mischievous extravagance. Even the ordinary discipline of the workshop has in varying degrees given way."

The report also stated that more manual instruction of various kinds is needed for both boys and girls. It is to compulsory continuation classes that educational and social reformers look with the greatest confidence as a step towards the final solution of the juvenile problem. The Committee recommend that it should be an obligation on the local education authority in each area to provide suitable continuation classes, and upon all young persons between 14 and 18 years of age to attend them, except (*a*) those who are under efficient full-time instruction in some other manner ; (*b*) those who have completed a satisfactory course in a secondary school recognised as efficient by the Board of Education and are not less than 16 ; (*c*) those who have passed the matriculation examination of a British university, or an equivalent examination, and are not less than 16 ; and (*d*) those who are under part-time instruction of a kind not regarded as unsuitable by the Board of Education and entailing a substantially greater amount of study in the day-time than the amount to be required by statute.

All classes would be held between the hours of 8 a.m. and 7 p.m., and employers should be under an obligation to give the necessary facilities for their employés to attend.

Electric Culture.—Mr. Ashley, of Bold-street, Southport, has decided to make an experiment in the electric culture of potatoes on two plots of land adjacent to the electricity works.

The apparatus is practically complete, and will be installed as soon as the land has been ploughed up. Poles will be erected in the earth, from which will be suspended a network of wires, which will be charged with current at a very high voltage—something like 500,000 volts. Electric current will be supplied from the Corporation electricity works.

Interest on Local Loans.—The Treasury notify that on loan granted out of the Local Loans Fund the following rates of interest shall be charged in future.

On loans secured on local rates, not exceeding 30 years, 5½ per cent.; not exceeding 50 years, 5¾ per cent.

Interest on Reserve Funds.—St. Pancras (London) Borough Council have rescinded their resolution of June last deciding that interest earned by the electricity reserve fund account be transferred to the electricity revenue account, and in future such interest will accrue to the reserve fund. The amount in question is about £1,500 a year.

Labels for Parcels.—The "Z" Electric Lamp Mfg. Co., Ltd., of Southfields, has prepared an artistic adhesive label for addressing parcels, which it is prepared to supply its customers in the trade.

From the sample we have seen, the labels are of an attractive character, printed in colours, and there is plenty of space for the name and address of the consignee. Customers will be supplied free of charge with the labels, and the name and address of each customer are printed on them by the "Z" company.

Prohibited Imports.—A Royal Proclamation was issued on March 30 prohibiting the importation of various goods into the United Kingdom, including the following :—

Manufactures of aluminium and aluminium powder ; printed books and other printed matter including posters or daily, weekly and other periodicals imported otherwise than in single copies through the post ; glass and manufactures of glass, hardware, lacquered wares, machine tools and parts therefor (excluding small tools), agricultural machinery, motor cars, motor cycles and parts (other than tyres).

Prohibited and Restricted Exports.—The Privy Council ordered the following amongst amendments to be made in the schedule of prohibited and restricted exports as from March 30 :—

Delete :—(C) Insulating materials, oxides of lead ; (B) leather belting ; (B) lead (except pig lead)—alloys of lead, solder containing lead and manufactures of lead or its alloys not otherwise prohibited ; (C) internal combustion engines for marine propulsion and parts thereof.

Add :—(A) Leather, leather belting ; (A) lead, lead alloys and manufactures of lead or lead alloys ; (A) engines for use on board ship (including Diesel and other internal combustion engines for marine propulsion) and parts thereof ; (A) machinery for steam ships and parts thereof ; (A) ships' auxiliary machinery ; (A) ships' telegraphs and parts thereof, steering gear and parts thereof ; (A) winches ; (A) windlasses.

The National Revenue.—For the year ended March 31 the total revenue from the telephone service was £6,400,000, a decrease of £450,000 compared with 1915 ; and the telegraph receipts were £3,350,000, an increase of £100,000. The estimated telephone revenue was £6,850,000 and the telegraph revenue £3,250,000.

Trading With the Enemy.—The "London Gazette" of March 30 contains additions to the Statutory List of firms and persons with whom trading by firms and persons in the United Kingdom is prohibited.

These include *Chili* : Allgemeine Elektricitäts Gesellschaft (Santiago and Valparaiso).

Tyne Engineers' Wages.—The Committee on Production has awarded the Tyne engineers, who recently resumed work after a strike, an advance of 2s. per week as from the first full pay in February, this being independent of the advance of 5s. granted on March 1.

University of Liverpool.—The Faculty of Engineering provides complete courses of instruction in civil, mechanical, electrical and marine engineering, naval architecture, mathematics and physics. The prospectus of the Faculty may be obtained from the Registrar, Mr. Edward Carey.

Digitized by Google

TENDERS INVITED AND ACCEPTED.

Cooling Towers.

The Electricity Committee of Hull Corporation invite tenders for the cooling towers required in connection with the extensions of plant at their Sculcoates-lane generating works. Forms of tender and specifications from the City Treasurer, Mr. T. G. Milner, and tenders addressed to the chairman of the Electricity Committee, Guildhall, Hull, are to be in by noon, April 12.

Turbo-alternators, Transformers and Condensing Plant.

Warrington Electricity and Tramways Committee require tenders by noon April 11, for supply of one 3,000 kw. turbo-alternator and surface condensing plant. Specifications from Borough Electrical Engineer.

Motors and Transformers.

Warrington Electricity and Tramways Committee require tenders by noon April 11 for the supply of Motors and Transformers. Specifications from Borough Electrical Engineer.

Arc Lamp Carbons.

St. Pancras (London) Borough Council invite tenders for the supply of arc lamp carbons, delivery to be made as required. Specifications from the Electricity Department, Offices 57, Pratt-street, N.W. 1, and tenders to Town Clerk by noon of April 12.

Internal Combustion Engine and Generator, &c.

Aylesbury Corporation require tenders for the installation of a 200 kw. direct-coupled internal combustion engine and generator, with fuel plant and accessories. Specifications from the Electrical Engineer.

Trays for Coal Elevator.

Salford Corporation want tenders by noon April 9 for the supply of Mild Steel Trays for coal elevator at the electricity works. Particulars from the Borough Electrical Engineer.

Bradford.—The Corporation have accepted the tender of the National Rail & Tramway Appliances Co. for the supply of 100 tons of c.-i. brake blocks.

Ilford.—The Council has accepted the following tenders for annual supplies:—

Incandescent Lamps: Cryselco (Ltd.) and Electrical Mfg. & Supplies, at present prices; London & Rugby Engineering Co., at prices quoted. Joint Boxes and Fuse Boxes: W. Lucy & Co., on sliding scale, in accordance with prices of copper, iron and porcelain at time of order.

Marylebone (London).—The Borough Council are recommended to accept the tender of E. Green & Sons, for the supply and erection of new economisers in accordance with their estimate for £1,860.

St. Helens.—The Council have placed an order with Babcock & Wilcox for two new boilers.

Southwark (London).—The Electricity Committee has sanctioned the purchase of two 3 h.p. motors (at £45. 15s. 7d.) to replace existing machines on hire to consumers, and two motors of 11 h.p. and ½ h.p. respectively, at £58. 11s., to be supplied to a consumer on cash terms.

Swansea.—The following tenders have been accepted by the Corporation:—

Stirling Boiler Co., water-tube boilers, and accessories; Musgrave & Co., mechanical draught fan; G. & J. Weir (Ltd.), boiler feed pump; Mather & Platt, electric pumping plant for the Water Committee, at £681. 10s.

Walthamstow.—The Urban Council has accepted the following tenders for annual supplies:—

Lighting Department.—Dussek Bitumen Co., jointing material; Chamberlain & Hookham, meters; Electrical Mfg. & Supplies Co., lamps; Vacuum Oil Co., oils.

Tramways Department.—W. Wood & Co., trolley heads; Anti-Attrition Metal Co., trolley wheels; Docker Bros., raw sienna, varnish and gold size; R. Kearsley & Co., paints.

APPOINTMENTS VACANT AND FILLED.

London County Council invite applications for the position of electrical engineer in the tramways department, at a salary ranging from £1,200 to £1,500 a year. Applications on official form to be obtained from the Clerk of the Council, County Hall, Spring-gardens, S.W., must be returned by 1 p.m. April 23.

London County Council also require an operation superintendent (£500 to £700 per annum) and a development superintendent (£500 to £800) for the traffic branch of their tramways department. Applications by April 23 for the former, and May 7 for the latter appointment.

A foreman is wanted for an electrical instrument shop. *See advertisement.*

An electrical draughtsman with experience in dynamo and motor design is required by an advertiser.

Messrs. Isenthal & Co. (Ltd.), Denzil Works, Willesden, N.W., advertise for a capable store-keeper and cost clerk.

An additional lecturer and demonstrator will shortly be required in the engineering department of the Borough Polytechnic Institute, Borough-road, London, S.E. 1. Salary £160 to £180 per annum.

Mr. E. H. Snook, of Southampton, has been appointed charge engineer at Southwark temporarily in succession to Mr. Boothby, who recently resigned on account of ill-health.

Mr. A. W. Clegg, acting electrical engineer at Accrington, was appointed by the Council on Monday as borough electrical engineer and manager in place of Capt. H. Gray, who had resigned.

BUSINESS ITEMS.

Messrs. George Schultz & Co. (Ltd.), 10, Arthur-street, London, E.C., ask to state that the winding up of the affairs of Meirowsky & Co. (A.G.) in this country by the Board of Trade does not in any way affect their position or business, in which only British subjects have been and are interested.

Electric Motors.—The Swedish General Electric (Ltd.), 5, Chancery-lane, W.C. 2, have recently issued their stock list of d.c. type K motors and of Century single-phase motors and fans. Copies of the list will be sent to those interested.

The McGraw Publishing Co. and the Hill Publishing Co. have been consolidated as the McGraw Hill Publishing Co. (Inc.).

The new company acquires all the properties and interests of the two companies, including the following technical journals: "Electrical World," "Electric Railway Journal," "Electrical Merchandising," "Engineering Record," "Metallurgical and Chemical Engineering," "The Contractor," "American Machinist," "Power," "Engineering News," "Engineering and Mining Journal," and "Coal Age." Two of the papers, "Engineering News" and "Engineering Record," will be consolidated under the name "Engineering News-Record," with Mr. Charles Whiting Baker, now editor of "Engineering News," as editor-in-chief. Mr. James H. McGraw will be president of the new company.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of June 14. *Further particulars are set out in an advertisement.*

Patent Amendment.—The British & Overseas Engineering Syndicate (Ltd.) seek leave to amend the Specification of Letters Patent No. 15,599 of 1903, granted to Valdemar Poulsen for "Improvements relating to the production of alternating electric currents." Notice of opposition must be given within one calendar month from March 21.

BANKRUPTCIES, LIQUIDATIONS, &c.

A composition of 5s. in the £ to the creditors of Edward W. B. Wright, electrical therapeutic expert, formerly of 133, Oxford-street, London, W.C., has been approved and the receiving order has been discharged. Claims to Mr. E. W. J. Savill, 14, Bedford-row, W.C., by April 11.

An application for the discharge of Hy. Neville Kaye, engineer, 31, Kingsthorpe-road, Sydenham, London, S.E., will be heard on April 27 at the Court House, Greenwich, S.E.

Claims against the Colston Electrical Works (Ltd.), 9, Denmark-street, Bristol, are to be sent by April 11 to Mr. C. H. King, 26, Baldwin-street, Bristol.

A meeting to receive an account of the winding up of the Torbinia Engineering Co. (Ltd.) will be held at 7, Bloomsbury-square, London, W.C., on May 4.

Digitized by Google

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Direct Spanish Telegraph Co. (Ltd.)

The 65th ordinary general meeting was held on March 28, under the presidency of Sir John Denison-Pender, K.C.M.G., the chairman of the company.

The SECRETARY (Mr. Fred. Thos. Preddle) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: The traffic receipts show an increase over those of 1915 of £6,837, which must be considered satisfactory, remembering that the receipts of 1915 were themselves much larger than those of the year before. The ordinary working expenses show an increase of £2,880. The increase in expenditure at the Comapny's head office is £310, of which £211 figures in the salaries account, this being partly occasioned by normal increases and partly by the large volume of traffic passing over our cables. At the company's stations the net increase is £2,600, and this is practically divided between the salaries and the stationery accounts. The former shows an increase of just over £1,600, which is accounted for by extra payments which we have been compelled to make in order to enable us to cope with the heavy traffic, and also the usual increases granted under the salary scheme in operation. The stationery account is increased by £790, which is due to the increase of traffic and also to the very high prices which we have now to pay for stationery. Income tax, of course, shows a considerable increase, and I would remind you that the amount charged for excess profits duty (£26,235) represents our liability for the years 1914 and 1915. The balance remaining to be dealt with is £57,708. 13s. 11d., and we propose to apportion this as follows: Dividend on the preference shares for the year at 10 per cent. will come to £3,000, the dividend on the ordinary shares of 5 per cent. for the year comes to £3,232. 15s., and the bonus of 2 per cent. on the ordinary shares will absorb £1,293. 2s. We transfer to reserve fund £5,000 and to the fund for the provision for investment fluctuations £3,134. This will leave £42,048. 16s. 11d. to be carried forward, subject to excess profits duty for 1916. We must not lose sight of the fact that our large revenue is chiefly due to the war—not so much from increased cable traffic between Great Britain and Spain, as owing to lines which carried the traffic in normal times being now otherwise occupied, thus throwing more on our cable. We have also been very fortunate in having got through the year without any cable repairs—a circumstance which makes a very great difference in the profit the company is able to show. The question of your directors' fees being paid free of income tax was referred to at our last general meeting, and you will be asked to-day to approve the principle. The ordinary shareholders have received their dividends and all salaries have for many years been paid free of income tax, and we think the directors might also claim a similar privilege, which, I would add, exists in many large similar companies. We have an insurance scheme, but we have never had a pension scheme for our staff, and your board are going to take that matter up and see how such a scheme can be worked out. I beg to propose that the report and accounts be adopted.

Mr. FRANCIS ALEXANDER JOHNSTON seconded, and the motion wasc arried unanimously and the dividends recommended were declared.

The retiring director, Sir J. Denison-Pender, K.C.M.G., was re-elected. A motion approving of the payment of the directors' remuneration free of income tax was unanimously passed, and the auditors (Messrs. Deloitte, Plender, Griffiths, & Co.) were re-appointed. A vote of thanks to the directors (moved by Mr. Sidney Collett and seconded by Mr. A. R. Hardie) was unanimously accorded, and the proceedings then terminated.

W. T. Henley's Telegraph Works Co. (Ltd.)

The 38th ordinary general meeting was held on Friday last, Mr. Sydney Gedge, M.A., the chairman, presiding.

The SECRETARY (Mr. A. E. Salmon) read the notice convening the meeting, and the report of the auditors having been read,

The CHAIRMAN, in moving the adoption of the report of the directors and the balance-sheet, observed that the report was an exceedingly good one having regard to existing adverse circumstances. By the Excess Profits Act the amount of profits the company could take was fixed; anything else—if there was anything else—must go into the coffers of the State. For work the company had the greatest difficulty in obtaining raw material, and even a greater difficulty in delivering goods when completed. He did not make any complaint, but the directors had constantly to keep in mind the fact that they were not doing work, and could not do work for their former customers. Whether or not any rivals were springing up who would endeavour to rob the company of their ordinary commercial work when peace was declared it was hard to say. At all events, they had to prepare and they were preparing for such a state of things, as would be noticed from an inspection of the accounts. Having drawn attention to the results of the working for the past year, and referred in some detail to the allocation of the profits and to the proposed strengthening of the reserves, he stated that no fewer than 796 of their staff and workmen had joined his Majesty's Forces, of whom, he regretted to state, 28 had been killed in action or had died of wounds, while 90 had been wounded, the total number of the casualties up to date being 133. The company were now employing over 800 women, and every care was being taken to provide for their welfare and comfort.

The MANAGING DIRECTOR (Mr. Geo. Sutton), M.I.E.E., in seconding the motion, stated that their commercial trading had nearly entirely disappeared. The profit, which was very handsome, might be a little larger than was shown. They expected eventually that other sums would come to the credit of the company, as they were making claims upon the Government in regard to depreciation and machinery bought by them. Thoss claims, however, had not yet been settled, and in dealing with the accounts the profit had been taken after allowance for special taxation, and they had shown the worst position to the company. The shareholders might therefore expect that when a settlement was obtained the position would really be better than appeared from the accounts. He thought it matter for regret that the accounts for 1915 as regarded taxation had not yet been settled. If the accounts for that year had been settled the directors would have been able to give a more accurate statement of the company's profits for 1916. At the meeting last year he informed the shareholders that the Act provided that an allowance should be made against the excess profit paid by the company in respect of any machinery or plant which they purchased for war requirements and which the directors did not contemplate would be of any use to the company when the war closed; but in their negotiations with regard to the 1915 settlement the taxing authorities suggested that certain claims which had been made on that account should be spread over a number of years. He, however, submitted that if such machinery made excess profits, the first charge upon those profits should be the cost of that machinery and that there should be no question of spreading it over a number of years. He thought the excess profit taxes were badly conceived, and he did not think they were being carried out by the taxing authorities as generously—or, should he say, as justly?—as had been expected when the Act was passed. A good deal of commercial business was included in the accounts for 1916 because that class of business had been gradually shut down since the beginning of last year, and was being shut down now more vigorously by the authorities than previously. He quite agreed that it was necessary to stop all non-essential work. He thought that the arrangement made with regard to excess profits might have been considerably improved upon by Parliament. He thought that the profits, by which the company received 20 per cent. over their standard period and nothing more (except that they got some allowance, which was not fixed yet, in relation to any enlarged capital they might have) was thoroughly bad for the industries of this country. The object of men of business trained in the working of industries was to run the business with which they were connected as economically as possible, to turn out their work as efficiently as they could, to sell at a good price and to give a good return to those who had invested their capital. That incentive, however, was taken away in present circumstances. He did not object, but with a depleted staff it was regrettable that they had for more work to do than they had ever previously had in connection with statistics and information concerning the company's business which they had to furnish to Government departments. He did not wish them to think that he was complaining of excess profits payment; on the contrary, he thought it was a very proper thing that war profits should go to the State. He was only complaining of the way in which the taxation was imposed. The company's relations with regard to their workpeople were very satisfactory. They had made a very great advance in the rates of wages, but that was only right in view of the considerable increase in the cost of living, but he complained of the receipt of instructions from Government departments to increase the wages of certain classes of the workpeople, such instructions being given without any consultation with the management. He might mention in this connection that at one of their works only 30 people came under a certain award of the Board of Trade for an advance in wages, and in consequence he had exercised the directors' authority to raise the wages at the works inquestion by between £12,000 and £15,000 a year to some of their people in order to prevent dissatisfaction. With reference to the large dividend being paid by the company, he desired to repeat that the Directors were able to pay a large dividend because a great deal of the profits made in former years had been left to the company to trade with and no interest had to be paid upon that capital. They had plenty of orders on their books and a large number of orders which ought to have been executed 6, 12 or 18 months ago, which might be good or not at the present time—orders from foreign buyers. Foreign trade was shut down and meantime certain other nations were pushing their products anong the company's customers. Japan and the United States especially were very active in the British Colonies, South America and neutral States, but he thought that when the war was over the company would have no difficulty in dealing with such competition. They would be able, he believed, to get their connections back and to keep their trade, but they would be confronted with this position when the war closed—that the Government would instantly stop their work, and when that happened, the company would have no work in their factories. They could make work by manufacturing for stock, but as their managing director, he

Digitized by Google

was very doubtful whether he would be willing to place any considerable amount of work on their machinery with copper at two or three times its normal value and with the certainty that if they made stock with the existing high prices of raw materials they were bound to lose money on everything they manufactured. He could only say that the financial position of the company was strong—stronger, perhaps, than the shareholders imagined ; their reserves were large ; and, so far as he could see, speaking with all his experience, the company would be able to weather the worst storm that might arise at the close of the war.

The motion was then carried unanimously and a resolution was passed sanctioning the declaration of a dividend on the ordinary shares at the rate of 15 per cent. (less tax) including the interim dividend of 5 per cent. paid in September last, and of a bonus of 10s. per share (less tax). The retiring directors and auditors were re-elected, and a resolution was passed authorising the directors to apply a further sum of £5,000 to the staff pension and benefit fund. The proceedings terminated with votes of thanks to the directors and staff for their services during the past year and to the chairman for presiding.

ALDERSHOT GAS, WATER & LIGHTING CO.—At the recent meeting it was reported that the electricity department had made considerable progress during the past year, as there was an increase of nearly 76 per cent. in sales over the previous year. The chairman (Mr. W. T. Robertson) said the results of the electricity department had been marvellous ; it was an extraordinary thing that at the end of the second year they were able to announce that it had been placed on a paying basis. There were few electric light companies in the country which could equal that record in the time.

BRITISH ALUMINIUM CO. (LTD.)—Mr. A. W. Tait, who presided over the meeting on Friday, said that while he was unable to give any particulars of the uses to which the metal was at present being put, there was no doubt that the experience which was being obtained during the war, including the production of light alloys, would be of the greatest possible use in extending the field of development for the metal for ordinary commercial purposes. There was a strong probability that the motor-car industry after the war would manufacture their engines largely from aluminium because of its lightness and consequent saving in running costs and of its qualities of quick radiation of heat. He was of opinion that it would not be very long after the cessation of hostilities before the commercial development and expansion in the uses of the metal would take up the increased supply, and possibly also call for further production. They were pushing on with certain hydraulic works at Kinlochleven for the provision of additional water supply to the Blackwater reservoir from another catchment area. The work had been in progress for some time, but it was considerably retarded owing to shortage of labour and materials, and also to inclement weather. The work was of national importance, because of the urgent need for the metal in practically every branch of the service. Work had also been proceeding for some time to increase the available water supply for the works at Vigelands (Norway). The maintenance of supplies of raw materials and coal required by their various works in Great Britain and Norway had been exceedingly difficult and had on many occasions caused considerable anxiety. As the whole of the bauxite had to be shipped from the South of France, they had constantly to make provision for possible contingencies. After giving an analysis of the accounts, he said that the profits were £379,519. After providing for income-tax, legal expenses, depreciation of investments, prior lien debenture, and debenture stock service, reserves, &c. the available balance was £104,962. 15s. After allowing for the preference and interim dividends the directors recommended a final dividend at rate of 12 per cent. per annum on the ordinary share capital (making with the interim dividend 10 per cent. for the year), leaving to be carried forward £26,926. 11s. Referring to the recent speech of the President of the Board of Trade (Sir Albert Stanley) that it was the intention of the Government to do everything they could to assist and foster the key industries of the country, he said that the aluminium industry was undoubtedly one of the key industries of the country, and well merited such assistance as the Government could see its way to give. It was also necessary that there should be a speeding up on the question of research, and research in the aluminium industry, particularly in alloys, was of great importance.

BRITISH ELECTRIC TRANSFORMER CO. (LTD.).—Mr. A. F. Berry, who presided over the annual meeting last week, said that the directors did not consider it advisable to recommend a larger dividend than that paid last year (7½ per cent.) on the ordinary shares. The amount carried forward to next year was about £1,176 in excess of that brought in, and only about one-half of the earned profit was recommended for distribution. With regard to the past year's working, they carried out large volumes of work, and all things considered, had obtained fair prices, though the question of price was one that had to be watched very carefully in view of the tendency of the prices of materials and labour to rise. They started the current year with more work in hand than last year, but it was quite impossible to forecast from year to year what might happen. The staff in the works and offices were pulling together and bearing their respective loads and troubles with a spirit beyond all praise. He recommended the shareholders to give the company an opportunity to help them and their friends with "Tricity" canteens such as they had latterly installed for some leading works. Those were especially important in view of the serious shortage of food, as very considerable savings could be effected, not merely by the use of "Tricity" cookers, but by the adoption of what he would call "Tricity" methods of cooking. Although there were many thousands of persons who benefited through the introduction of "Tricity" methods, there was far more to be done, and to meet the increased demand they were extending their premises. They had now acquired the completed works adjoining them on their western side. Last year he referred to the phenomenal rate of growth of the electrical manufacturing industry since the outbreak of war. The past year had seen still greater strides taken in the march of electrical progress That extraordinary development continued and was carrying the country swiftly into the electric age and to a general recognition of the value of electrical energy to the engineering and most other trades. Electrical engineering had stepped well forward into the ranks alongside of other branches of engineering and agriculture, and at last the country had awakened to the importance of "producers." They had seen the producers who "do" things win the tardy recognition of those who "talk" things only, and thought they governed. He strongly suggested that those who were concerned with production should link up with the Federation of British Industries, as they had recently done.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.).—In moving the adoption of the annual report and accounts at the meeting last week the chairman (Mr. H. R. Beeton) explained why the directors recommended a reduction in the annual dividend which had been regularly distributed for the last 13 years. The Summer Time Act and lighting restrictions had affected them adversely, and the phenomenal rise in the price of coal and a general increase in working charges had also increased the expenditure. In spite of a steady growth in lamps connected and of a 10 per cent. increase in price, and in spite also of the development of electric cooking, which now amounted to over 10 per cent. of their total output, the falling off in receipts was about £600. They burned less coal, but they paid much more for the reduced quantity. The increased coal cost was £500, and would have been less but for a delay in the delivery of their new 1,500 kw. turbo-alternator. The new generating set was now working most satisfactorily and was largely reducing their coal consumption. The coal position continued an anxious one. The increase in wages continued to grow in consequence of gratuities to meet the increased cost of living and allowances to dependents of employees on active service. The expenditure on voluntary allowances was about £1,200. The burden of administration devolving upon their reduced staff had been borne with cheerfulness and devotion.

FARNHAM GAS & ELECTRICITY CO.—At the recent meeting it was stated that the electricity department had generated 140,698 units against 143,028 last year. The company had been affected by the lighting restrictions and by transport and other difficulties.

HADFIELDS (LTD.)—Sir Robert Hadfield presided over the meeting last week, when dividends and a bonus amounting to over 30 per cent. for the past year were sanctioned. The chairman congratulated Sheffield University on the establishment of a Faculty of Metallurgy, on having provided in the person of Mr. H. A. L. Fisher a Minister of Education, and in the appointment of Dr. Ripper as Vice-Chancellor and Prof. Arnold as the first Dean of the Metallurgical Faculty.

O. C. HAWKES (LTD.)—At the meeting on Friday the chairman (Mr. O. C. Hawkes) said that they had decided to close their Australian agency. The ordinary shareholders had been without any return for some time, and it was, therefore, only right and proper when the company had earned it they should get a dividend.

ISLE OF WIGHT ELECTRIC LIGHT & POWER CO. (LTD.)—At the recent meeting it was reported that the stringent lighting restrictions and the effect of the Summer Time Act had caused a large reduction in revenue from lighting, which had only partially been made up for by increase in prices and by the increased supply taken by power users. At Ventnor and Bonchurch the connections were equal to 897 kw. (against 871 kw. in 1915), at Sandown and Shanklin 968 kw. (against 940 kw.), at Newport and Cowes 2,364 kw. (against 2,099 kw.) and at Ryde and St. Helens 1,264 kw. (1,186 kw.), or a total of 5,493 kw. (against 5,096 kw.). The year's profit was £8,971, compared with £10,493. After providing for interest and sinking fund on debentures (£5,500) and 5 per cent. dividend on the preference shares (£2,500), the balance was £2,338. A sum of £2,000 was placed to renewal fund account and £338 carried forward.

LAUNCESTON & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The past year's receipts were £1,102 (against £1,233 in 1915), and working expenses £635 (against £516). The increased expenditure was largely due to battery cleaning and renewal, and the purchase of two new motors for blowing the fires. The number of consumers increased from 205 to 227, and the 8 c.p. lamps connected from 5,631 to 6,413. The gross profit was £466. After deducting bank charges and preference dividend, the net profit was £340. A dividend of 2½ per cent. has been declared on the ordinary shares, £125 has been placed to depreciation and £37 is to be carried forward.

LIVERPOOL DISTRICT LIGHTING CO. (LTD.)—The chairman (Mr. Chas. M'Laren) stated at the meeting last week that the supply of electricity in Waterloo and Crosby showed satisfactory progress, the quantity sold during 1916 being 599,740 units. There had been a falling off in the supply to householders and tradesmen for lighting, but that had been counterbalanced by additional sales to the War Office, so that the total revenue was almost the same as in 1915. The available balance was £4,257, and a dividend of 4 per cent per annum was declared, £1,341 being placed to depreciation and £1,055 carried forward.

LLANELLY & DISTRICT ELECTRIC LIGHTING & TRACTION CO. (LTD.)—Mr. A. R. Holland presided at the meeting on the 26th ult., and congratulated the shareholders on a more satisfactory showing than for 1915, due to a general all-round improvement in revenue from the electricity supply and tramway sections. The working expenses had greatly increased owing to coal and labour difficulties. New power consumers were being secured at satisfactory rates under long-term contracts, and

Digitized by Google

in view of the general progress arrangements had been made for increasing the plant at the power house. The plant extension was expected to be in service towards the latter end of April. The increases in the profit enabled the directors to recommend a slight increase in the dividend on the ordinary shares. Dividends at rate of 6 per cent. per annum on the cumulative preference and 3 per cent. per annum on the ordinary shares were declared, and £1,483 was carried forward.

MINEHEAD ELECTRIC SUPPLY CO. (LTD.)—The report for 1916 states that lighting restrictions and the increased cost of fuel and repairs adversely affected the financial results of the year's working. The units sold for heating and cooking showed an increase and the total units sold were 236,533, against 230,416 for 1915. The average price obtained fell from 3·40d. to 3·36d. per unit. The profit (after paying debenture interest) was £1,466. After paying the preference dividend and 8 per cent. on the ordinary shares, and putting £850 to depreciation and reserve, £56 was carried forward.

NEWMARKET ELECTRIC LIGHT CO. (LTD.)—At the meeting last week the directors reported that during 1916 the equivalent of 489 33-watt lamps were connected to the mains, making the total connected 31,925 lamps. The profit on the year's working (added to £219 brought forward) was £1,843. After paying debenture interest (£710), the balance was £1,133. The directors recommended that £650 be carried to reserve for renewal of plant, and that the balance of £483 be carried forward.

The Chairman (Mr. F. E. Gripper) said that during the year war conditions had affected them very severely. Comparing the year with 1913, the year before war broke out, although they had connected a considerable number of new consumers, their revenue from lighting had fallen off by £824. They had supplied more electricity for power, which had increased their revenue from that source by £199, but owing to the increased cost of coal and other materials their expenses had been increased by £191. The profit had, therefore, been reduced by £867 compared with 1913. That decrease had taken place notwithstanding the increases in the prices charged to consumers. The directors regretted the absence of a dividend, but they were satisfied that in view of the uncertainty as to what might be in store for them during the present year, it was wise to conserve the resources of the company.

SLOUGH & DATCHET ELECTRIC SUPPLY CO. (LTD.)—Mr. C. J. Jackaman presided over the recent meeting when it was reported that last year the capital account had been increased by £4,848, making the total £72,246. The equivalent of 3,275 30-watt lamps had been added during the year. The total available for distribution was £3,487, of which £1,500 was allocated to depreciation and reserve. A dividend of 3 per cent. (less tax) was recommended, the balance of £192 being carried forward. The chairman said that they had increased their sale of units by nearly 28 per cent., but the increase in revenue was only 25 per cent. There was a reduction of £600 in the receipts from lighting. One of the largest boilers in their works broke down, and their engineer succeeded in obtaining two splendid second-hand boilers, the combined steaming capacity of which considerably exceeded that of the boiler taken out of service. They had also spent £4,290 on a new cable to meet the increased load. The average price of coal for 1915 was under 22s. per ton, but for 1916 it was nearer 29s. The average price of oil in 1915 was 98s. 3d. per ton, whilst for 1916 the average price was 162. 5d., and at present it is 207s. 9d. per ton. The fuel bill had risen by £2,106 over 1915, or over 76 per cent. They were having fitted to their Diesel engines apparatus which would admit of the use of a much cheaper oil and a contract for the supply of that oil has already been entered into. In their provisional order the maximum price they might charge for the lighting units was fixed, but no such protection was afforded as to the maximum price the company was to pay for the fuel consumed in generating those units. In all other industrial undertakings the price of the article produced would vary in harmony with the cost of the raw material used, plus, no doubt, some percentage of profit. All that the directors could do was to raise the price of the unit to the maximum in June, 1916. In Sept. last they entered into a five years' contract for the supply of electrical energy for power to Messrs. G. D. Peters & Co.

URBAN ELECTRIC SUPPLY CO. (LTD.)—The gross profit for 1916 amounts to £64,983, compared with £68,513 in 1915, and after deducting the expenses the balance is £61,772. The amounts required for interest and debenture stock redemption absorb £43,748, leaving an available balance of £18,024. The directors recommend that £10,000 be placed to reserve for depreciation, and that a dividend of 2½ per cent. for the year be paid on the preference shares (£6,250), leaving to be carried forward £1,774. The total connections of the 13 undertakings of the company were equal to 33,886 kw., against 30,376 kw. in 1915, and 27,606 kw. in 1914.

NEW COMPANIES, &c.

AMALGAMATED TRADERS (LTD.) (146,953).—Private company. Reg. March 29, capital £10,000 in £1 shares, to carry on the business of brass and ironfounders, metal workers and dealers, electrical and general engineers, &c.

HATTON MODEL ENGINEERING CO. (LTD.) (146,786).—Private company. Reg. March 22, capital 5,000 in £1 shares, to carry on the business of engineer., electricians, &c.

V. D. LINDEN & CO. (LTD.) (146,704).—Private company, reg. March 20, capital £5,600 in £1 shares, to carry on the business of metallurgists, metal merchants, chemical manufacturers, electrical and general engineers, &c. First directors, M. J. de Smet de Naeyer E. Manne and F. Van der Linden (all permanent).

NOTTINGHAM ELECTRO-PLATING CO. (LTD.) (146,641).—Private company, reg. March 19, capital £7,000 in £1 shares (3,000 pref.), to take over the business carried on as the Nottingham Electro-Plating Co. First sole director, E. Wilford.

VICTORIA CHEMICAL CO. (LTD.) (146,393.)—Private company reg. March 9, capital £11,500 in 10,000 ordinary shares of £1 each and 30,000 deferred shares of 2s. each, to take over from T. Hadham, F. H. Rogers and F. B. Dehn the option of purchasing from J. A. Kendall his patent No. 26,896/12 for the treatment of chlorides of the alkali metals for obtaining useful products therefrom, and the option of purchasing a patent which J. A. Kendall holds jointly with the executors of the late Sir J. Swan for improvements in manufacture of metallic sodium. First directors are T. Needham, F. H. Rogers, F. B. Dehn and A. G. Elliot.

RECEIVERSHIP.

NEW ERA SIGNS (LTD.)—Notice is given of appointment of G. I. Rowley, 74, East-hill, Wandsworth, S.W., as receiver on March 16, 1917, under powers contained in debentures, dated May 1, 1916.

CITY NOTES.

MEMORANDA.—(April 3).—Consols, 54¼. Consols Pay Day, May 4. Stocks and Shares Ticket Days, April 12 and 26. Pay Days, April 13 and 27. Price of Silver, 36 13/16 d.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended March 31 of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stocks (less tax).

EASTERN TELEGRAPH CO. (LTD.)—The company announce the payment by warrants on May 1 of interest for the half-year ending 30th inst. on their 4 per cent. Mortgage debenture stock. The transfer books of the debenture stock will be closed from April 25 to 30, inclusive.

SUBMARINE CABLES' TRUST.—Notice is given that on the 16th inst. the coupon due on the 15th inst. will be paid by Messrs. Glyn, Mills & Co., 67, Lombard-street, London, E.C. New sheets of coupons will be ready on the 30th, and may be obtained at the offices of the Trust, Electra House, Finsbury-pavement, E.C.

VICKERS (LTD.)—The directors recommend a final dividend for the year 1916 of 1s. 6d. per share (tax free) on the ordinary shares, making 2s. 6d. per share, or 12½ per cent. for the year.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From March 24, 1917, *to* March 30, 1917.

IMPORTS.

London.—*U.S.A.:* Elec. machinery, £7,118; telegraph material, £371; unenumerated, £6,682. *Japan:* Unenumerated, £732. *France:* Elec. carbons, £878; unenumerated, £233. *Switzerland:* Elec. machinery, £118; unenumerated, £952. *Holland:* Elec. glow lamps, £722. *Japan:* Unenumerated, £732.

EXPORTS.

To Australasia.—*Auckland:* Unenumerated, £289. *Melbourne:* Elec. machinery, £60; wire and cable, £17; unenumerated, £347. *Sydney:* Elec. machinery, £324; elec. lamps, 12,450 n.o.; unenumerated, £383. *Wellington:* Elec. lamps, 4,330 n.o. *Adelaide:* Elec. machinery, £32; unenumerated, £14. *Christchurch:* Unenumerated, £122. *Brisbane:* Unenumerated, £128. *Perth:* Unenumerated, £11. *Dunedin:* Unenumerated, £182. *Freemantle:* Elec. machinery, £140. *Timaru:* Unenumerated, £25. *Lyttleton:* Elec. machinery, £46.

Africa.—*Cape Town:* Elec. lamps, 900 n.o.; wire and cable, £17; unenumerated, £770. *Port Elizabeth:* Wire and cable, £54; unenumerated, £228. *Durban:* Elec. machinery, £645; wire and cable, £733; unenumerated, £1,620. *East London:* Wire and cable, £437; unenumerated, £565. *Chinde:* Unenumerated, £51. *Zanzibar:* Unenumerated, £257. *Biera:* Elec. machinery, £121; unenumerated, £76. *Morocco:* Elec. machinery, £120.

Egypt.—*Port Sudan:* Telegraph material, £11. *Alexandria:* Elec. machinery, £2,100; unenumerated, £54.

India, Ceylon, Indo-China and Straits Settlements.—*Bombay:* Elec. machinery, £1,543; unenumerated, £478. *Calcutta:* Elec. machinery, £713; wire and cable, £104; unenumerated, £58. *Singapore:* Unenumerated, £48. *Penang:* Unenumerated, £89. *Bangkok:* Elec. machinery, £24; unenumerated, £25. *Sourabaya:* Unenumerated, £49. *Kilindini:* Telegraph material, £39; unenumerated, £181. *Port Swettenham:* Unenumerated, £44. *Madras:* Unenumerated, £248. *Ceylon:* Unenumerated, £162.

China.—*Hankow:* Unenumerated, £68. *Hongkong:* Elec. machinery, £139; unenumerated, £96. *Shanghai:* Unenumerated, £11.

U.S.A.—*New York:* Elec. machinery, £192.

South and Central America.—*Buenos Ayres:* Elec. machinery, £22; elec. lamps, 1,000 n.o.; unenumerated, £691. *Valparaiso:* Unenumerated, £88. *Rio de Janeiro:* Unenumerated, £35.

West Indies.—*Bermudas:* Telegraph material, £59. *Trinidad:* Unenumerated, £39.

Holland.—*Rotterdam:* Unenumerated, £26. *Amsterdam:* Elec. machinery, £26; unenumerated, £293.

France.—*Dieppe:* Elec. machinery, £40; wire and cable, £195; unenumerated, £585. *Dunkirk:* Elec. machinery, £1,000. *Bordeaux:* Elec. machinery, £159; unenumerated, £155. *Paris:* Elec. machinery, £1,164; unenumerated, £1,051.

Portugal.—*Oporto:* Unenumerated, 108.

Norway.—*Trondhjem:* Wire and cable, £34.

Japan.—*Yokohama:* Elec. machinery, £97.

Malta.—Unenumerated. £27.

FOREIGN GOODS (duty paid and free).

Bombay: Unenumerated, £183. *Boulogne:* Unenumerated, £21; *Colombo:* Unenumerated, £16. *Durban:* Unenumerated, £40. *Kilindini:* Unenumerated, £52. *Madras:* Unenumerated, £112.

IN TRANSIT.

Singapore: Elec. lamps, 562; *Shanghai:* Unenumerated, £93.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

Digitized by Google

THE ROUND TABLE.

By "KVA."

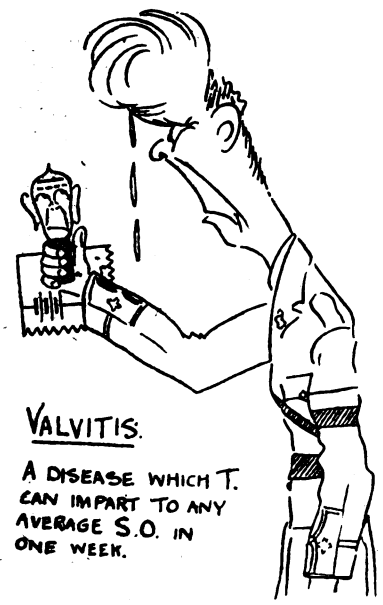
Event of the Week.—Aylesbury U.D.C. increases the salary of its electrical engineer to £225 per annum, rising to a maximum of £250 per annum by (easy) stages of £12. 10s. per annum!

* * * *

The British Association will not meet this year owing to limited travelling facilities, &c. What a relief for next year's President, who will now be able to select a subject for his inaugural address!

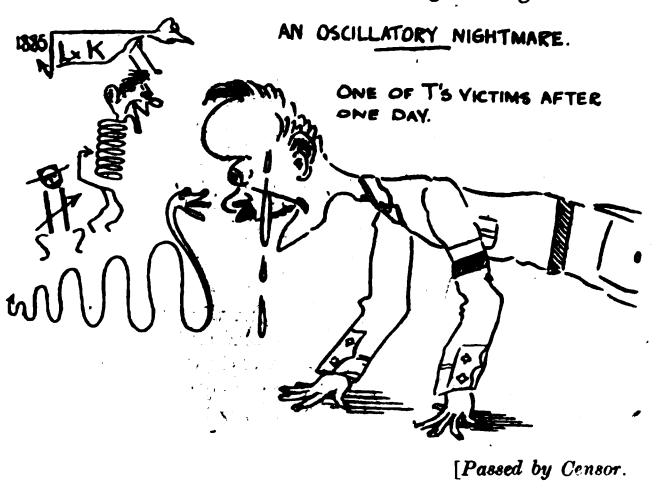
* * * *

Lieut. W. R. H. Tingey, R.E., has kindly sent me a couple of sketches which are intended to illustrate the effects of his tabloid wireless lectures upon his students. The complete



[*Passed by Censor.*

course occupies a week, during which time there is a tendency for the mind to become "jambed." I understand that it is even difficult to "cut in" with a message asking the victim if



[*Passed by Censor.*

he will have a drink! Wireless men generally will appreciate the clever way in which the artist has made diagrams and formulæ take horrific shapes.

THOMAS A. EDISON.

1847. February 11. 1917.

Full three score years and ten have passed
Since first beheld the light of day
Eyes planned to search earth's wonders out,
And watch the growth of science's sway.

Created, all the world to bless,
His inmost soul divined the call;
Though Nature's forces blocked his way,
Yet strength of will o'ercame them all.

Through years of consecrated toil
No selfish motives ruled his mind;
A genius in the work he loves,—
At home, devoted, thoughtful, kind.

His best he freely gives the world,—
The world which loves its gifted son;
Despite success already gained,
His greatest deeds have but begun.

A master mind, well trained and keen,
Has conquered where the many fell:
This tribute fame accords his name,—
"Behold he doeth all things well."

May years of usefulness and peace
Long grace our true inventor friend;
Assured that while the ages last,
His name of names shall never end.

[From "Edison Life."

* * * *

Ten shoddy switches fixed all in a line,
One broke its contact spring, and then there were nine.
Nine little switches, china just like slate,
One developed faults within, and then there were eight.
Eight little switches, sparkling bright as heaven,
Contact rocker broke off one, and then there were seven.
Seven little switches, famous for their tricks,
One stripped its cover thread, and then there were six.
Six little switches, more or less alive,
One gave a chap a shock, and then there were five.
Five little switches, fixed just near the door,
One lost its insulance, and then there were four.
Four little switches, working far from free,
The rocker pin came out of one, and then there were thre .
Three little switches, feeling rather blue,
China link broke on one, and then there were two.
Two little switches, smacking like a gun,
Contact arm on one got skewed, and then there was one.
The little switch that then was left, got cracked across its face,
British switches came along and quickly took their place.

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), April 3, 1880.]

The Electric Light on the Embankment.—This light will be continued for another year, the Board of Works having accepted the terms of 2½d. per hour per light. The Board have also granted the Edison Telephone Company permission to lay wires in the subways in Southwark-street and Commercial-road.

Use of the Telephone at the Volunteer Review on Easter Monday.—The telephonic communication established between Newmarket Farm and Lord Renelagh's brigade on Castle Hill worked satisfactorily under the superintendence of Colonel Wiggans, 16th Lancers. The distance spoken over was about a mile, and the appliance was found of considerable service in transmitting orders and giving and receiving intelligence.

Very Considerate.—Our erratic French contemporary "L'Electricite" (March 5th) says: "We see with pain that certain French scientific journals have noticed and illustrated certain articles on the Birmingham wire gauge. Every innovation tending to retard the disappearance of feet, inches, lines, gallons, pounds, &c., will be banished from these columns as unworthy to figure in a serious scientific publication. The best service that can be rendered to English scientific men is to bury in silence this proof of their ignorance

TUNGSTEN FOR ELECTRICAL CONTACTS
MORE EFFICIENT AND MUCH CHEAPER THAN PLATINUM.
Recommended for use for X-Ray Targets, and as Contacts on Induction Coils and Tapping Keys, Magnetos and similar devices where there is frequent making and breaking of Electric Current. Also suitable for Gas Engines, Circuit Controllers, and like purposes.
Write for Particulars.—
THE L.P.S. ELECTRICAL COMPANY, 14, Howick Place, Westminster, S.W.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

Digitized by Google

SIEMENS

IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars
Distribution Boards
Main Switchboards

Write for particulars to —

SIEMENS BROTHERS DYNAMO WORKS LIMITED
Head Office: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: Western 6349. Telegrams: "Siembralos, Kens, London."
Lamp and Supplies Dept.: 58 & 59, UPPER THAMES STREET, E.C. 4.
Telephone: City 5350. Telegrams: "Siemotor, Cent., London."

HOME BRANCH ADDRESSES:

Birmingham—Central Ho., New St.
Bristol—30, Bridge Street.
Cardiff—89, St. Mary Street.
Glasgow—66, Waterloo Street.
Manchester—196, Deansgate.
Newcastle—64-68, Collingwood Sheffield—22, High St. [Bldgs.
Southampton—46, High Street.

Branches in Principal Towns Abroad.

21s. net. Post Free 21s. 6d. Vol. III.

ELECTROMAGNETIC THEORY.

BY

OLIVER HEAVISIDE.

The opening chapter of Volume III. deals with "Waves from Moving Sources," and after two appendices on the Size and Inertia of Electrons and on Vector Analysis, there is a lengthy chapter on "Waves in the Ether."

"THE ELECTRICIAN" PRINTING & PUBLISHING COMPANY, LIMITED,
1, 2 and 3, Salisbury Court, Fleet Street, London, E.C. 4.

Price 15s. net, postage 6d. extra (U.K.).
Over 600 pages. Very fully illustrated.

ELECTRIC SWITCH AND CONTROLLING GEAR.

A Handbook on the Design, Manufacture and Use of Switchgear and Switchboards in Central Stations, Factories and Mines.

BY

C. C. GARRARD, Ph.D., M.I.E.E., A.Am.I.E.E.

"THE ELECTRICIAN" PRINTING & PUBLISHING COMPANY, LIMITED,
1 2 and 3, Salisbury Court, Fleet Street. London, E.C. 4.

U.S.A. NAVAL RADIO STATIONS.

The radio station recently built for the United States Navy Department at Chollas Heights, near San Diego, Cal., is now in regular service. The power house plant, which is nominally rated at 200 kw., operates on the Poulsen system, and is the most powerful thus far put into service by the Department.

It is reported that the tests of the new plant have exceeded the Government requirements. The aerial is carried by three 600 ft. self-supporting steel towers placed in a triangular position. The operating and office building is separate from the power house, and is provided with a sound-proof operating room. There are also barracks for operators, and several buildings for officers in charge. This plant is the third in the chain of naval high-power radio stations, of which Arlington was the first and Darien the second. Pearl Harbour and Cavite are the next two to be equipped, and these will have apparatus of much higher power than that at San Diego. The whole of the stations are being equipped by the Federal Telegraph Co., and will be operated on the Poulsen system.

THE GERMAN ELECTRICAL INDUSTRY.

In the circular issued by the British Empire Producers' Organisation attention is called to a recent article in the "Frankfürter Zeitung" on the position and prospects of the electrical manufacturing industries in Germany. It appears that on an aggregate capital of £36,390,000 the principal companies paid for 1915 an average dividend of 10½ per cent., compared with a little over 9 per cent. in 1913 and 1914. The profits increased from £3,873,250 in 1913 to £4,223,000 in 1914 and £5,181,350 in 1915, and as there is no excess profits tax in Germany, large sums are no doubt being appropriated towards supporting the resumption of export trade after the war.

The "Frankfürter Zeitung" states that:—"More than any other German large-scale industry, the electrical industry was characterised, already before the war, by enormously extended works and by a carefully organised financial system which spread its net over half the globe. The industry thus became one of the strongest of the pillars on which German industrial expansion rested, but because of its international interests it offered many points of attack in a time of crisis like the present. Yet the industry has not only withstood the onslaughts made upon it, but has actually improved its financial position. The remarkable nature of this achievement becomes apparent when it is borne in mind that the industry is cut off from some of its important foreign interests, that these very interests have been endangered by a ruthless policy of persecution, and that the industry has been almost completely deprived of a branch of its activity which is vital to it, viz., its export trade. The industry has achieved its successes by reconstructing itself for purposes of war work. The enormous factories with their exemplary organisation and their hosts of skilled workers and technical specialists, have become indispensable centres of war activity. But while the net profits have been high, the dividend rates have not been commensurate with them. This is due—(1) to the very large sums required for war relief to workers; (2) to the need for heavy reserves to cover factories abroad, foreign securities and foreign claims; (3) to the necessity for laying by sufficient sums to make good the wear and tear of machinery which the war has worked at exceedingly high pressure; and (4) to maintain the strong financial position of the industry, which alone will enable it to organise itself on a fresh peace basis, and to win back the spheres of influence at present attacked by the hate-engendered business policy of Germany's enemies.

"It is of the utmost importance for the economic position of Germany after the war that large-scale industries like the electrical industry should make far-sighted provision for the future. The disparity between the net profits and the dividends actually paid to shareholders in the electrical industry is really evidence of strength."

U.S.A. ELECTRICAL ENERGY SALES IN 1916.

The "Electrical World" reports that in what was undoubtedly the best industrial year on record the central stations of the United States increased their income from light and power sales by 15 per cent. and delivered 22·5 per cent. more energy to consumers. The earnings for 1916, according to the returns received by our contemporary, were more than $415,000,000, or an increase over those of 1915 of $54,000,000, while the output was considerably in excess of 23,000,000,000 kw.-hr., an increase of 4,265,000,000 kw.-hr.

The December returns showed the earnings to have reached $41,000,000 and the output was 2,190,000,000 kw.-hr., or an increase in income over December, 1915, of 15 per cent., and in output of 20·8 per cent. December established a record both for income and output. The growth was largely due to an increased power load, a very appreciable factor being the scarcity of coal. Many isolated plants were threatened with complete shut-down unless they accepted central station service. Many stations that had contracts covering a long period were forced to go into the open market and buy whatever they could at the prevailing prices. Coal, labour and repairs were considerably more costly in 1916 than in previous years. The growth of the industry from an output of 1,500,000,000 kw.-hr. in January, 1915, to one of 2,200,000,000 kw.-hr. in December, 1916, is an indication of the progress made by the supply industry.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

GOULAH! GOULAH! GOULAH!

Thus the abracadabra of certain Oriental Conjurers who produce Sand Lizards from 10 centime pieces, and other weird feats of legerdemain.

The wonder evoked by these and others, such as the Basket and Mango Tree Tricks, has been recorded in reams of writing: but who devotes any reflection to the infinitely greater marvel of the transmutation of gross matter into the Perfect Cable, as performed daily, without spectacular incantations, in the workshops of the B. I.?

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Vicmaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.
ELECTRICAL MACHINERY
Engineers, Edinburgh.
See our Illustrated Advt. next week.

Digitized by Google

Electrical Engineers and Manufacturers

The House for Electric Heating.

Special Offer of "Quead" and "Ensign" Fires from Stock. Be Patriotic and Save Coal.

Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.

Telephone: Gerrard 7601 (2 lines)

Petrol Engine Sets.

Manufactured in sizes from 2 kw. to 20 kw.

Quotation for larger sizes on application.

F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON

"FORMITE"
(TRADE MARK).
BRITISH MADE SYNTHETIC RESIN.

WHEN STOVED IS UNAFFECTED BY
HEAT (Does not Soften),
CHEMICALS,
SOLVENTS.

FOR MOULDED AND BUILT-UP INSULATION.

For Samples and Particulars write—
THE DAMARD LACQUER CO., Ltd.,
98, BRADFORD STREET, BIRMINGHAM.

Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
PHOSPHOR TIN.
PHOSPHOR COPPER.

TRADE MARK.

CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.

GENUINE
M & M VULCANISED FIBRE.
MOSSES & MITCHELL, 122 & 124, GOLDEN LANE, LONDON, E.C.

INSULATION BEADS
...only satisfactory substitute for ... Wire; also for flexible ... etc. SAMPLE STOCKS ...
...HOLDER-HARRIDEN, LTD., ... STREET, LONDON, E.C.

ELECTRIC FAN STANDARDISATION.

The "Electrical World" states there is now evidence that the standardisation rules recommended by the Fan Manufacturers' Section of the Associated Manufactuiers of Electrical Supplies are being followed out by fan manufacturers wherever possible. The standardisation of nomenclature is particularly noticeable in the 1917 catalogues. The old term of "desk and bracket" has been replaced by the term "non-oscillating." Fans, therefore, are of two types, oscillating and non-oscillating.

In 1916 a number of manufacturers furnished cord and plugs with their fans, and this year practically all the others have followed suit, so it is safe to say that less than 10 per cent. of the 1917 output of fans will be furnished without cord and plugs. The fan manufacturers are now discussing standard length for the cord, but as yet no decision has been reached. Some are standing for one length and some another.

Considerable progress has been made in the standardisation of ceiling fans. In this connection recommendations have been made regarding size, number of blades and number of speeds. Owing to the fact, however, that a number of ceiling fans which do not comply with this standard were left over from last year, it is doubtful if the recommended standard will become general practice before 1918. In larger sized fans standardisation is noticeable, but below the 12-in. sizes there is a greater variety of sizes among the different manufacturers.

ELECTRICAL PROGRESS IN CHICAGO.

During the year 1916 it is reported that the connections for motor service to the mains of the Commonwealth Edison Co., of Chicago, were more than twice those of 1915 and aggregated 52,300 H.P. This figure is exclusive of street railway loads and of the demands for traction service.

To secure this load the company's contract department closed 3,122 contracts, among which were some 30 contracts covering the replacement of large isolated plants.

The lighting business obtained by the company increased 47 per cent. over 1915, or a net increase of over 1,000,000 50-watt equivalents. To give an idea of the work of the department in developing and putting into service new industrial heating devices, the "Electrical World" gives the following list of devices which have been developed and put into service during the past year: Putty warmers, wax compound heaters, cattle prodders, new type of gluing machines, enamelling ovens, drying rooms, electric heaters for oil cars, sand heaters, cloth steamer, seed germinator, heating sprinkler valves, lumber treaters, pyrographic machines, pearl shell heating, printing press ink heaters, bake ovens, fur dryers and optical furnaces.

During the year the estimating division handled 3,852 contracts amounting to $619,403, an increase of 51 per cent. in contracts and 88 per cent. in the amount of contracts compared with 1915. In this total were included 3,142 house-wiring contracts amounting in the aggregate to $406,908.

ELECTRIC SAFETY LAMPS IN AMERICAN COLLIERIES.

In the course of a discussion on a Paper recently read before the Coal Mining Institute on the "History and Development of the Electric Mine Safety Lamp," the "Iron and Coal Trade Review" states that some American mine managers gave their experiences in the use of the electric safety lamp.

Mr. J. M. Armstrong said he had 14,000 lamps in operation. The batteries of those which have been longest in use had been operated without reconstruction for 21 to 22 months. His men were all well disposed towards the lamps, and quite willing to use them. Mr. W. L. Affelder said he was using Wolf safety lamps at one of his mines, but had replaced them with Edison electric cap lamps. At first he installed only 65, and he nearly had a strike on his hands because the rest of the men thought the 65 who had the cap lamps were being unduly favoured. Wolf safety lamps were run for a total of 11,436 lamp shifts, and the total cost was 0·65d. per lamp per shift, excluding cost of labour in caring for and delivering the lamps. The cost of the electric cap lamps was 0·29d. per lamp per shift for everything but labour. As a further advantage, the new lamps increased the efficiency and the output of the men. The men at another mine regarded the electric lamps even more favourably than they did the carbide lamps they had been using before the mine had been declared unsafe for naked light working. They paid 2½d. per shift for the electric lamps, but said that they saved money by the change, as they would buy a carbide lamp nearly every month. Mr. E. M. Chance said that the electric cap lamp had distinct advantages over the old types of safety lamps, but it did not give as much light as the unprotected lamps.

Digitized by Google

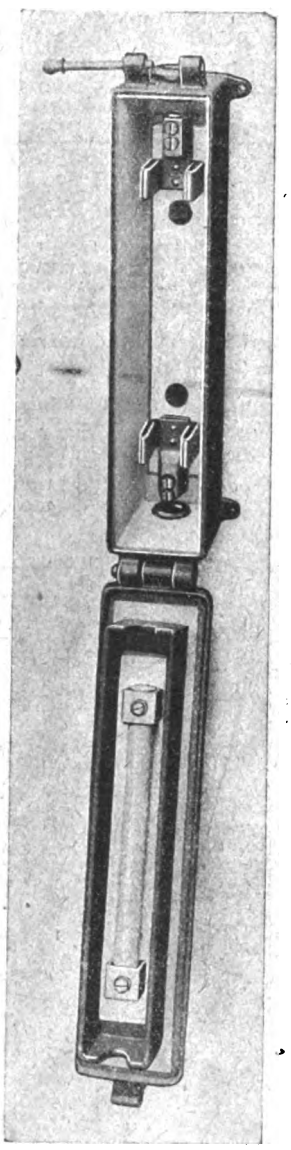
REYROLLE'S

SIX SPECIAL LINES

(1) 500-V. IRONCLAD **SWITCH FUSES.**

(As Illustration.)

50 and 100 amps. capacities.
Deals satisfactorily with short circuits.
Fireproof Linings.
Easy and safe for re-wiring.
No costly refills required.
Ordinary fuse wire used.



(2) **MOTOR STARTERS.**

Drum Type with Free Handle Circuit Breaker (interlocked), also Lever Type.

(3) **WALL PLUGS.** W.T., for outside use, as supplied to Admiralty, and Dustproof for Works use.

(4) **H.T. ARMOURCLAD SWITCHGEAR.**

(5) **MINING SWITCHGEAR.**

(6) **PROTECTIVE DEVICES,** to isolate faulty sections on Power Supply Systems without interruption of supply through Sound Sections.

A. REYROLLE & CO., LTD.

HEBBURN-ON-TYNE, England.

On War Office, Admiralty and India Office Lists.

Digitized by Google

☞ THIS ISSUE COMMENCES A NEW VOLUME. ☜

SUBSCRIPTION ORDER FORM.

THE ELECTRICIAN:
The Leading Journal of the Electrical and Allied Industries.

Please supply THE ELECTRICIAN weekly, commencing with next issue, to the address following:—

Name .....

Address .....

.....

Date .....

ANNUAL SUBSCRIPTION (U.K.): 28/- post free. ABROAD: ONE YEAR, 30/-.

This order should be forwarded, with remittance, to
"THE ELECTRICIAN" PRINTING & PUBLISHING COMPANY, LIMITED
1, 2 and 3, Salisbury Court, Fleet Street, London.

The
"Lancashire" Squirrel Cage Induction Motor

The "Lancashire" Squirrel Cage Induction Motor with centrifugal clutch and switch is cheaper in first cost, cheaper to maintain, easier to work and less liable to break down than any other type of Motor with switch-gear.

Ask us to send you Publications Nos. 139 and 146, which contain all details concerning both motors and clutches.

Lancashire Dynamo & Motor Co., Ltd.,

TRAFFORD PARK, MANCHESTER.

Telephones:
City 7450 (6 lines).

Telegrams and Cables:
"Ironclad, Manchester."

Hydro-Extractor driven by "Lancashire" Squirrel Cage Induction Motor.

LEWIS'S SCIENTIFIC CIRCULATING LIBRARY.

ELECTRICAL, MECHANICAL & GENERAL ENGINEERING TEXT BOOKS & TECHNICAL WORKS.

New Works and New Editions can be had from the Library immediately on Publication. Telephone: Museum 1072.

SUBSCRIPTION, Town or Country, from ONE GUINEA.
READING ROOM open Daily to SUBSCRIBERS.

H. K. LEWIS & Co. Ltd.,
136, GOWER STREET, and 24, GOWER PLACE, LONDON, W.C.

COMBINATION PIN PLUG AND LAMPHOLDER ADAPTOR.

Simplex Conduits (Ltd.) have recently put on the market a useful accessory which effects a combination enabling a lamp standard, small heater, toaster or suction cleaner to be connected up to either standard two-pin wall plug or lamp socket, whichever connection is most convenient for the particular situation where it is to be used.

The two parts of the combination are connected by a small brass chain. A very useful feature of the combination is that when used to connect any small circuit on to a lamp socket it converts the lamp socket for the time being into a two-pin socket, and the pin plug can be used to connect up in the ordinary way; if, however, temporary disconnection is required, the pin plug can be removed and remain ready to hand (suspended by the chain) for re-connection. It thus gives the convenience of a switch, and breaks circuit on both poles, and the pin points are "dead," and therefore safe, after removal, no portion of the subsiding circuit remaining alive. The adaptor is substantially constructed, the lampholder attachment being the brass connecting plugs moulded into fireproof material, or cocus wood, and the plug points being mounted on a china head with fibre discs for convenience in wiring. The adaptor is suitable for any and all temporary circuits up to 5 amperes at 220 volts.

CHEAP INDUSTRIAL POWER.

At the annual meeting of Coalite (Ltd.) last week the chairman (Mr. H. Willmott) said that there could not be any marked change in the finances of the company until the works at Barnsley were in full operation and proved the process to have the value that they attached to it.

They hoped the plant would start working soon; the delay in its completion had been due to labour difficulties and war conditions. Now that every civilised nation had become alive to the vital importance, not only of conserving its coal energy, but of providing cheap power for industrial enterprise, as well as to the enormous value attaching to the recovery of the many valuable by-products from coal distillation, it was manifest that low temperature carbonisation must progress by leaps and bounds. So many improvements had taken place, principally of an engineering character, in connection with the standardising of the Barnsley plant, that they were quite satisfied that it would be a long, long time before any possible competitor could gain anything like the knowledge that they possessed. Referring to the committee of the President of the Board of Trade to deal with the economical supply of electric power, he said that they were perfectly satisfied that their process would give the country cheap electric power, which was the greatest economical factor they had to face, and, in addition, all the many by-products obtained from low temperature distillation, such as motor spirit and the heavier oils, that the country was importing at present at an enormous cost, in addition to which there were the other valuable by-products.

HYDRO-ELECTRIC DEVELOPMENT IN QUEBEC.

It is reported that the demand for electrical plant and supplies, especially for electric motors, is very brisk in the Montreal district. The call for motors is mainly due to munition requirements, and also to the activity in the pulp and paper industries. The "Electrical News" states that the electrical drive in factories of all descriptions is increasing rapidly, and with this comes the demand for current which has grown to an enormous extent during the last few years. The supply firms report that business is very good, and that the great difficulty is to obtain raw materials, even at the largely enhanced prices ruling.

The Chicoutimi Pulp Co. has just purchased a large amount of electrical and hydraulic machinery for itself and subsidiary concerns, with a view to extending operations. The contract for the supply of the electrical equipment has been given to the Canadian Westinghouse Co., while the S. Morgan Smith Co. (York, Pa.) got that for the turbines. At the Chicoutimi Co.'s plant at Pont Arnault two 1,875 k.v.a. 2,000-volt three-phase 7,200 alternations 277 revs. per min. water-wheel generators will be installed, together with a 125 kw. 125-volt 500 revs. per min. water-wheel exciter unit, 12 625 k.v.a. transformers of 12,500 volts high-tension and 2,200 volts low-tension 60 cycles, and a switchboard for the power house. The two turbines by the S. Morgan Smith Co. are to be each of 2,500 H.P. direct connected to the generators, and the exciter turbine is to be of 175 H.P. The turbines will work under a head of 53 ft. They are to be fitted with Lombard oil-pressure governors. The present plant consists of one generator turbine and one exciter turbine of the same capacity as the new equipment. For the pulp mill at Chicoutimi a voltage regulator, two 1,800 H.P. 2,200-volt three-phase 60-cycle 257 revs. per min. motors for the pulp grinders, with switchboard equipment has been ordered.

At the plant at Quiatchouan Falls a 750 k.v.a. 550-volt three-phase 60-cycle 720 revs. per min. water-wheel generator, an exciter and a switchboard will be installed.

Machinery for the Saguenay Light & Power Co. at Bagotville, comprises a 750 k.v.a. 2,200-volt three-phase 7,200 alternations 514 revs. per min. water-wheel generator, an exciter and a switchboard. For the Ha! Ha! Bay Sulphite Co. (Bagotville) 40 motors of various sizes for the new sulphite mill and apparatus for the sub-station, consisting of step-down transformers and switchboard equipment, have been contracted for.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,030. [Vol. No. 2 Lxxix.] FRIDAY, APRIL 13, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES	57
Arrangements for the Week	59
Large Generator and Transformer Failures on the Rand Power Companies' Systems. By A. E. Val Davies. Illustrated	60
Machine-Switching Telephone Gear.—*Discussion*	62
Wheatstone Bridges and Some Accessory Apparatus for Resistance Thermometry. By E. F. Mueller. Illustrated	64
"THE EVIL THAT MEN DO LIVES AFTER THEM"	66
Some Points in Connection With Engineering Specifications. By J. Shepherd	69
Tramways With Rectified Current. Illustrated	71
LEGAL INTELLIGENCE	72
Volunteer Notices	72
COMMERCIAL AND INDUSTRIAL SECTION	75
Electricity Supply	76
Tenders Invited and Accepted	78
Financial Matters	79

NOTES.

Mercury Rectifiers.

THE mercury rectifier has been with us for a number of years, but so far its progress has been slow. There have been many difficulties to be overcome, and these could only be eliminated as the result of somewhat prolonged experience; moreover, someone has to be found to bear the cost of this pioneer work. Now, however, satisfactory results on a commercial scale appear to be obtained. An example is to be found in two Brown-Boveri installations on Continental tramways, particulars of which will be found elsewhere. In one of these, mercury rectifiers of a total capacity of 300 kw. are used for giving current at 600 volts. In large rectifiers of this class, made with iron containers, there has always been some difficulty in maintaining the vacuum, and consequently it has been usual to have a vacuum pump constantly running. From the point of view of cost and efficiency this is something of a detail, but unfortunately it eliminates one of the characteristics which the rectifier ought to possess - namely, that of being a piece of apparatus without moving parts. This is important when the rectifier is to be used in competition with motor-generators or with rotary converters. In the present instance it was found that the vacuum pump could be shut down after a certain period. Presumably it is sufficient to run the pump at intervals. As this has been found to be the case in both installations, we may assume that this class of rectifier has reached the stage when it shows advantages as compared with rotary plant. The statement is made that the overall efficiency of the installation, between half and full-load, is 93·2 per cent., and that the rectifiers are more economical than the previously used generators by 20 to 26 per cent. It might be thought that there would be some difficulty in working the rectifiers in parallel with other plant, but it has been found that they can be run in parallel with motor generators or with the machines supplying the Zurich tramways. This being so, it appears that the rectifier is worth more serious consideration than it has probably received on the part of most engineers in this country hitherto.

The Manufacture of Large Transformers.

IT is idle to claim kinship with men like FARADAY if our manufacturers will not benefit by FARADAY'S discoveries. The following is taken from the Discussion on a Paper read before the South African Institute of Electrical Engineers:—

> The PRESIDENT: Have you tried any English transformers? You have tried German and American. I do not know whether the English transformers are any good or not.
>
> Mr. BERNARD PRICE (Past President): I would like to ask the size of the largest British-built transformer that you know of.
>
> The PRESIDENT: Are there any representatives of the English manufacturers of transformers here to-night?
>
> Mr. GOULD: I would like to say opportunity is a good thing. English manufacturers have, to my mind, never had an opportunity of supplying really large transformers.
>
> Mr. BERNARD PRICE: I do not wish my remark to be taken as disparaging to British manufacturers, but the point is a very important one at the present time. It has been said that British manufacturers have not had the opportunity, but the question really is, have they accepted the opportunity?
>
> The PRESIDENT: Of course, the selling price has always to be taken into account. I agree that it is a matter requiring investigation.

We wonder what the reply of the British manufacturer will be? In the past there has been far too little of the heavy electrical business done in this country for the overseas market. Our "engineers" have been learnedly critical about the various systems of lighting, cooking and heating and such like trifles, while their competitors have been doing the engineering business. If it be that there are no designers of large transformers in this country we should imagine that such men could be induced to come over from America or from the Continent. We know of one inducement which is tempting to most men. To our mind the man who succeeds in business is the man who makes his opportunities, and if none of the large and old-fashioned firms will stir themselves in this matter, we hope that smaller firms will endeavour to secure some of the orders. In recent years the South African power companies have placed orders for 400,000 k.v.a. of transformers, the ratings varying from 4,000 k.v.a. to 12,000 k.v.a., and as far as our own people are concerned it has been a case of "Na poo."

The Teaching of English.

ONE result of the war has been the general stimulus to the study of foreign languages. At several of the chief universities of the country chairs of French, Russian and Spanish have been established, and there is every reason to encourage this development. Neglect of foreign languages has certainly been a great hindrance in the past. But hardly enough importance is yet attached to an even more crying need—the study of English. It is a common experience at the universities and technical colleges that the first year students almost invariably show little power of expression. They cannot write a lucid account of their experiments, and it not infrequently happens that a candidate who has acquired the art of expressing his ideas takes a place above men who have much greater aptitude for technical and scientific pursuits, but fail entirely to state their ideas in well-constructed and correctly-spelled sentences. The same deficiency is met with among business men and engineers in practical life. The writing of reports is to them not infrequently irksome and laborious, and the experience of scientific and engineering institutions is a repetition of those of teachers. The common difficulty in securing suitable

Digitized by Google

Papers is due very largely to the disinclination of engineers to put their ideas on paper. It is often said that those who know the most are least able to express their knowledge. It may be doubted, however, whether even an undeniably gifted man of action would not be even more efficient had he cultivated literary style. Writing, like teaching, is often a revelation of what we do not know, or know imperfectly.

Its Commercial Importance.

But it is, perhaps, in the commercial field that inability to write constructional English imposes the greatest handicap. In the commercial world the man who can only write "commercialese" is a back number. In dealing with foreign trade particularly the literary gift is a valuable asset. The average Frenchman, for example, who is an artist in language, is at once captivated by terse and lucid expressions and revolts against cumbrous and indefinite phraseology. And as the Englishman rarely condescends to express himself in a foreign language it is the more important that he should fully understand his own. We hope, therefore, that in the educational advances which are promised us in the near future the study of English will not be overlooked. We do not require that boys at school should be unduly taxed by grammatical intricacies or curiosities in mediæval English, but they should at least become accustomed to write freely and clearly in the English of the present day.

Iron and Steel Institute.—The annual meeting of the Institute will be held at the Institution of Civil Engineers on Thursday and Friday, May 3 and 4, 1917, commencing on Thursday at 10.30 a.m. and on Friday at 10 a.m. A number of Papers will be read.

A National Technical Lending Library.—There is a movement on foot by the Technical and Commercial Libraries Committee of the Library Association to form a national lending library of scientific and technical literature. It is suggested that such a library might be founded in connection with an existing State library, such as that at South Kensington, or with an existing State scientific department. The books would be made available for country readers, the idea being that municipal authorities should act as local agencies. In rural areas there might be local agents, or the books would be lent direct to students or officials of factories. In Germany a general public technical library is being established at Frankfort-on-the-Main.

Methods of Suspension on Italian Electric Railways.—Electric traction on the Italian railways has made great strides of late, a feature of which, commented on in "Engineering," is the complete standardisation of apparatus. Thus on a total of 700 km. (435 miles) of electrified line, haulage is effected by a single type of engine. Italy has also specialised by selecting from the longitudinal and cross-suspension systems concurrent in Europe and America one system, the cross-suspension only. This method is particularly applicable in view of the mountainous nature of much of the country traversed, and on the Valtellina railway, which was the first to adopt high-tension three-phase current, involving two contact lines under different voltages, has distinct advantages.

Manufacture of Porcelain for Electrical Purposes.—In a recent issue of the "Revue Générale de l'Electricité, Mr. R. Legouez refers to the rapid development of the manufacture of porcelain materials for electrical work in France. Previous to the outbreak of war France purchased 500 metric tons of porcelain accessories from Germany per annum. Already this amount is being manufactured at home, and the larger works hope soon to be in a position to become exporters of such material. An inquiry addressed to seven works showed that a production of 5,000 tons of electrical porcelain products had been attained; contracts already carried out or in course of execution reached 7,000 tons, and very soon the extensions in progress will enable an output of 9,300 tons to be counted upon.

Electricity and Agriculture.—With the reduced shipping tonnage and shortage of labour, "The Times Engineering Supplement" remarks, the country should face the problem of the more general utilisation of electricity for agricultural work. The Light Railway Commissioners, it is stated, have devoted most of their efforts to the extension of ordinary tramways, and have not sufficiently considered the provision of genuine light extension-railways such are as badly needed for the conveyance of agricultural produce. There is also a great scope for the development of electrically driven agricultural implements. A great many farms, especially dairy farms, might long ago have been wired for electricity with national advantage, and in this respect we are much behind many foreign countries.

Effect of Barometric Pressure on Temperature Rise.—An informative article by Mr. V. M. Montsinger on "Effect of Barometric Pressure on Temperature Rise of Self-cooled Transformers," appeared in a recent issue of the "General Electric Review." Tests are described which were made at altitudes of 305 metres, 1,830 metres and 3,360 metres. For certain kinds of transformer tanks the temperature rises at the highest altitude were some 12 per cent. greater than those recorded at the lowest altitude. The author developed formulæ to enable the effect of altitude to be taken into account. As the recommendations concerning altitudes given in the Standardisation Rules are inapplicable for oil-cooled transformers of the kind used in the experiments the author recommends the inclusion of the formulæ in the rules.

Faraday Society.—A general discussion on "Osmotic Pressure" will be held by the Faraday Society on Tuesday, May 1, 1917, at 8 p.m., in the rooms of the Chemical Society, Burlington House, W. Sir Oliver Lodge, F.R.S., will preside over the discussion, which will be opened by Prof. Alfred W. Porter, F.R.S. Dr. F. Tinker will read a Paper on "The Colloidal Membrane: Its Properties and its Function in the Osmotic System"; and Mr. W. R. Bousfield, F.R.S., will read a Paper on "Osmotic Pressure in relation to the Constitution of Water and the Hydrates of the Solute." It is expected that Prof. H. E. Armstrong, F.R.S., the Earl of Berkeley, F.R.S., Prof. A. Findlay, Prof. J. C. Philip, Dr. G. Senter, Dr. S. A. Shorter, Mr. W. C. Dampier Whetham, F.R.S., and others will take part in the discussion.

Michael Faraday: His Life and Work.—In a lecture recently delivered before the Coventry Engineering Society, Mr. A. P. Young gave an account of the life and work of Michael Faraday. People in the British Isles, he remarked, are apt to neglect their great national heroes of science, and it is only of late that sufficient stress has been laid on the epoch-making nature of Faraday's discoveries. The British Isles, however, contributed many great scientific figures during the 19th century, and the Anglo-Saxon race may be said to show special aptitude for discovery and research. In Faraday's case his achievements were the more remarkable because he started in humble circumstances, and with few advantages. Apprenticed to a bookbinder his interest in scientific matters was aroused by reading philosophical books that came under his care. As is well known, he made Sir Humphrey Davy's acquaintance, after listening to a series of lectures at the Royal Institution at which, owing to Davy's patronage, he subsequently secured a small appointment. Mr. Young drew freely on the late Prof. Silvanus P. Thompson's book on Faraday's work. This work can conveniently be divided into three sections, 1816–1830, 1831–1839, and 1840–1860, thus covering a period of 44 years. His most famous discoveries in electromagnetism and electrolysis were made in the middle period; in the final period he was concerned largely with magneto optics; while the initial period covers varied experiments on such matters as alloys of steel, optical glass, the liquefaction of gases and the production of benzol—three, at least, of these matters are of considerable topical interest at

Digitized by Google

the present time. There were, of course, many other subsidiary investigations. Indeed, one of the most striking features of Faraday's work was the wonderful variety of ground covered and his fertility of imagination in discovering new fields of investigation. There is much to be said for Tyndall's comment:—"Taking him for all in all, Michael Faraday was the greatest experimental philosopher the world has ever seen."

Electrical Association of Australia.—At the recent annual meeting Mr. W. N. Kernot was elected president (Mr. W. H. Alabaster and Mr. F. A. Carty being past presidents), Mr. A. McHinstry and Mr. A. N. Macnicol vice-presidents, and Messrs. Clements, Hargrave, Harper, Kendall, Lane, Newbigin and Newton members of council. Mr. A. Maling is the honorary secretary. There are 227 members of the association.

Institution of Electrical Engineers.—The Institution premises having been taken over by H.M. Government, temporary offices have been secured at 1, Albemarle-street, London, W.1. The telephone number will remain "Gerrard 764," and the telegraphic address will be "Voltampere Piccy London." The meetings for the remainder of the session will be held at the Institution of Civil Engineers, Great George-street, S.W., at 6 p.m.

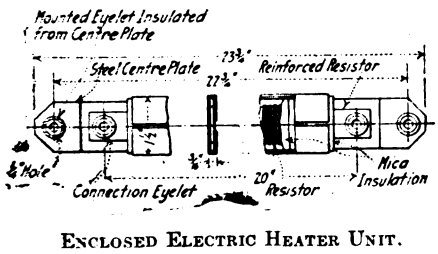
At the monthly meeting of the Scottish Local Section of the Institution, held on April 3rd, Mr. Stothert, who presided, announced the office-bearers for next session as follows:

Chairman, Arch. Page; *vice-chairmen*, E. T. Goslin and A. S. Hampton; *hon. secretary*, Joseph Taylor; *asst. hon. secretary*, Wm. F. Mitchell; *ordinary members of committee*, F. H. Whysall, W. W. Lackie, W. B. Hird, Prof. M. Maclean, Alex. Lindsay, A. S. McWhirter, D. M. Macleod, Arch. Wilson, J. E. Sayers, Sam Mavor and J. F. Nielson.

At the meeting of the Manchester Local Section on the same date the following nominations were announced:—

Chairman, C. J. Beaver; *vice-chairmen*, A. P. M. Fleming and J. A. Robertson; *hon. secretary and treasurer*, Julius Frith; *members of committee*, H. Allcock, A. S. Barnard, W. Cotsworth, W. Cramp, E. M. Hollingsworth, A. G. Livesay, Prof. E. W. Marchant, H. A. Ratcliff, Ald. Wm. Walker, Prof. Miles Walker, H. T. Wilkinson and W. J. H. Wood.

Electric Heating Units for Crane Cabs.—The Cutler-Hammer Mfg. Co., of Milwaukee, has developed a heating unit for outdoor crane cabs that requires little space and provides sufficient heat for the coldest of weather. A heavy perforated metal plate is supported about 2 in. from the floor and flat type heating units placed in the air space between the plate and the floor. A warm air current will then circulate up through the perforations. Additional units may be distributed at other points for raising the temperature to a comfortable degree. The heating units have a capacity of 500 watts, and can be used on either direct or alternating-current systems. They are 1½ in. wide, $\frac{3}{16}$ in. deep and 2 ft. long, just like a flat ruler, and can be installed singly or in groups connected in multiple like so many lamps. A steel jacket entirely encloses the nickel chromium resistor, which is, in turn, enclosed in mica. Standard units are made for 115, 230 and 250-volt circuits.



Enclosed Electric Heater Unit.

Making Cutting Tools by Electric Welding.—A recent issue of "Machinery" describes a method employed by the Westinghouse Electric & Mfg. Co. at Pittsburgh to produce welded cutting tools for its planing machines and lathes. The high-speed tip is first tacked to the machinery steel shank, and after applying borax as a flux, the welding is completed. The tool is then laid in mica dust to cool gradually. The tool is then given an initial grinding, after which it is tempered and the grinding operation completed. This makes the tool ready for use. The machinery steel shank used may be of either hot or cold-rolled or carbon steel and of any desired length, while the steel tip should be short. The metal of the shank, which is relied upon to reinforce the tip, is built out and around the latter. In this way, it is explained, a larger radiating surface is provided, as well as a conducting path of greater area back to the butt of the tool, which keeps down the temperature at the cutting end. An ordinary Westinghouse electric arc welding equipment, such as is employed for the welding or repair of castings, is used, a Norway iron electrode 5/32 in. in diameter being utilised. To secure the best results a current of approximately 100 amperes is recommended and a voltage of from 60 to 70 volts The work, it is stated, should not be hurried, although a good operator should be able to weld from 25 to 30 tools having a cross-section of 1½ sq. in. in a 9½-hour day.

The same journal also mentions the application of electric welding in steel mills, for treating rolls that "chip out." Such rolls are no longer scrapped. The chipped portion is first filled in and welded, after which it is machined or chipped and filed to shape. After the work has been completed, it is practically impossible to detect the point at which the weld has been made except by close examination. The repairs are apparently permanent, and will wear as long as any other part of the roll. One company is making all its repairs of this kind with the electric arc, and is also repairing worn wobblers and broken gear teeth in this way.

PERSONAL.

Engineer-Lieut. F. G. Creswell, R.A.N., who is in charge of the Australian Commonwealth Naval Radio Service, has been promoted to Radio-Commander. As we announced on May 12, 1916, the Commonwealth's wireless system, formerly attached to the Postmaster-General's Dept., was transferred to the Navy Dept., and Lieut. Creswell succeeded Mr. J. G. Balsillie as head of the service, although the latter has continued to act in a consulting capacity.

Mr. Pakenham W. Beatty, chief engineer of the Anglo-Argentine Tramway Co., left Argentina at the beginning of this month to offer his services to the British War Office. Mr. Beatty has been engaged in Argentina for some years upon the equipment of electricity supply and tramway undertakings.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, April 14th.

Birmingham and District Electric Club.

7 p.m. At the Swan Hotel, New-street, Birmingham. Paper on "Electricity in Factories," by Mr. W. Y. Anderson, A.M.I.E.E.

MONDAY, April 16th.

Newcastle Local Section, Institution of Electrical Engineers.

6.45 p.m. At the Mining Institute, Newcastle-on-Tyne. Discussion on "Wayleaves," with Introductory Paper by Mr. C. Vernier.

TUESDAY, April 17th.

Institution of Civil Engineers.

5.30 p.m. At Great George-street, Westminster, S.W. Annual General Meeting.

Association of Supervising Electricians.

7.15 p.m. At St. Bride Institute, Bride-lane, Ludgate-circus, E.C. Paper on "The Wiring Rules of the I.E.E.," by Mr. W. R. Rawlings, M.I.E.E.

THURSDAY, April 19th.

Royal Institution.

3 p.m. At Albemarle-street, Piccadilly, W. Lecture on "Industrial Finance after the War: The Character of the Industrial Struggle of To-day," by Prof. H. S. Foxwell, M.A. (Lecture I.)

FRIDAY, April 20th.

Institution of Mechanical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, S.W. General Meeting, Presidential Address to be delivered.

1st LONDON ELECTRICAL ENGINEERS.

For Notices *see* p. 72.

Digitized by Google

LARGE GENERATOR AND TRANSFORMER FAILURES ON THE RAND POWER COMPANIES' SYSTEMS.*

BY A. E. VAL DAVIES.

This Paper deals with a few examples of breakdowns of generators and transformers, taken from the experience of the power companies during the last four years. The plant in question is all of German design and manufacture. The generators are of the turbo-alternator type, of ratings varying from 3,500 k.v.a. to 18,000 k.v.a., and their speeds are either 1,000 or 1,500 revs. per min.; the aggregate rating of the generating plant being 218,800 k.v.a. The transformers dealt with are all of the water-cooled type, the ratings varying from 4,000 k.v.a. to 12,500 k.v.a., the total being 388,500 k.v.a.

Generators.

Faulty Design of Stator End Connections.—Seven generators, each of 12,000 k.v.a. and of identical design, were installed in certain of the power stations. They were wound with one bar per slot, and the current per phase was roughly 1,400 amperes. The joints between the stator bars and the end bends were of most primitive design, and were, to start with, mechanically weak.

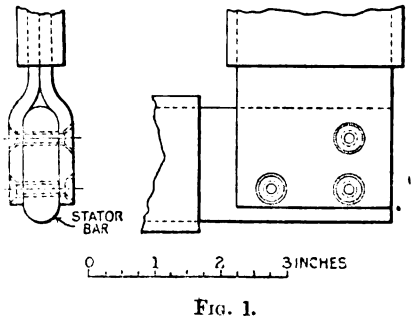


Fig. 1.

As will be seen from Fig. 1, three hollow rivets were provided to hold the two forked ends of the bends to the bar, and the joint thus made was soldered with a soldering iron. In sweating up a joint of this nature it is essential first to heat up the metal to a temperature sufficient to cause the solder to run. The best that can be said of the original joints is that they looked sound. On opening them up, however, a great majority were found to be devoid of solder inside, having merely a beading of solder round the edges. These were usually resweated satisfactorily by means of a blow lamp, but the lack of mechanical strength was still evident, and the trouble with the joints still recurred, and accounted for a good deal of the trouble which was experienced.

The usual course of failure was as follows: The thin beading of solder cracked away, leaving the joint held by the rivets only; it then heated up and gradually burnt away the surrounding metal until the joint ultimately failed by melting off the end of the bar and bend.

On three occasions the following arcing burnt into the binding wire of the rotor, which thereupon slacked away, and ripped the insulation from the remainder of the end windings. This defective joint was responsible for the loss of many thousands of pounds directly and indirectly, and it passes my comprehension that any large firm could have allowed such a poor job to leave their works. The position at one time was such that immediately a machine could be spared, it was opened and examined for possible bad joints; but (as they were all insulated) it was necessary to cut away the covering of numbers of the joints to eliminate those which were defective; and in the case of the bottom section of the stator this necessitated the removal of the rotor, which is a heavy and lengthy job.

This type of joint has been replaced by that shown in Fig. 2, and at great expense all existing joints of the old pattern have now been altered.

Referring to Fig. 2, the existing stator bar (*c*) was milled down at the points (*d*), and over the end of the bar was slipped the strap (*e*) which is riveted to the bend (*a*) and slotted to correspond with the projection (*f*), which is left on the bar after milling out the portions marked (*d*); this construction provides rigidity endwise. The wedge (*b*) is then driven home, and after the five rivets (*g*) have been inserted and closed up, the whole joint (which had been previously tinned) is then rapidly heated up with a blow lamp and filled in with solder. It will be noticed that the joint is a sound mechanical job before any solder is applied, and this is essential in a connection carrying 1,400 amperes. No further trouble of this nature has been experienced.

Failure of Rotor Binding Wire.—The rotors of all the generators dealt with in this Paper are fitted with wire binders round the ends of the rotor windings. The arrangement is shown in Fig. 3, and it will be noticed that abutting the rotor poles a copper-alloy wire is used to prevent, to a certain extent, the magnetic leakage which would occur if steel wire were used. Special steel wire is then laid on in the remaining space. The ultimate strength of the steel wire is 128 tons per square inch. The copper-alloy wire has an ultimate strength of 40 tons per square inch. Both classes of wire are laid on at a tension corresponding to 20 tons per square inch. The problem of forecasting the stress in a binder of this description is, of course, indeterminate, for although an elaborate theory exists for the ideal case, in practice so many variables and unknown quantities come into play that a high factor of safety is resorted to. However, there can be no question as to the mechanical strength of the binders under review. Their very construction eliminates the possibilities of internal stresses and unrelieved strains to which a solid shrunk-on cap might be subject, but this hardly compensates for their unfortunate proclivity, once the outer turns are burnt through, of stripping into miles of wire, which forthwith is ground up in the air-gap of the machine, ruining not only the windings, but often the core-plates of the stator as well.

This unfortunately has occurred three times, and we have endeavoured to improve matters by removing the two outer layers of wire and relaying them with steel wire right across the face of the binder with the last layer "clipped" or "laced" with a metal tape at every 6 in. of the periphery. This work has been expensive, as the cost of the wire alone is considerable.

Heating of Rotor End Winding Binder.—On two machines of 18,000 k.v.a. rating, but of different speeds and design, the rotor binding wire has been found to heat up to a temperature sufficient to melt the solder on it, and thereafter the solder has been flung off on to the end-windings of the stator. It should be noted that in both these machines the current in the stator bars (which overhang the rotor binder) is high. Although there have been no actual breakdowns from this cause the possibilities are evident. I believe the trouble is due to eddy currents in the binder caused by the unsymmetrical flux set up by out-of-balance loads on the machine. It has been suggested that the unbalanced magnetising current taken by three-phase shell-type transformers accounts for the unbalancing of generator loading, and unsymmetrically spaced transmission lines have also been held suspect.

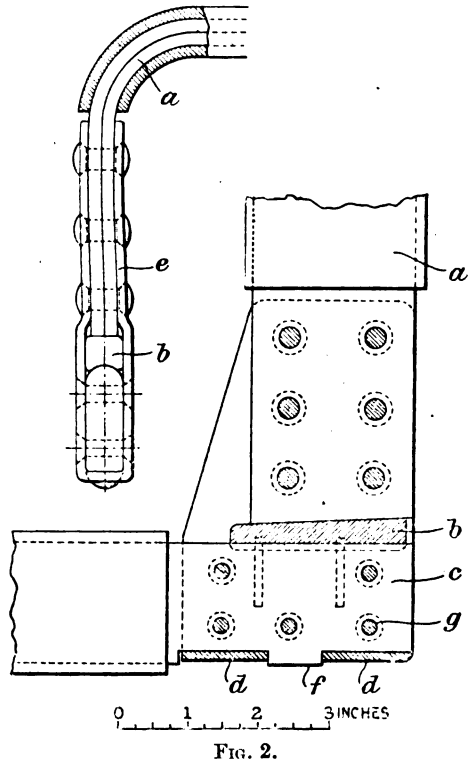


Fig. 2.

Investigation has shown that out of balance load amounting to approximately 7 per cent. exists on the centre phase of the system, and this is possibly sufficient to account for the overheated binding wire.

* Abstract of a Paper read before the South African Institute of Electrical Engineers.

Digitized by Google

Failure of Insulation on End Winding Stays.—In this case a 15,000 k.v.a. machine while on load suddenly tripped, and was removed from commission for examination. The failure was found to be due to the breaking down to earth of a micanite bushing which was interposed between one of the end connections and a slotted gunmetal bracket, which formed part of the gear for bracing the end windings. The arcing which immediately followed burned off the end of a stator bar, but before any further damage could be done the machine was isolated by the differential gear, which, on operating, also removes the exciting current from the rotor.

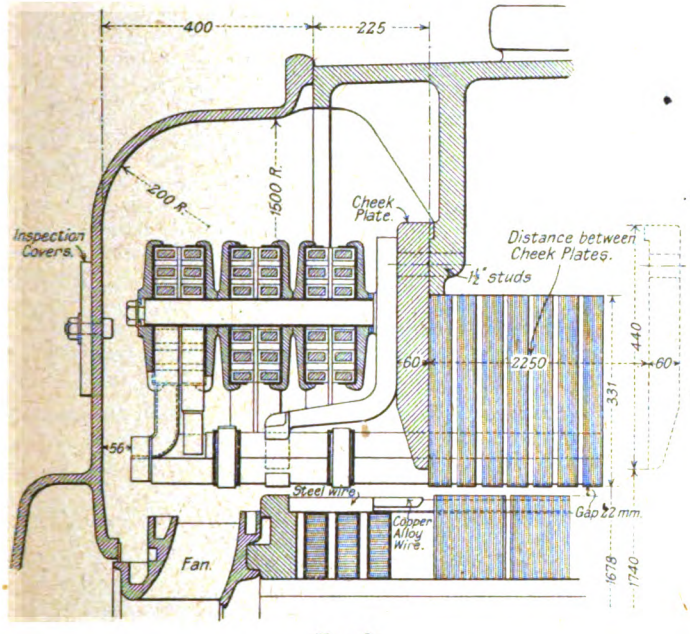


Fig. 3.

This machine is fitted with a four-pole two-layer winding, and, as the stator is divided into two sections horizontally, the dividing line passes through the end connecting bends on both sides, and at both ends of the stator. On this account three men were occupied for three days in disconnecting the end winding joints before the upper section of the stator could be removed for the renewal of the damaged stator bar.

An interesting development of this breakdown is worth noting. As it was necessary to remove the rotor from the machine during the repair to the damaged bar, the centre main bearing was opened up. It was then seen that the corresponding journal was heavily pitted. The explanation of this fact was soon apparent. During the flashing and arcing which occurred at the time of the breakdown, an arc was struck between the stator bar and the rotor fan. The rotor being permanently insulated from earth at the exciter end pedestal bearing, the oil film in the centre bearing had then impressed upon it approximately 3,000 volts, and, of course, broke down; hence the pitting.

Several of the remaining micanite bushes showed signs of wear and vibration, and, as the insulation provided on the end connections was practically negligible if the micanite bushing were neglected, it was decided to remove the brackets altogether and eliminate the possibility of further failures.

As an example of the indifference on the part of the manufacturers as to the maintenance costs of their machines, it should be noted that the cost of removing the upper section of one of these stators for the purpose of examining, for instance, the rotor, amounts to nearly £100 in labour and insulating material. Whereas had they adopted the more usual three-layer lap winding the connections would have been confined to one end of the machine, and could have been disconnected by two men in an hour. As it is, the heavy copper connecting links between the top and bottom sections are bolted to the end windings in most inaccessible corners, necessitating the use of special ratchet spanners.

Fire in a Dry Air Filter.—This breakdown occurred on a 12,500 k.v.a. generator fitted with a dry air-filter, composed of a zig-zag arrangement of filter cloths in wooden frames, which is installed beneath the generator floor level. Owing to the failure of a current transformer installed 12 ft. away from the filter and on the generator side of it, severe arcing presumably set fire to the filter cloths, which were supposed to be fireproof according to the specification, with the result that the whole filter immediately became ignited and burnt furiously, aided by the immense draught provided by the rotor fans of the generator. As the dampers were thereupon closed (by hand) the damage was practically confined to the filter cellar, although the generator rotor and end windings were in the meantime considerably scorched.

On later machines fitted with these dry air-filters, fusible fire links are provided which, on fusing, immediately allow by-pass doors to divert the draught. There is no doubt that filters unequipped with the above device constitute a very grave source of danger, and I believe that in any case they are thus regarded by the American Fire Underwriters. Their future use is very improbable, as the wet air filter provides an alternative as safe as it is effective, and these will replace all existing dry cloth filters now in operation in power companies' stations.

Failure of Insulation of a Stator Bar.—This case occurred while a machine was running light, fully excited, preparatory to going on load. As it was not on load there was no switch to trip, but the differential gear provides for this contingency, and immediately removed the excitation from the rotor, thus confining the damage to the single bar which failed.

The question of moulded micanite stator bars and their useful lives is open to considerable discussion. Mr. H. M. Hobart, in a recent contribution to the American I.E.E., put the safe life at, I think, 10,000 running hours, which, under conditions prevailing in the large power companies on the Rand, would mean about two years' service, and in some cases only slightly more than a year's service.

Experience on the Rand does not confirm this rather pessimistic view in practice. There are machines running now with their original bars in use after more than 45,000 running hours, and there are one or two cases where 50,000 running hours have been exceeded. I do not maintain that the insulation has not deteriorated as a whole. It undoubtedly has; but I think the deterioration is also due to other causes, such as: (*a*) Disintegration by vibration, (*b*) abrasion by cooling air, (*c*) actual rattling of bars in slots, due to shrinkage of insulation and drying out of supporting medium, (*d*) weak spots caused by faulty manufacture.

The bar which failed on this occasion had impressed on it at the time 2,650 volts. As it had been pressure tested to 20,000 volts before being put in the machine 15,000 running hours previously, it is obvious that it either suffered by mechanical damage or was affected by a form of deterioration inherent to it. This latter view finds more favour, for, as it will be seen from Fig. 4, the bar being oblong, the makers have worked in a strip of micanite along the flat side of the bar before proceeding to roll on the micanite. The result is that an air space is left right along the length of the bar at the point where the micanite moulding passes over the flat strip referred to above. During the periodical pressure tests to which these machines have been subjected, almost 100 bars have failed at pressures less than 10,000 volts, and the failures have occurred invariably along the line of this air space. As the cost of renewing one stator bar on these machines amounts to about £10 (labour and material), it will be seen that £1,000 has been spent on a form of insurance against breakdowns of this nature.

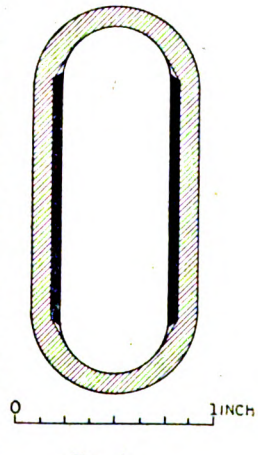


Fig. 4.

The damage resulting from the failure of a micanite stator tube in an 18,000 k.v.a. machine is illustrated in the original Paper. For some obscure reason two of these machines were fitted with loose stator tubes in preference to the usual moulded-on form of micanite. As is well known, these tubes soon swell in the air ducts and are generally objectionable on account of their lack of mechanical strength, and also because it is impossible to exclude air from inside them.

This breakdown has caused existing ideas on the subject of earthing the neutral points of generators to be modified. The practice had been to earth the neutral either solidly or through a resistance of low value, and on this account, should a stator bar fail, the damage is bound to put the machine out of commission for a certain period. It has, therefore, been decided to insert a 5-ampere fuse in the neutral lead of all machines, arranged in series with a current transformer to which is connected a relay. Should an earth fault develop, the fault current while blowing the fuse will also operate the relay, which in turn will trip the generator switch and also remove the excitation from the rotor. This arrangement should confine the

Digitized by Google

damage to a puncture of the insulation without subsequent burning of the conductors or core. Should the machine be urgently required it could be put into commission again minus the neutral earth connection.

TRANSFORMERS.

Puncture of Water-cooling Coils.—(*a*) *Iron Pipes.*—In this case a bank of four 6,000 k.v.a. transformers working on a ratio of 80,000 to 20,000 volts failed within a few days of each other owing to the perforation of the cooling coils, with consequent flooding of the windings by water. The damage was in all cases considerable, but more unfortunate was the loss of the plant itself at a time when it was urgently required.

The first of the faulty cooling coils was examined, and when cut open it was found that during the process of galvanising the interior of the tubing, a lump of zinc had been left in the bore. This constricted the area and caused the stream of cooling water continually to impinge on the side of the tube. The resulting scouring action of the jet of water prevented the formation of the usual deposit of matter which acts as a protective coating on the sides of the tube, and as the water possessed decided acidity the continued erosion finally caused the puncture of the tube and consequent breakdown of the transformer. As the trouble appeared to be common to all of the cooling coils, they were cut up into a large number of pieces, and each piece was cleared of obstructions, which in several cases nearly blocked the bore of the pipe.

The coils were then rebuilt and welded by the oxy-acetylene process, and have given no trouble since. This series of failures proved very expensive to repair.

(*b*) *Lead Pipes.*—In this type of cooling coil lead pipe of $\frac{3}{4}$ in. internal bore is used. In a batch of six transformers there have been four failures owing to the perforation of the cooling coil, and in each case the breakdown has been due to the faulty drawing or extrusion of the tubing. The sound tube has a thickness of $\frac{1}{8}$ in., but in certain of these faulty coils the thickness of metal varies from a few thousandths of an inch on one side to nearly $\frac{1}{4}$ in. on the side opposite.

Failure Due to Lightning.—On large transformers (6,000 k.v.a. to 9,000 k.v.a.) failures directly due to lightning have been almost entirely confined to a group of core-type transformers. These have a ratio of 80,000 to 20,000 volts, and usually breakdown, not singly, but in groups of three or four. The strange part of these breakdowns is that almost invariably the failures in each transformer are identical—*i.e.*, similar coils fail in each transformer. The usual characteristics are breakdowns between turns at a point about 5 per cent. of the turns inwards. The failures have always occurred on the 80,000-volt winding, which is connected in mesh with the insulation of 1·5 per cent. of the turns at each corner of the mesh re-inforced.

I do not know why 1·5 per cent. of the total was fixed for the number of end turns—it can only have been a hazard—for to arrive at any proportion of the winding a definite impressed frequency must be assumed, and since the frequencies met with in practice—due to surges or lightning—may vary from a few thousands up to millions, it would seem saner thoroughly to insulate every turn of the winding. This is the argument used, I believe, by certain of the large American manufacturers whose transformers have given great satisfaction on the Rand, for, at the generator end of the transmission line to which these particular core-type transformers are connected there are a number of 9,000 k.v.a. American shell-type transformers, which have always survived when the German core-type transformers at the step-down end of the line have failed in lightning storms. It is, however, by no means certain that the American transformers have been called upon to stand equivalent stresses, as it is a recognised fact that the arresters at the generator end of the line seldom operate during lightning, whereas the arresters at the step-down end of the line are frequently active, indicating the probability that a pressure surge developing in the line is felt with greater severity at the end remote from the generators. This might, perhaps, reduce what appears to be a disparity in the two makes of transformers.

Failure of Magnetic Circuit.—In this case a 12,500 k.v.a. core-type transformer was removed for examination after tripping, and on attempting to lift off the upper yoke of the core it was found to be thoroughly welded to one of the vertical limbs.

This breakdown was due to a succession of failures of the insulation around the core bolts in both the top and bottom yokes. The resultant flow of current melted into a solid mass almost a cubic foot of iron core plates in both the top and bottom yokes, and presumably, after the pad of insulating material between the yoke and limb had been damaged, a further circulation of current took place across the joint thus made, with the above disastrous results. The net result of this breakdown has been the scrapping of the transformer and its replacement by a shell-type transformer of American manufacture.

MACHINE-SWITCHING TELEPHONE GEAR.

The following is an account of a discussion which took place before the Institution of Electrical Engineers on Mr. F. R. McBerty's Paper on the above subject. An abstract of the Paper appeared in THE ELECTRICIAN of March 23 and April 6.

Mr. F. GILL said according to the Paper 200 tests were made and two calls—1 per cent.—went wrong. That did not seem to be big enough. It was important, because that characteristic had to be multiplied by 10,000, 50,000 or 100,000. Could the author give any information on subscribers' irregularities? They were important in manual work, and might also be important when subscribers worked dials. The author said certain exchanges were company owned and certain others were administration owned. Those owned by the administration took about 62 per cent. more labour to maintain than the others. Lost and delayed calls were treated in the Paper as if they were the same. One could tolerate a much greater percentage of error if a call was merely delayed than if the call was actually lost. The Paper showed that the number of machines to be provided varied greatly according to the method adopted of computing the machines. If one went to too high a probability of success it meant a pretty serious cost at the outset. A service should be conducted in a commercial spirit, to give a reasonable service at a reasonable cost, and with a reasonable chance of profit on low rates. It was important not to put in too many switches. The author said it was very desirable that a standard method of computing the switching machines should be agreed upon as a basis of rating or comparing systems of different types. It did not mean that a man would put in something better or worse, but for comparative readings it might be reduced to the same thing. He did not think the percentage of calls lost or delayed was the chief thing. If two different switches had 1 per cent. lost or delayed it might make a great deal of difference whether it was 1 per cent. delayed for 1 second or 1 per cent. delayed for 10 seconds. What should be aimed at was a total seconds' delay. Suppose one called for the delay not to be greater than 100 seconds in 100 calls, an average of 1 second per call, and a maximum delay in any case not to exceed 20 seconds What were Mr. McBerty's views on that? His only quarrel with the author was on first cost. The author did not help them on that matter. Had any of the cases quoted been put in on the basis of economic selection? Had they been put in by deliberately paying increased cost for possibly an improved service, or had they been put in without any real economic selection, and merely on the basis that it was a proper thing to do, and got rid of the operator? For the conditions he was studying it did not prove it. Then the question arose by how much the automatic gear must be reduced to make it satisfactory. If 100 were taken as first cost for manual, the automatic first cost must be about 140 or 145. Could the author give them any help on that subject?

Mr. E. A. LAIDLAW said the figures given in the Paper for manual operating represented the best practice on up-to-date C.B. switchboards, but women's wages might reasonably be expected to increase considerably. He agreed that the two types of switches, the step-by-step with a vertical and rotary motion, and the motor-driven switch described in the Paper were the most successful. A larger switch than 100 lines appealed at first sight to telephone engineers who had been engaged on traffic, because of their knowledge that greater efficiency per junction was obtained with a larger group of junctions, but with machine switching a switch of 100 lines could be made to give as good a service as a 200-line switch, as incoming calls could be brought through a standard intermediate distributing frame and first and second pre-selections or line finders. The fluctuations in traffic were proportionately smaller in a group of 100 lines than in a group of 10 lines, but the fluctuations on a group of 200 was little less than in a group of 100, and a switch with 20 junctions per level or row was not warranted from a traffic standpoint. On the connectors as at present arranged in automatic exchanges that distribution could not be obtained, and the number of connectors to be fitted must be what was required for the particular 100 or 200 subscribers. Decreases or increases in the percentage of connectors had to be made from time to time, but extra banks of connectors (the cheapest part of the switch) could be provided in the initial equipment, and the mechanism be fitted when required. The advantage of 100-line over a 200-line switch appeared to be that it retained the decimal system without any translating devices and was very flexible. In the United Kingdom about half the lines were connected to exchanges of less than 1,000 lines, and for these exchanges step-by-step mechanism appeared preferable, from a cost point of view, to motor driven. For exchanges above that the first cost and maintenance of the two systems, appeared to be about equal. The "by-path" system gave distribution both for calling and called subscribers, the traffic being distributed on the intermediate frame according to traffic and equally distributed over all preliminary and final switches. The results obtained with that system confirmed the author's statement that as the art of automatic telephony got more

Digitized by Google

established the tendency would be to increase the efficiency of the common elements. In computing lost calls he had often used the percentage figure of the existing engaged calls during the busy hour, and, working on the law of probability, found out what decreases in the percentage the instantaneous disconnection would produce. Assuming busy-hour traffic on a manual exchange gave 17·4 per cent. of the subscribers engaged, on an automatic exchange the instantaneous disconnection, without allowing for any reduction in the holding time due to other reasons, would reduce that figure by 1·7 per cent., thus allowing for 17 calls per 1,000 to be choked by the switches, without depreciating the service below manual standards. The operator on semi-automatic and call distributing systems might be likened to an accumulator. In manual working rapid discharges at a high rate were demanded, whereas on the distributing system the discharge was regular and equal to the operator's capacity, so that the "load" the operator could take was increased. A curve given by Mr. Maycock in the Post Office Electrical Engineers' "Journal," in 1912, showed that the manual operator's efficiency rapidly declined when she had to cover more than one position, and another curve which he showed on the screen was a mean curve of a curve of Mr. Maycock's in the same journal, showing a number of operators on duty. Mr. Maycock's curve showed operator-hours 185½ for a given number of calls, whereas with traffic distribution the operators required would be 165½, a saving of 10·9 per cent. Distribution made the switchboard like a concertina, open when busy and closed when slack, and mechanical appliances, dispensing with cords, plugs, multiple jacks, &c., increased the load and decreased the cost of operators. He also showed a curve of the speed of answer on the Amsterdam semi-automatic exchange, which showed that the service was greatly improved as the long waits were reduced. With regard to maintenance of automatic exchanges, the remarks made by the author were borne out in this country, and a reduction could reasonably be hoped for. On 18 exchanges (with 1,100 lines working) used night and day on an average for two years, the man-hours per line per year worked out at 2·6. It must be remembered, however, that these equipments had less apparatus per line than a large exchange. Full automatic working appeared to be the most promising service, for the majority of cases, but semi-automatic, with call distribution and supervision, might be desirable in some cases, especially during transition to full automatic. It was too early yet to consider standardisation, as improvements were taking place very rapidly.

Col. C. B. Clay said Mr. McBerty had shown that automatic exchanges could compete, in efficiency and cost, with manual systems. Mr. McBerty had told him that he hoped someone would speak on behalf of the relay system. A system composed only of relays would do all the work of the systems referred to in the Paper, which he did not think were the last word in automatic telephony. In a relay system the mechanical apparatus was reduced to a minimum, and the plant was not subject to difficulties owing to the inertia of comparatively heavy switches. No work was done except when a call was being connected. A relay system worked with greater variation of voltage than a machine switching system, and allowed greater variation in the speed of the calling device, and the time required for a call would therefore be less than in any other system. From his experience it appeared that the maintenance cost of relay systems must be small. No fault had been found due to dirty contacts. At the main exchange in Christiania he was told that the relays were put in a cupboard high up on the wall, as they required no attention once they had settled down to work. Mr. McBerty said the difficulty of obtaining men of sufficient skill to maintain automatic equipment had often been unduly emphasised. It would be further reduced by the substitution of apparatus which was entirely a repetition of the same style of parts.

Mr. A. J. Stubbs (Assistant Engineer-in-Chief, G.P.O.) said the Post Office had under trial five different systems of automatic switches, not in the sense of bridging the gap between manual and automatic, but in the sense of securing the confirmation of the automatic system with what was essential in connection with the trunk system. Their aim was the combination of the trunk working and the ordinary local service. Standardisation in such a connection was, he was afraid, very far off. They had made one small attempt to secure standardisation by ensuring that the user of the telephone should always have the same system of dialling to deal with. Telegraphy and telephony were essentially different problems. The combination of automatic telegraph working, Morse, single needle A, B, C, printing telegraphs, and so on in one office was relatively simple, because the various systems worked quite independently on different circuits, but with telephony there was no question of re-transmission, and the whole of the system must work in combination.

Mr. Dane Sinclair said the way the author had got round the difficult corners showed there was science in common sense as well as in engineering. As far back as 1883 he (Mr. Sinclair) took out a patent for an automatic telephone exchange, and the model (which he thought was in the possession of the Institution) worked for a day or two. That was in the days of single earth-circuit lines. It gave place to the manual as a general thing, but he had never lost his faith in automatic telephones, and it was a great pleasure to him to hear such a Paper read by so high an authority as Mr. McBerty, and to see the equipment in operation. He was sorry Mr. McBerty had changed some of the old names. He called the connector and selector the feeler and the chooser. He would have preferred the title of the Paper to be "Automatic Telephony."

Mr. W. Aitken said it would have been better if the author had supplemented the work by a diagram. He had described more particularly the semi-automatic system, but he presumed the author was as greatly in favour of the full automatic. He (Mr. Aitken) wrote in May, 1911, a Paper on the Strowger automatic system. Most of the speakers were then a little doubtful as to the position to take up, but to-day it was taken for granted that automatic telephony was the right thing, and it was used in every progressive country. The Strowger system and Mr. McBerty's system were the only two distinctive systems in use, and both had given excellent results, but it was doubtful whether they were the last words, and there was no likelihood of standardisation for a long time. The relay system was wonderful in its efficiency and simplicity, and scored in some respects over the other systems. The author said the three limitations of time of switching, cost and number of machines, had determined the nature of mechanical line switches, and the time limit within which the switching operation must be completed had imposed the most rigid restrictions. This did not apply to the relay system, because the action was instantaneous whether it was the first or the last line of a group, whereas with machine switching there was a different time interval. The author also said the subsequent cost of maintenance was affected in a more important way by the multiplication of moving parts than by the multiplication of fixed parts. In the relay system the moving part was only a fraction of an inch, and there was practically no wear and tear. On first consideration of the relay system one jumped to the conclusion that the relay could only be used as a one or two-way switch, and that to get a combination of circuits there must be as many relays for each switch as there were circuits. That was not the case. By a particular combination of relays and a particular arrangement of wires access could be given from one line to a considerable plurality without having an expensive switch. Mr. McBerty's carriage call was interesting, and a very fine application of a device that was known to some extent some years ago in this country. Mr. Arthur Thompson was the first, he thought, to give a visual signal to the operator, but, of course, in a cruder form than that described in the Paper. The figures for maintenance which he (Mr. Aitken) gave in 1911 were taken with a grain of salt. Some engineers doubted the truth of the statement that the cost of the renewal of parts in the Grand Rapids automatic exchange of 7,500 lines was 1·8 cents per line per annum. Mr. McBerty's figure was lower, so apparently the maintenance of automatic systems was going to be a very small matter.

Mr. B. O. Anson said the author's traffic curves were well known to telephone men, but there were two ways of looking at curves of that type—the manufacturer's and the purchaser's. The manufacturer wanted some basis on which he could consider different combinations of contacts and switches, and the curve must be an instrument of precision in his hands, but the purchaser approached the thing after all that was over, and he was concerned primarily with satisfying himself that he was getting the correct number of channels through the exchange. These being two different problems, it seemed unnecessary for the telephone administration to go to very great refinements in the question of traffic curves. Several sets of curves would be necessary to take notice of different holding times, and curves obtained in the Post Office showed that the real variable was not the call nor the holding time alone; it was the product of the two. In manual working the important matter was the call, but in automatic it was the minutes. If in statistics a conversation was shown as 2½ minutes, and it should be three minutes, a serious under-estimate of plant would result. It would be equivalent to having made a similar error in the number of calls coming over the junction circuits. The holding time assumed an increased importance in the automatic service. The Post Office obtained curves from all the administrations they knew, drew their own empirical curve from them, and to guard against a deficiency of plant only put on 75 per cent. of the number of subscribers estimated for. Working strictly to statistics would produce very grave errors unless allowance was made for the fact that the statistics were obtained from a manual exchange and applied to an automatic system. The G.P.O. chart was not comparable to the other two mentioned by the author, as the G.P.O. chart was to utilise manual statistics and put in automatic exchanges, whereas the other two were to tell manufacturers how to manufacture the automatic exchange equipment without knowing the traffic. Traffic curves worked to small decimal places were not required by the administration operating the plant.

Mr. E. A. Petithory said automatic telephony was a case of history repeating itself. The first patent was taken out in 1879, and was followed by two in 1881. Those were all step by step. The first semi-automatic was taken out in November, 1881. He believed it was power-driven. The next—also power-driven—was in 1883, and there were two, power-driven, in 1889. The basic automatic patent was the Strowger. That was the first successful system. The next item of interest was Callendar's. His apparatus did not work, but he foresaw all the things that were being developed now. He used the two-wire system, with no earth return, and with primary and secondary circuit selectors; he had an apparatus for storage of calls, whereby a subscriber would get his call in time, if he waited. That also had the power-drive. Most of the failures had been through not consulting the traffic engineer, and not designing machines of a size to give maximum economy on first cost. There was little to choose between 100 and 200-line banks in an exchange of 1,000 lines. It would have been better if the author had given the number of calls per busy hour and the number of switches. The basic curve, 1,000 lines, was ideal from the manufacturers' point of view. Step-by-step mechanism was very simple, as the switches accepted the impulses direct. Storing devices would appear to be of great advantage in connection with semi-automatic working. He could not agree with the author's statement that step-by-step apparatus need be of massive construction owing to its high speed, and he thought the durability of the step-by-step and motor-driven switches was about the same. With the ratchet and step-by-step system there was no waiting so far as the subscriber was concerned, whereas the line finders described by the author took three seconds.

Digitized by Google

Mr. F. M. WARD said that it was an accepted fact that telephone switching could be done satisfactorily. He was of opinion that the tendency in the future would be to eliminate the mechanical features, and substitute equivalent electrical means. The Western Electric Co. in their manual junction boards originally used a ringing key, which was depressed and released by the operator. They afterwards employed a key which was held by a latch and released electromagnetically by withdrawing the latch when the subscriber answered. The latch was replaced by an electromagnetic clutch, but finally the keys were done away with and the ringing was now controlled by relays. A similar tendency to eliminate the mechanical parts was noticeable in automatic telephony. From experience during the past three years on a system in which the whole of the switching and connecting was done by relays, the apparatus was found to work satisfactorily within wide limits, and with a large variation of dial speeds. The hunting for an idle line was not step by step, and it took no longer to connect to the last trunk in a group than it did to connect to the first. The power needed by the electromagnet of relays was so small that destructive sparking was practically eliminated, and the battery voltage might vary considerably without causing trouble. Machine switching gear required maintenance men with mechanical skill and electrical knowledge, whereas relay working was a natural development of C.B. working, and with plenty of current and good contact pressure the attention required would be a minimum. However, he fully appreciated Mr. McBerty's valuable work in automatic telephony and the state of perfection to which the Western Electric system had been brought.

Mr. W. H. GRINSTED said he agreed with Mr. McBerty as to the results obtained from the probability calculations and their application to automatic exchange design. They served the same purpose as interest and sinking fund tables served for accountants. With regard to securing uniformity in the design of exchanges, the first thing to be done was to see that the methods used by different systems gave the same results. The authors' calculations as to distribution of calls and the number of times a certain number of trunks was exceeded substantially agreed with a curve he (Mr. Grinsted) obtained in 1907. The next step was to see that the mathematical results corresponded with practice. He showed a curve plotted by him in 1911 of results obtained by an engineer in charge of an automatic exchange, which showed that the mathematical results were sufficiently in accordance with practice to enable them to be used with confidence. The next step was to settle a standard rating.

Mr. JOHN LEE said if operators worked at 600 calls an hour the difference between human performance and machine performance was separated by a narrow line. He would like to know where that exchange was. Those on the traffic side of the Post Office wished to provide engineers and manufacturers with the most careful statistics, just as Mr. McBerty had placed the full store of his knowledge at their disposal.

Mr. H. H. HARRISON said he could show the author at Liverpool a switch that could be used as either trunk hunter or line finder, and which did hundreds of contacts per second, and yet stopped definitely when it found the idle trunk or the feeling line. There was a considerable difference in the number of motor switches between no-line and 100-lines. Between 100 and 200 the difference was not considerable, and from 200 to 1,000 the curve was very rapid. Had the author calculated the registering devices for registering over 100 lines?

Owing to the lateness of the hour, the author said he would send in his reply for the "Journal."

WHEATSTONE BRIDGES AND SOME ACCESSORY APPARATUS FOR RESISTANCE THERMOMETRY.*

BY E. F. MUELLER.

Summary.—A type of Wheatstone bridge suitable for use in resistance thermometry is described, in which plugs or dial switches are used and the circuits so arranged that the errors due to contact resistances are no greater than with the mercury contact bridges heretofore used. The application of these bridges to the measurement of resistances with potential terminals is described.

1. *Type of Bridge Required.*—A type of Wheatstone bridge which has been found to meet practically all the requirements of precision measurements with resistance thermometers is one having equal ratio arms of rather high resistance (100 ohms or more) and a variable resistance arm of about 100 ohms, variable by steps of 0·0001 ohm. Coils of 0·1 ohm (or even 0·01 ohm) and larger may be connected to mercury contact blocks and short-circuited by suitable amalgamated links. For resistances smaller than 0·1 ohm it is preferable to use a shunting arrangement, or, in some instances, a slide wire may be used. Plug or dial contacts should not, in general, be used directly in series with the variable arm as the variation in such contacts is of the same order of magnitude as the value of the smallest step.

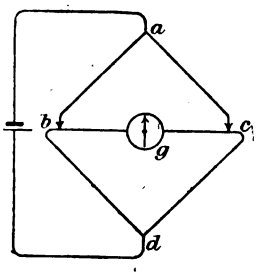


FIG. 1.—WHEATSTONE BRIDGE DIAGRAM.

2. *Improved Slide-wire Bridge.*—A consideration of the ordinary bridge diagram, Fig. 1, in which *ab* and *ac* are the equal ratio arms, shows that resistance may be transferred to or from the remaining arms at three points:—(1) By moving *d* along *bdc*, which is essentially the plan used in the Callendar-Griffiths bridges; (2) by moving *b* along *dbg*; and (3) by moving *c* along *dcg*. In (2) and (3) the bridge balance is not independent of the resistance of the moving contact as in (1), but the effect of variations of this contact may be reduced to any desired extent by increasing *ab* and *ac* with which the contacts are in series.

The method just described may be used to introduce the 1-ohm decade and the 0.1-ohm decade, a row of 1-ohm coils between contact blocks being connected along *bg* and a row of 0·1-ohm coils along *gc*, the moving points *b* and *c* being either plugs or dial switches.

3. *Bridge with Shunt Decades.*—Instead of a slide-wire, the smaller steps may also be obtained by the use of shunts. The general scheme of connections is shown in Fig. 2. There are two ratio coils of 250 ohms each and these are connected by a short (5 cm.) slide-wire, which is used in adjusting them to equality. The ratio coils terminate in long bars which may be connected by means of plugs to the contact blocks of the 1-ohm and 0·1-ohm decades. The 10-ohm coils are connected to binding-post blocks and the desired number of coils are introduced into the circuit by making connection to the appropriate binding post. This method of connection is satisfactory in most instances, but may prove a source of inconvenience when considerable changes in the resistance to be measured are encountered, as may be the case when several thermometers are to be measured successively with the same bridge. If this decade is to be much used, it is desirable to make it a plug decade or, perhaps better, to use mercury contacts.

(i.) *Shunted Decades.*—In choosing the values for the shunted coils the formula for resistance of coils in parallel was put in the following form:—If a resistance r is shunted by a resistance R, the effect of the shunt is to reduce r by an amount $\frac{r^2}{R+r}$. In the shunt decades—for example, the 0·01-ohm decade—R is given a series of values such that $\frac{r^2}{R+r}$ successively assumes the values 0·10, 0·09, 0·08—0·00; that is, successive values of R are defined by the equations $R+r=\frac{r^2}{0\cdot10}$, &c., to $R+r=\frac{r^2}{0.00}$. Consequently to secure even-valued coils a value was sought for r^2, which should contain the factors 7 and 9 and therefore be divisible by all numbers below 10. The value $r^2=1\cdot26$ was found to lead to suitable values for the coils of the 0·01-ohm decade. By making r_2 for the 0·001-ohm decade equal to $r/\sqrt{10}$ the successive values of R for this decade are made to differ by a constant amount from the values of R for the 0·01-ohm decade so that the corresponding coils for the two decades, with two exceptions, will be equal.

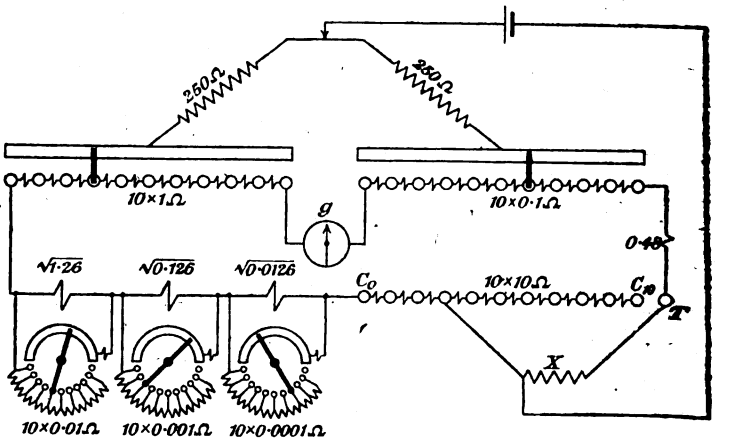


FIG. 2.—DIAGRAM OF CONNECTIONS FOR BRIDGE WITH SHUNT DECADES.

* Abstract of a Paper in the "Bulletin" of the Bureau of Standards. Those interested in the subject may obtain a free copy on addressing a request to the Bureau.

Digitized by Google

(ii.) *Adjustment of Ratio Arms.*—The slide-wire between the ratio coils is mounted inside the bridge in a vertical position and the slider is moved by turning a screw which engages the nut on which the slider is mounted. The head of this screw projects through a hole in the bridge top. The accuracy with which this adjustment can be made is limited only by the sensitivity of the galvanometer used, and errors due to inequality of the ratio coils may therefore be made absolutely negligible.

(iii.) *Temperature Control.*—The bridge is mounted in an oil bath and thermostatic control of the temperature is provided for. Power for operating the thermostat is supplied through a small (40-watt) transformer, which gives voltages up to 16 by steps of 1 volt. This transformer furnishes power for the heating coil. A buzzer, also operated from the transformer, indicates when the temperature of 30° has been reached.

A copper coil similar to the sealed coils used for the 10-ohm and 1-ohm decades mounted in the bridge and arranged so that its resistance can be measured with the bridge, shows that in such coils the fluctuations in the temperature of the oil, as the regulator operates, are almost completely damped out.

(iv.) *Effect of Contact Resistances.*—In order to make an estimate of the precision attainable with such a bridge it is necessary to assume the probable variations in the resistances of various kinds of contacts. For this purpose the following figures for the variation of various types of contacts when kept in good condition and correctly manipulated will be used :—

Type of contact.	Probable variation.
Binding post	0·00002 ohm
Plug	0·0001 ohm
Switch	0·0002 ohm

The figures quoted cannot from the nature of the case be accurate, but they were the best estimates obtainable for the variations in well-made contacts. Granting that a contact of any of the three types will maintain a constant resistance the precision attainable in the use of the bridge is limited by the contact resistances in series with the ratio coils to about 1 part in 2,000,000 and in the measurement of low resistances is limited by the contact resistances in series with the shunts to about 0·000002 ohm.

The effects of thermo-electromotive forces at the moving contacts are also reduced to such an extent as not to be a source of inconvenience in making measurements.

(v.) *Performance.*—Tests made with the bridge showed that readings consistent to 1 or 2 microhms could be made on resistances up to 10 ohms, thus indicating that at the time the tests were made the contacts were somewhat better than estimated above. The 1-ohm and larger coils are of the sealed type and have during two years shown no changes amounting to more than 2 parts in 100,000.

In this bridge the decade arrangement is used exclusively, and the question may arise as to whether the calibration can be made as accurately as in the bridges in which the 5, 2, 2, 1 combinations are used. There is, of course, an accumulation of errors in each decade, reaching a maximum at the middle of the decade. Such errors could be avoided by comparing groups of coils, but as a matter of fact, in calibration, such high sensitivity may be secured and utilised if the contacts are in sufficiently good condition, that it is sufficient to evaluate each coil separately and add the values. It is worth noting that the decade plan is less subject to error in measuring changes of resistance, as is always done in resistance thermometry. For example, using the 5, 2, 2, 1 arrangement, it is necessary to change all coils if the resistance measured changes from 4 to 6 ohms, while with the decade arrangement it is only necessary to add the two coils which are equivalent to the change to be measured.

Successive independent calibrations show that the errors occurring in calibration are not of importance.

The bridge may be calibrated in international ohms without the use of precision auxiliary apparatus (except a standard coil), since by the use of an external variable resistance, each coil of a decade may be compared (by substitution) with the sum of the 10 coils of the next lower decade.

4. *Dial Bridge.*—Another bridge of this general type but improved in details has been designed and constructed. It differs from the one already described principally in employing switches instead of plugs for the 1-ohm and 0·1-ohm decades, and in making the 10-ohm decade usable as a plug decade, or permitting connection directly to the coils through binding posts.

5. *Bridge Without Temperature Control.*—The bridges so far described are designed for work of very high precision, and thermostatic control of the temperature is practically necessary to secure the accuracy for which the bridges were designed. In a large number of instances, however, a lower degree of precision is permissible. A bridge has recently been designed for measurements of such accuracy as is attainable without thermostatic control of coil temperature. With manganin coils of the average grade, measurements can be made to about 1 part in 25,000 if the coil temperatures are known within 1° or 2°, and the indications of a mercury thermometer with its bulb near the coils should give the coil temperatures within this limit. The bridge, which is designed largely for use with thermometers having a fundamental interval of 1 ohm, has four dial decades, the arrangement of the 1-ohm and 0·1-ohm decades being similar to those in the bridges already described, while the 0·01-ohm and 0·001-ohm decades are secured by the use of shunts. There are also three 10-ohm coils connected to binding posts, so that the bridge has a range up to about 40 ohms, the smallest step being 0·001-ohm, and by utilising galvanometer deflections readings to 0·0001 ohm may be made.

The possibilities of such a bridge may be seen from the following :—An accuracy of 1 in 25,000 in resistance measurement corresponds to an accuracy of 0°·002 at −190°, about 0°·01 at room temperatures, about 0°·03 at 500°, and about 0°·05 at 1,000°.

By adding another decade giving steps of 0·0001 ohm, this bridge would also be made suitable for calorimetric measurements of high precision, when used with a calorimetric thermometer of 10 ohms fundamental interval. In such measurements the actual temperature of the coils is not of importance, but it is very essential that the temperature remain constant at least to 0·1° during the short time required for an experiment.

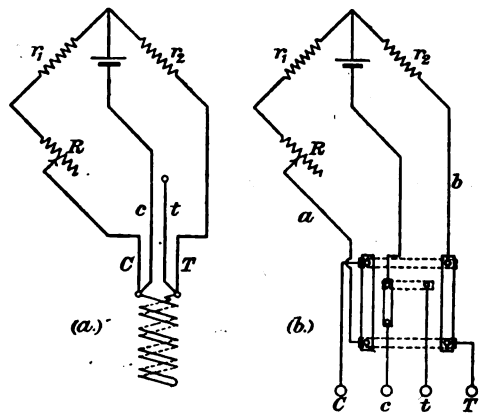


Fig. 3.—Diagrams to Illustrate Method of Measuring a Potential Terminal Resistance with the Wheatstone Bridge.

6. *Measurement of Potential Terminal Resistances.* — The advantages of thermometers with potential terminals over those which depend upon a compensating method for eliminating lead resistances are too obvious to require discussion. The resistances of such thermometers may be measured with the bridges described in this paper by the method illustrated with reference to Fig. 3*a*. If r_1 and r_2 are the equal ratio arms and the bridge is balanced, the following relation holds

$$R_1+C=X+T,$$

C and T being the "current" leads. If now T be connected to R and C to r_2 and the battery connected to t, a second balancing gives the relation

$$R_2+T=X+C.$$

Combining the two equations gives $X=R_1+R_2/2$.

This method cannot be used with a slide-wire bridge of the Callendar-Griffiths type.

In practice the interchange described is effected by the use of a mercury commutator, as shown in Fig. 3*b*. The use of such a commutator involves the introduction of connecting resistances a and b. It is evident, however, that if two resistances be measured successively, the difference between these resistances will be determined correctly, as the difference of the two values found. One of the two resistances may be equal to zero. The points of the commutator to which C and T are connected are therefore also connected to contact blocks, which may be short-circuited by a plug, the battery connection being also made to the plug at the same time. Since in this case the two potential terminals coincide, the resistance so measured must be equal to zero. Consequently, the difference between the bridge reading obtained in this way (zero balance) and the reading obtained in measuring the resistance of the thermometer will be the resistance of the latter.

It should be noted that the value obtained for the resistance of the thermometer is independent of the connections a and b, and also independent of the resistance of the plug. It will, however, be affected by variations in the mercury contacts of the commutator.

7. *Interchanger for Connecting several Thermometers.*—In many instances—for example, in inter-comparisons of thermometers—it is desirable to measure the resistances of a number of thermometers successively with a single bridge. This may be done without the necessity of connecting and disconnecting the thermometers by means of the arrangement, which is arranged for four thermometers, of which those not in use are short-circuited by the mercury contact links.

Digitized by Google

The Electrician.
FRIDAY, APRIL 13th, 1917.
Editorial and Publishing Offices:—
1, 2 & 3, SALISBURY COURT, FLEET STREET, LONDON, E.C. 4.
Telephone: City 4698-9. Telegrams: "Electrician Newspaper London."

"THE EVIL THAT MEN DO LIVES AFTER THEM."

Elsewhere will be found an abstract of an informative Paper on a subject with which every engineer, irrespective of his repute, is familiar, and on which most engineers—particularly engineers of repute—are silent. The subject referred to is that of the mistakes made in engineering design and construction. Although at the moment we are unable to consult his Paper, we believe it was the late Sir Benjamin Baker who said of a young engineer that his training was incomplete if none of the retaining walls had collapsed which he had designed.

The Paper, of which we give an abstract, deals with a few examples of breakdowns of generators and transformers taken from the experience of the Victoria Falls Power Company and allied companies during the last four years. The plant in question, unhappily, is all of German design and manufacture. We say unhappily because bad engineering is not peculiar to engineers of teutonic origin. And "unhappy" is the correct word to use in connection with all engineering work, good, bad and ind fferent, which by right ought to have been executed in the workshops of Britain.

It is unfortunate that all the breakdowns referred to occurred on German-built machinery. This may lead home manufacturers to think (and their salesmen always assert that such is the case) that their machines are less liable to faults than those of their competitors. Like Sir Benjamin Baker's young engineer, those engineering firms which never make mistakes have a great deal to learn. We give an abstract of this Paper, not because we wish to set a lie in circulation, but in order that our readers may obtain useful experience at little cost to themselves.

The generators on which the breakdowns occurred are of the turbo-alternator type, of ratings varying from 3,500 k.v.a. to 18,000 k.v.a., and their speeds are either 1,000 or 1,500 revs. per min., the aggregate rating of the generating plant being about 220,000 k.v.a. The transformers dealt with are all of the water-cooled type, the ratings varying from 4,000 k.v.a. to 12,500 k.v.a., the total being about 400,000 k.v.a. Of the nine examples given by Mr. A. E. Val Davies six deal with generators and three with transformers.

The first example is that of faulty design of stator end connections. This example reminds one of the "sealing wax and string stage" of electrical engineering, and the mechanical design could not very well be worse; the electrical design certainly could not be worse. We hope the time is at hand when electrical engineers will stick to engineering and leave solder to the plumber and gasfitter. For conductors carrying heavy currents we are strongly in favour of large and well-clamped contact-surfaces with *locked* nuts. The second and third examples deal with the rotor binding wire. Mr. Davies rightly observes that eliminating the possibilities of internal stresses hardly compensates for the unfortunate proclivity of the wire winding, once the outer turns are burnt through, of stripping into miles of wire, which forthwith is ground up in the air-gap of the machine, ruining not only the windings, but often the core-plates of the stator as well. Here again wire is to the rotor end winding what solder is to the stator end connections. The proper construction is, unquestionably, the solid cap.

In the third example the rotor binding wire was found to heat up to a temperature sufficient to melt the solder in it, and thereafter "the solder was flung off on to the end-windings of the stator." This surely is what the engineer would expect to happen to molten solder moving at a considerable peripheral speed.

Equally instructive is the failure of the insulation on the end winding stays given in the fourth example. The failure itself, though accompanied in this case by interesting phenomena, is not of an uncommon kind, but the author's account of the cost of removing the upper section of the stator should teach a lesson not only to manufacturers but also to users of turbo-alternators. In studying these examples we are at a loss to understand how the manufacturers induced the buyer or his agent to accept the machines. Were we in the market for expensive machinery of this kind we should insist on seeing the working drawings of important details and of getting the opinion of a competent engineer before allowing them to be used, the more so if the machines had to be maintained at our expense after the six or twelve-month "faulty materials or workmanship clause" had expired.

Owing to the failure of a current transformer . . . severe arcing . . . set fire to the filter cloths, which were supposed to be fireproof . . . with the result that the whole filter . . . burned furiously, aided by the immense draught. This is Mr. Davies' fifth example. The remedy is to use the wet air filter, and this is being done.

The last example given in the Paper of a generator breakdown is that of the failure of the insulation of a stator bar. The manufacturer is clearly at fault in this case, as he "worked in a strip of micanite along the flat side of the bar before proceeding to roll on the insulation. The result is that an air space is left right along the length of the bar . . ." A hundred of these bars failed during the periodical pressure test at pressures less than 10,000 volts, and the failures "occurred invariably along the line of this air space." In this case also, the user is to blame for allowing this novel method to be used. The cost of renewing a bar on the machines amounts to about £10 (labour and material), so that most of the £1,000 already expended would have been saved had the proper slot lining been insisted upon in the beginning, and in addition the machines could have been kept in commission for a much longer period. The use of an air-pocketed micanite stator tube in preference to the usual moulded-on form of micanite for an 18,000 k.v.a. machine resulted in the burning out of about 6 in. of the stator-iron.

Of the transformer examples the first deals with the puncture of iron and lead water-cooling pipes. With the iron pipes it was found that in some cases the bore was practically choked, in others that the galvanising was bad. In the case of the lead pipes breakdown has been due to the faulty drawing or extrusion of the tubing—in certain of the faulty pipes the thickness of the metal varied from a few thousandths of an inch on one side to nearly ¼ in. on the opposite side. We believe that forced oil cooling has been introduced. This is to be preferred in all cases where the size of the installation is such that it will bear the extra cost.

The eighth example, that of failure due to lighting, needs closer examination. It is curious that almost invariably similar coils failed in each transformer, the breakdowns occurring on the high-tension side between turns at a point about 5 per cent. of the turns inwards. The insulation of 1½ per cent. of the turns at each corner of the mesh was

Digitized by Google

reinforced. In this case it is unfortunate that there is no direct comparison with transformers having all the insulation reinforced and working under identical conditions. We do not understand what Mr. Davies means when he says that "it would seem saner thoroughly to insulate every turn of the winding." If he means to secure a uniform factor of safety we agree, but at the same time we would observe that uniform thickness of insulation throughout will not necessarily give a uniform factor of safety.

A succession of failures of the insulation around the core bolts in both the top and bottom yokes of a 12,500 k.v.a. core-type transformer melted into a solid mass almost a cubic foot of iron core plates in both yokes, and the destruction of the pad of insulating material between the yoke and limb welded the upper yoke to one of the vertical limbs of the core. The net result of this breakdown was the "scrapping of the transformer" and the substitution of a shell-type transformer of American manufacture. It is not every power company that is in the happy position of being able to scrap a 12,500 k.v.a. transformer on account of a minor defect. If the facts are as stated it is evident that in this case a little extra insulation on the bolts would have sufficed, and we think that engineers would be unwise in condemning a thoroughly good mechanical construction (which the shell-type is not) on account of a small, though important, detail which is easily corrected.

Though not on the large scale described by Mr. Davies, most engineers are familiar with breakdowns of the kind with which he deals. As we have said, such breakdowns are common to all countries, and he would be no engineer who thought that the German engineers would not avail themselves promptly of the experience which has been bought at the price of their reputation. A full discussion of the mistakes made by our engineers would be profitable to the industry as a whole, and those bringing forward their mistakes may rest assured that those who criticise them have, in their time, made mistakes nearly equal in number to the jobs for which they have been responsible.

SOME POINTS IN CONNECTION WITH ENGINEERING SPECIFICATIONS.*

BY J. SHEPHERD.

Specifications, whether long or short, should contain all salient facts necessary for the contractor to carry out his work, and should include a lucid description of the conditions under which the contract is to be completed.

Specifications for work of some magnitude usually consist of three distinct parts, namely, general conditions, detailed technical requirements and a bill of quantities.

General Conditions.—The general conditions, which are of the nature of standing orders, are usually of a legal character. They are of great weight and importance and are usually drafted by lawyers. In many cases they have grown to imposing documents, and unfortunately have sometimes formed a weapon which has been used to the detriment of the industry generally, since they have resulted in orders being sent abroad where the foreign contractor, owing to his distance from this country, has escaped the results of several of the conditions.

Whatever general conditions are adopted, I am strongly of the opinion that all matters in dispute should be referred to independent arbitration, provided that the progress of the work is not prejudiced thereby; that is to say, the two sides should agree as to what points are in dispute, and these can then be the subject of independent arbitration after the work is completed.

Detailed Technical Requirements.—This part of the specification is entirely the engineer's province, and in it he has clearly to define his requirements. Before he can do so he must make up his mind as to what he really does want and having done so he should lay down his requirements in the simplest language.

Bill of Quantities.—Wherever possible the work should be scheduled and a complete list of quantities closely estimated and arranged for pricing up should be given. In this bill of quantities should be included any provisional sums for extra work or for any special apparatus which it may be desired to purchase.

Having very briefly outlined the skeleton of a specification, a few examples may now be given of various specifications. In considering these specifications the attitude of the purchaser must not be forgotten. That attitude might perhaps be defined thus:—

"The market includes a large number of willing and eager suppliers anxious for our contracts at reasonable prices; the engineer shall therefore draft a clear and concise specification free from all looseness of thought or description or errors of any character. When the tenders are received to such a specification, we can, without misgiving of any kind, accept the lowest tender, no matter from whom it may be, and in order that we may know that the prices tendered are reasonable, the engineer shall, with the tenders, and before they are opened, submit his estimate of the cost of the work."

The specifications described below have all been drafted to suit such a general condition of affairs as far as it is possible to do so, and those members who do not agree with the drafting of the specifications must bear in mind the conditions under which they were drawn up.

One essential difference between a specification for machinery of standard design and a specification, for, say, civil engineering or architectural work, should be once at observed. No engineer with whom the author is acquainted is so bold as to issue working drawings of, say, a turbo-generator, high-speed engine, or water-tube boilers which he may desire to purchase. On the other hand, nearly all civil engineering and architectural work is the design and is carried out to the detailed drawing of the civil engineer or architect. But even in this branch of the profession the old order is changing with newer methods of construction, such as structural steel work, reinforced concrete, &c., which requires certain of the designs to be left to the specialists who handle this type of construction, and there is but little doubt that in the future the change will become more pronounced.

The engineer has the choice of two methods of specifying. These are:—

1. By issuing detailed drawings of his requirements and accepting the responsibility of the design, leaving the contractor to be responsible for the material and workmanship.

2. To define the conditions and results to be obtained, leaving the contractor to meet the requirements with his standard products if and when they are suitable

If the engineer specifies the conditions and leaves the manufacturer to offer his standard designs, the results will generally be satisfactory if the engineer is allowed to select a firm of ripe experience. Unfortunately, however, the tender of such a firm is seldom the lowest, and the premises were that the lowest tender should be accepted.

Again, the manufacturer has not always extensive experience of the running of his own plant or the opportunity of rectifying the weak features of the design, which use alone will discover. Also it is not uncommon for some manufacturers to perceive with difficulty any defects in their products.

The following are the salient features of a number of recent specifications.

Coal.

In a large modern generating station having a good load factor, and coal at normal prices, the generating costs per unit may be taken:—

Salaries and wages	0·030d.
Coal and ashes	0·160d.
Oil, waste and stores	0·004d.
Repairs to plant and buildings	0·012d.
Total	0·206d.

Coal and ashes thus represent 78 per cent. of the total. With the present high prices of coal the proportion is now even higher.

When buying by contract some form of scientific specification is necessary where locality and circumstances allow a free market and the specification described below is framed with a view to buying coal in this manner. As over 1,000,000 tons have been purchased in this way, it may be said to have proved itself useful by the only true test, namely, experience.

* Abstract of a Paper read before the Institution of Electrical Engineers

Digitized by Google

Roughly, the specification may be said to contain and set out—
Quantity required, viz. 165,000 tons per annum;
Minimum quality to be accepted, viz.:
Calorific value not less than 11,000 B.Th.U.
Moisture must not exceed 14 per cent. for washed nuts or 9 per cent. for unwashed nuts.
Small coal must not exceed 30 per cent.
Ash must not exceed 15 per cent.
Delivery by steamer and the berthing conditions are also set out.
Methods of sampling are given in detail and the methods of testing are specified.

When tendering, the contractors are requested to state both the price and the values offered of the following particulars:—

(A) Calorific value in British thermal units.
(C) Moisture in percentage by weight.
(E) Small coal „ „
(G) Ash „ „

These values must not be inferior to the minimum values allowed as already described.

The specification provided for the adjustment of the price paid for any particular cargo in accordance with the values actually obtained for that cargo, the adjustment being made as set out below.

"Should the quality of the coal in any cargo, as ascertained by samples tested, be found different, as regards calorific value, moisture, small or ash from the values offered in the schedule, the prices or sums payable as aforesaid shall be varied in the manner following, viz.:

"(*a*) If the calorific value be greater than the number of British thermal units per pound offered in the schedule the price per ton shall be increased in the same percentage ratio as the increase in the calorific value.

"(*b*) If the calorific value be less than the number of British thermal units per pound offered in the schedule the price per ton shall be decreased in the same percentage ratio as the decrease in the calorific value. Provided always that the Council shall have the right to reject the whole cargo if the calorific value be less than 11,000 B.Th.U. per pound.

"(*c*) If the moisture be less by weight than the figure offered in the schedule the weight of the coal to be paid for shall be increased beyond the quantity actually weighed out by a percentage equal to the percentage decrease of the moisture.

"(*d*) If the moisture exceed by weight the figure offered in the schedule the weight of the coal to be paid for shall be decreased below the quantity actually weighed out by a percentage equal to the percentage increase of moisture. Provided always that the Council shall have the right to reject the whole cargo if the moisture exceed 14 per cent. by weight for washed nuts or 9 per cent. by weight for unwashed nuts.

"(*e*) If the proportion of small coal in either singles or doubles be less by weight than the figure offered in the schedule when determined in the manner set out in Clause No. 10 of this specification, the weight of the coal to be paid for shall be increased beyond the quantity actually weighed out by a percentage equal to one-quarter of the percentage decrease of small coal.

"(*f*) If the proportion of small coal in either singles or doubles exceeds by weight the figure offered in the schedule, when determined in the manner set out in Clause 10 of this specification, the weight of the coal to be paid for shall be decreased below the quantity actually weighed out by a percentage equal to one-quarter of the percentage increase of small coal. Provided always that the Council shall have the right to reject the whole cargo, if the proportion of small coal exceeds 30 per cent. by weight.

"(*g*) If the percentage of ash when determined in the manner set out in Clause No. 10 of this specification be less than the figure offered in the schedule, the net rate per ton of coal shall be increased by one penny for every 1 per cent. reduction in ash.

"(*h*) If the percentage of ash when determined in the manner set out in Clause No. 10 of this specification be more than the figure offered in the schedule the net rate per ton of coal shall be reduced by one penny for every 1 per cent. increase in ash. Provided always that the Council shall have the right to reject the whole cargo if the proportion of ash exceeds 15 per cent."

The adjustment may appear somewhat cumbrous, but in practice is not found to be so, and an actual copy of an invoice worked out in detail is given in the original Paper.

The volume of business dealt with by specifications of the character described was 100,000 tons in 1906, increasing year by year to 160,000 tons in 1915. This necessitated the removal from the boiler house of from 10,000 tons to 16,000 tons of ashes per annum.

If the recovery of by-products becomes practicable in a power station, modifications in the specification for coal will no doubt become necessary to suit the nitrogen contents of the fuel.

The specifications have enabled purchases to be made in the open market for the past 10 years without giving rise to a single dispute as to the value of the coal determined on delivery and for which the price was adjusted on the determination.

Laying Cable Conduits.

The work of laying cable ducts is very similar in character to that of laying gas or water pipes. The method adopted by one of the Governments Departments was to pay a fixed rate per lineal yard of work actually carried out, the contractor taking the risk of difficult work and having to stand the loss of work partially completed, but abandoned owing to obstructions encountered later.

Such a method of contracting is open to many objections, as the work becomes too speculative, the unknown quantities being too great. Either the contractor loses a lot of money or else he provides large amounts for contingencies which may or may not arise.

For work of a similar character which the author has carried out, the specifications for the work, though more elaborate, were found to be fair to both parties in so far as difficult work is paid for if met with, at tendered rates set out in the bill of quantities, and, if difficult work is not met with, the contingencies provided for do not require to be met.

The general body of the specification contains but little novelty, the chief interest being in the bill of quantities, which is divided into three sections, as follows:—

(A) *Duct-laying* of various numbers of cable ducts laid in every kind of roadway or pathway construction. The rates tendered per yard run. Cover excavation to normal depths and widths, removal of useless obstructions, lighting, watching, fencing, &c., carting away surplus material, levelling the bottom of the trench, laying conduits or pipes in cement, concrete and mortar, filling in the trench, ramming and permanently reinstating the surface, testing each cable-duct line, including the cartage of the ducts from the nearest depot. The rates tendered cover work laid both at normal depths and in trenches of normal width.

(B) *Construction of Manholes.*—The manholes for drawing in the cables are spaced about 100 yards apart and are of two types and various sizes to suit the bank of ducts.

The work of constructing the manholes is divided into the following sections:—(*a*) Excavation of the ground; (*b*) the foundation upon which the box is built; (*c*) the brickwork of the box; (*d*) the construction of the top or cover of the box; (*e*) the permanent reinstatement of the surface, whether road or footway.

(C) *Miscellaneous works* of all character which may be required, such as excavation for extra depths or for extra widths, extra bricklaying at various depths, rates for concrete laid at various depths, timbering left in trenches, steel or cast-iron piping, paving and surface re-instatement of every kind, &c.

In practice it has been found to be comparatively simple with a specification of this character and with a comprehensive schedule of prices to adjust at once and to price up all work of usual difficulties. When, however, the work becomes of extraordinary difficulty involving excavation in water, running sand or the like, provision is made in the specification for the contractor to carry out the work on a prime cost basis, plus 15 per cent., but in only one case during 11 years was it found necessary to resort to this method.

Work to the value of £250,000 has been carried out to specifications of this character with but one dispute where a particular class of work had been incorrectly priced and the estimated quantities of that class of work were largely exceeded.

Substation Switchgear.

Having no less than 23 substations containing rotating machinery of from 2,000 kw. to 6,000 kw. capacity, the problem of purchasing switchgear became one of importance.

At the commencement general requirements to be met were stated, leaving the maker to supply his standard apparatus to meet the conditions laid down. Three substations were equipped in this way by two contractors; one for the high-tension apparatus and the other for the continuous-current feeder panels. The result was not satisfactory.

Within six months the low-tension panels had practically to be rebuilt and within six years the high-tension panels had to be scrapped to suit Home Office Regulations.

For all later substations working drawings were issued of all the panels and apparatus and parts for interchangeable manufacture were loaned to the contractor.

The method was entirely satisfactory to the purchaser; competitive tenders on equal footing were obtained, and sound and interchangeable switchgear was purchased, requiring a minimum quantity of spare parts.

There are, of course, drawbacks to such a system of purchasing. It is not adapted for purchases on a small scale, and it becomes difficult with standard designs to introduce modifications from time

Digitized by Google

to time, which otherwise in a smaller system would be adopted. On the other hand, the maintenance of such switchgear was particularly good, amounting to practically nothing on the high-tension side, and it was generally confined to renewals of circuit-breaker contacts on the low-tension side.

Reconstruction of Motor-Generators.

After working continuously night and day, several of the earlier motor-generators began to fail from various causes. After careful consideration, it was decided to provide a renewals fund on the basis of reconstruction every 10 years, and the first year's programme included the reconstruction of 17 motor-generators of 300 kw. and three motor-generators of 500 kw. capacity. An estimate of the cost of the work was furnished to the financial authorities, and the makers of the plant were approached for prices. As the results were by no means comparable, a specification was drafted, working drawings were got out and tenders invited by advertisement.

The lowest tender was that of a firm practically unknown, but a visit to their shops proving satisfactory, the contract was let to them at the price tendered and the result was in every way satisfactory.

In conclusion, the author would remark that, to specifications such as those described, over £2,500,000 worth of work has been purchased, and of that large sum not more than £1,500 was spent abroad and that for articles which were not manufactured in this country. In the past a large amount of foreign purchasing has taken place, resulting in the foreign manufacturer frequently escaping rigid inspection, burdensome general conditions, exacting wage rates and other labour conditions.

TRAMWAYS WITH RECTIFIED CURRENT.*

There are now two tramways worked by rectified current, and as the mercury rectifiers have worked satisfactorily, some particulars may be of interest. In November, 1915, the transformer station of the tramway through the Limmat valley started working with an installation of 300 kw. of mercury rectifiers, giving current at 600 volts. The total length of the line is 12 km.; ordinarily there are four cars on the line, but on Sundays this number is increased to seven or eight. The heaviest gradient is 1 in 22. Before the rectifiers were started, the power station contained two motor-generators, each giving 80 kw., which were always joined in parallel. Two rectifiers were then installed, each giving 150 kw. continuously, or 240 kw. for short periods. One of these is sufficient to take the whole load at all times. The rectifiers have, moreover, the advantage of taking up much less room than the motor-generators they have displaced. The connections are shown in Fig. 1. Three-phase current at 6,000 volts and a frequency of 50 is supplied through a transformer as six-phase current to the rectifier at a suitable voltage. The phase voltage on the secondary side of the transformer is 530, and that between two anodes of the rectifier is 1,060 volts. The two rectifiers are mounted on one baseplate; each has six anodes, which are not cooled by water. The vacuum vessels are cooled by overhead return condensers. In order to keep the apparatus continuously in action, the kathode of the rectifier is separately excited from an exciting transformer of 0·5 kw. capacity. Thus, whether current is taken by the external circuit or not, an auxiliary arc is continuously maintained, which takes about 5 amperes. The two rectifiers are quite independently excited, and can work separately or in parallel. The start is effected quite simply by a transformer

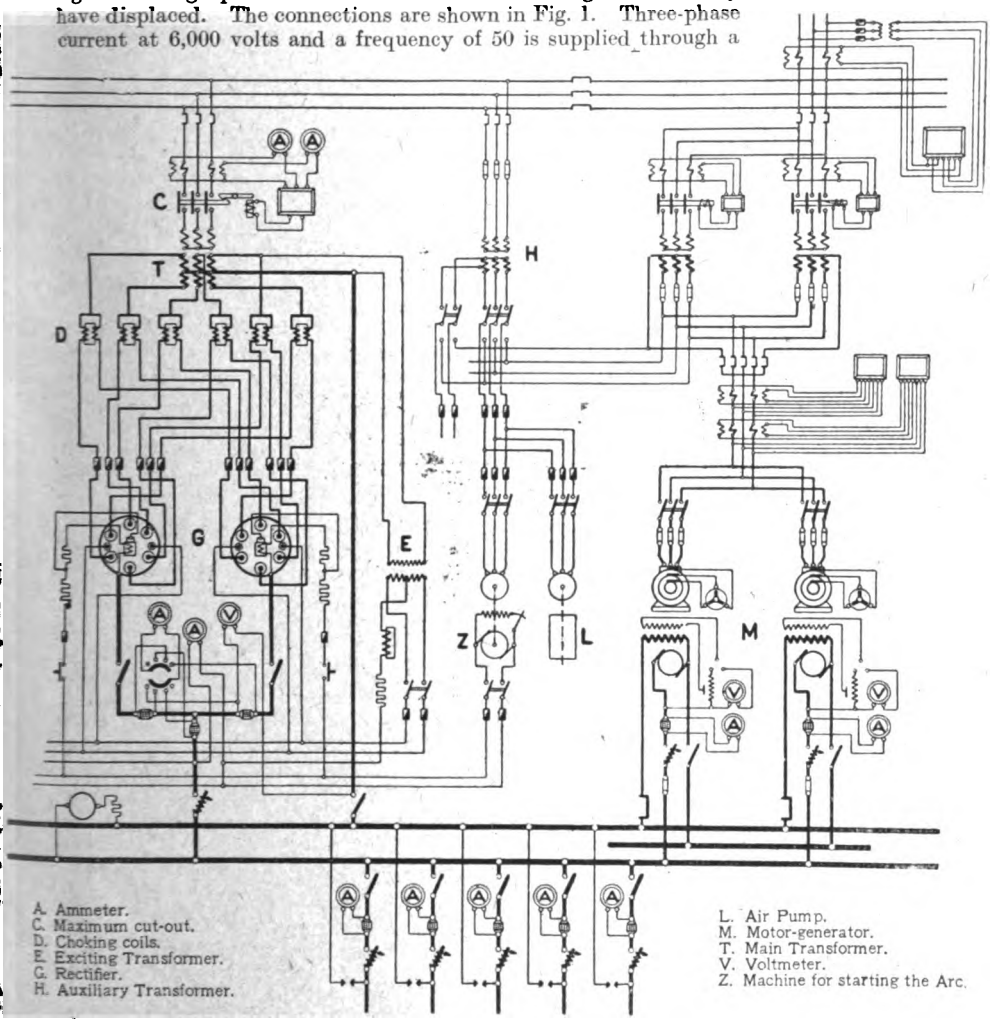


Fig. 1.—Diagram of Connections. (Brown-Boveri.)

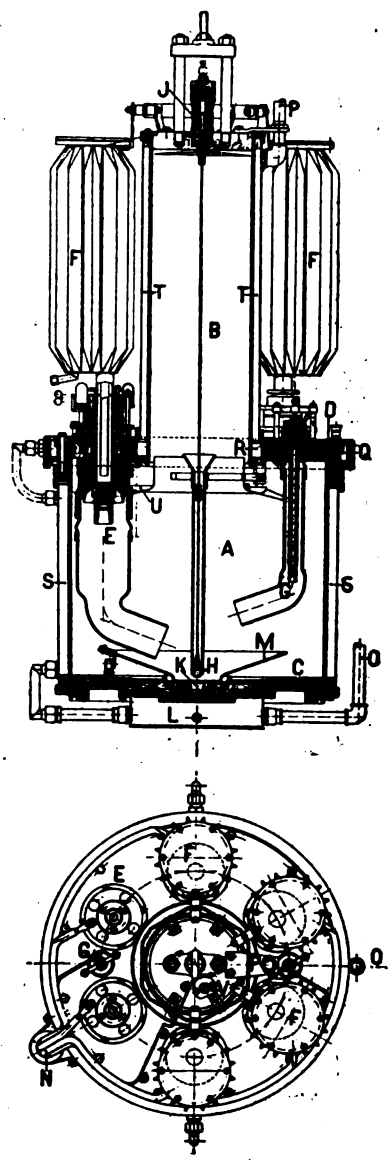


Fig. 2.—General Construction of Rectifier.

A. Working Space.
B. Condensing Chamber.
C. Base Plate.
D. Anode Ring.
E. Main Anode.
F. Anode Cooler.
G. Exciter Anode.
H. Starting Anode.
J. Starting Solenoid.
K. Cathode.
L. Cathode Cooler.
M. Cathode Shield.
N. Connections.
O. P. Connections to Condensers.
Q. R. Cooling Channels to the Anode Ring.
S. T. Cooling spaces for Containing Water.
U. Mercury Receiver.
V. Vacuum Connection.

* Abstract of an article in the "Brown-Boveri Mitteilungen."

Digitized by Google

giving 1 kw. The only thing required is to press a button on the switchboard, which controls the separate excitation, and the installation is then in a position to supply current. A vacuum pump was kept steadily at work for the first two months, but this has since been found to be unnecessary in consequence of the high vacuum, due to the make of the apparatus and the gas-absorbing capacity of the arc. This is really of great importance; the prospects of this type of apparatus depend largely on the possibility of working it without any rotating or moving accessories. The cooling is also effected without the necessity of any attendance. Oscillographic records show that the voltage varies in vibratory fashion between 600 and 750; but the current is remarkably steady, a fact probably due to the high inductivity of the network, which consists of series traction motors. The overall efficiency of the installation between half and full-load is 93·2 per cent. The voltage-fall in the rectifier is independent of the load; the efficiency depends essentially on that of the transformer, and is quite satisfactory even at low loads. Records extending over considerable periods show that the new rectifiers are between 20 and 26 per cent. more economical than the motor-generators were. The rectifiers can be worked in parallel with the motor-generators or with the machines supplying the Zurich tramways. The voltage fall between no-load and full-load in the motor-generators amounts to 14 per cent., including that in the transformers; with the rectifiers it varies between 5 and 17 per cent., and depends largely on the transformers.

A second instance of this kind of installation is to be found in the tramways at Deuben, near Dresden. The line was started at the beginning of this year. The total length of this line is about 16 km., and there are no marked gradients. The output of the rectifier is 400 kw. at 520 volts. Two-phase current is supplied to the primary side, and is then passed through two single-phase transformers, being conveyed to three rectifying cylinders in the form of four-phase current. Each cylinder contains four main anodes and two auxiliary anodes for the separate excitation. The various main anodes have each a radiator of ribbed iron, with a constant water-content, in order to cool the mercury packing at the points where the connections are made to the anodes. Each cylinder is intended to give a normal output of 200 kw. at 520 volts; one or two cylinders are kept at work according to the necessities of the case. The third cylinder is used as a stand-by. They are put in parallel with the help of choking coils. The fall of voltage, due to the choking coils, is 5 per cent. at full-load. The general construction of the rectifier is shown in Fig. 2. If a cylinder of the rectifier is to be switched on to the tramway network it is first connected up through an ohmic resistance, which allows a current of 100 amperes to pass. This is done to ensure the running in parallel with one of the other cylinders or with one of the turbo-generators. The two primary high-tension phases alter their voltage by a maximum of 10 per cent. in the course of the day. This is corrected by inserting a single-phase induction regulator in a secondary phase, which enables the voltages of the phases taken to the rectifier to be adjusted. The rectifier is started by a motor-generator of 1 kw. capacity, and the lighting-solenoid is actuated through a press button. The three rectifying cylinders are connected to a vacuum pump, a stop cock being placed between the pump and each cylinder. But here again it has been found unnecessary to keep the pump continuously in operation. The rectifier is run in parallel with a buffer battery and with other generators; this is done by means of the already mentioned choking coils. At full-load the efficiency is about 92 per cent. Up to the present the rectifiers in this station have given an output of 430,000 kw.-hours without any kind of visible deterioration in the electrodes or in other parts. The installation at present works quite satisfactorily.

Electric Progress in Japan.—We notice in the "Liverpool Journal of Commerce" some interesting particulars of electric development in Japan. The Lake Inawashiro plant now includes six 10,000 H.P. turbines, and transmits power at a pressure of 115,000 volts over 140 miles of transmission lines in Tokio. This is one of the big hydro-electric schemes which Japan has now put in service. At the end of 1914 there was a total of 1,940 stations supplying electricity, 390 of these being central stations, 24 railway plant, 47 combined railway and central station plant, 1,366 isolated plants, and the remainder official installations. The water-power stations number 695, steam 788, and gas-driven stations 547. The total capacity of these stations is 608,544 kw., of which 341,809 kw. are central stations, 140,000 isolated plants. The water-power equipment totalled 366,243 kw., steam 217,967 kw., and gas stations 24,344 kw. There were 21,909 miles of aerial and 751 miles of underground transmission lines.

LEGAL INTELLIGENCE.

Italian Wireless Telegraph Inventions.

Radiogonometer and Triangular Directive Aerial Patents.

There has been a legal suit before the Magistrates' County Court and Court of Cassation of Turin between Professor Alessandro Artom and Cav. Giovanni Agnelli, Cav. Ludovico Scarfiotti and Ettore Bellini, engineer, with the intervention of Mr. Alessandro Tosi, about the interpretation and execution of a legal act dated April 5th, 1912, by Rolando, Notary public, by which Messrs. Bellini, Agnelli and Scarfiotti, the two latter also in the interest of Mr. Tosi, had agreed (amongst other things) to refrain from any kind of discussion, even in print, with reference to the priority, property and subsistence of Professor Artom's inventions in the field of wireless telegraphy. Such a controversy had been occasioned by publications of Mr. Tosi, by means of which he had attributed to himself and to Mr. Bellini the invention protected by Artom's patents, Italian No. 88,766, of the 11th April, 1907; French No. 378,186; and German No. 203,139, commonly known under the name of "Radiogonometer," and to other persons the invention protected by the Italian patent 88,765, commonly known under the name of "Triangular dirigible aerials." The case was definitely decided by the judgment of June 26th, 1915, of the Court of Cassation of Turin, which rejected the claim presented against the judgment of July 18-24, 1914, of the County Court of Turin. In virtue of such judgment it is established by the aforesaid act of the Notary Public Roland that the inventions relating to triangular directive aerials and the radiogonometer belong to the intellectual patrimony of Professor Artom, and that the agreement to refrain from any opposition and discussion, even in print, also refers as a matter of legal consequence to the inventions themselves.

Alfred Gerard, *Advocate.*

Workmen's Compensation.

At Preston County Court last week, Judge Sturges declined, on account of the inadequacy of the sum, to approve a settlement under the Workmen's Compensation Act awarding Margaret Casson, aged 18, £25 for the loss of the end of the index finger of the right hand while cleaning a machine at the works of Messrs. Dick, Kerr & Co.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from The Electrician Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"The Journal of the Institute of Metals," Vol. XVI., edited by G. Shaw Scott, M.Sc. (London: The Institute of Metals.) Pp. lx.+370. 21s. net.

"Electric Traction." By A. T. Dover, A.M.I.E.E. (London: Whittaker & Co.) Pp. xix.+667. 18s. nett.

"Manufacturing Costs and Accounts." By A. H. Church. (London: Hill Publishing Co.) Pp. viii.+452. 21s. net.

"Electrical Equipment: Its Selection and Arrangement, with Special Reference to Factories, Shops and Industrial Plants." By Harold W. Brown, B.S. (London: Hill Publishing Co.) Pp. xiii.+229. 8s. 4d. net.

"The Driving of Machine Tools." By T. R. Shaw, A.M.I.Mech.E. (London: Scott, Greenwood & Son.) Pp. viii.+221. 4s. net.

"Engineers' Year Book of Formulæ, Rules, Tables, Data, &c., for 1917." By H. R. Kempe, M.Inst.C.E. (London: Crosby Lockwood & Son.) Pp. 2151. 20s. net.

"A National System of Economics"! By J Taylor Peddie, F.S.S. (London: The University Press.) Pp. xxv.+299. 5s. net.

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Lieut.-Col. C. B. Clay, V.D., Commanding.

Orders for the Week.

Officer for the Week.—Platoon Commander of Platoon No. 1.

Next for Duty.—Platoon Commander H. de P. Birkett.

Monday, April 16.—Technical for Platoon No. 9, at Regency-street; squad and platoon drill, Platoon No. 10; signalling class; recruits' drill, 6.30 to 8.

Wednesday, April 18.—Instructional class, 6.15; platoon drill, Platoon No. 1.

Thursday, April 19.—Platoon drill, Platoon No. 7; ambulance class by M.O., 6.30; signalling class.

Friday, April 20.—Technical for Platoon No. 10, Regency-street; squad and platoon drill No. 9; recruits' drill, 6.30 to 8.30.

Saturday, April 21.—Commandant's parade, 2.45, uniform, for route-march. Fall in at Putney Bridge Station. Drums and bugles to attend.

Sunday, April 22.—Special work at Bombing School. Parade Clapham Junction Station (City & S.L. Tube Railway), 9.45 a.m. Uniform, haversacks, water-bottles. Midday rations to be carried. As this work is very important the Commandant would like to see much larger parades.

Musketry.—For all companies, see notice at Headquarters.

Note.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street, W.)

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

The Restrictions Upon New Issues. We desire to draw attention to the criticism of the New Issues Committee of the Treasury made by Mr. Ford, chairman of the Edison Swan Electric Co., at the extraordinary meeting last week. Mr. Ford's remarks are reported in another column, but we wish to emphasise the great importance of the question from the national standpoint. It was only after very lengthy correspondence and trouble that the issue of £100,000 in preference shares of the company was sanctioned.

It must obviously be to the interest of the country that British manufacturers should expand their trade, particularly trade formerly in enemy hands; yet, apparently, the Treasury Committee was prepared to allow one of the oldest electrical concerns pass away for want of £100,000, for it was only when Mr. Ford had intimated that, unless consent was granted it would be necessary to give notice to various Government departments that important contracts on hand could not be carried out, was permission granted. During the period between the date of the company's application and the sanction of the Committee new companies were registered involving upwards of 19½ million pounds, including a very large sum for concerns of no public utility, such as kinemas, &c. We agree with Mr. Ford when he says: "If the energies of the Treasury Committee cannot be directed to investigating and refusing permission to the registration of new undertakings, if not commercially sound or essential, they should not withhold sanction to additional issues of capital required for the carrying on or expansion of old-standing and important British industries actually doing national work."

* * * *

Tramways and Road Subsidence. In the last issue of the "Journal" of the Tramways and Light Railways Association there is an interesting note on the position of a tramway company, part of whose track had been let down by a subsidence caused by colliery workings underneath.

The question was submitted to the association's honorary solicitor, and in a lengthy reply it is pointed out that the right of support, upon payment of compensation for non-working, which is given by statute to local authorities as regards their sewers, and to gas and water authorities as regards their mains, is not enjoyed by tramway undertakers. On the contrary, sec. 59 of the Tramways Act, 1870, provides specifically that "Nothing in this Act shall limit or interfere with the rights of any owner, lessee or occupier of any mines or minerals lying under or adjacent to any road along or across which any tramway shall be laid to work such mines and minerals, nor shall any such owner, lessee or occupier be liable to make good or pay compensation for any damage which may be occasioned to such tramway by the working in the usual and ordinary course of their mines or minerals." The section is limited in its application to "tramways" laid "along or across a road," and "tram-roads" or tracks constructed on land acquired under a provisional order or special act, or on land over which an easement has been acquired are excluded. In the latter group of cases it would appear that the rights of the parties depend upon the terms of the purchase, subject, however, to the condition that, in the absence of a specific reservation to the owner or occupier of minerals to let down the surface, sufficient support must be left for the track, and if this is not done, and subsidence occurs, a remedy will lie in damages.

* * * *

Dealings in Lead. The Ministry of Munitions has issued an order prohibiting dealings in lead situated outside the United Kingdom, except under licence from the Ministry, unless it is for the purpose of carrying out a contract in writing existing prior to April 6, for the sale or purchase of white lead, lead oxides, lead manufactures, lead alloys, or lead compounds, or for a contract in writing existing prior to Feb. 2 last for the sale purchase of any other kind of lead.

Licences must also be obtained for dealing in any lead situated in the United Kingdom, except (*a*) for a contract or order for the time being in existence certified to be within classes "A" or "B" in the order of the Minister of Munitions as to priority; or (*b*) for necessary repairs or renewals requiring immediate execution and involving the use of not exceeding 1 cwt. of lead, and not exceeding 28 lb. of white lead, lead oxide or lead compound.

Maximum prices are fixed for the purchase, sale and offer of lead. The use of lead for any manufacture or work is prohibited except in the two cases mentioned above. (*c*) For type casting from metal already in the form of type on Feb. 2, 1917, or from lead purchased for that purpose prior to that date; and (*d*) under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions.

The regulations also require all persons to make monthly returns of stocks, purchases, &c., to the Director of Materials (A.M.2. (E), Hotel Victoria, Northumberland-avenue, London, W.C. 2, to whom also all applications for licences to purchase or use lead should be made.

The following are the maximum prices fixed:—

Pig Lead.—Virgin pig lead £29 per ton net ex ship £30 per ton net ex store or ex refiners' works.

Scrap lead or re-melted scrap lead, £26 per ton net ex sellers' premises.

Manufactured Lead.—Sheet lead, £39. 10s. per ton; lead pipe, £40 per ton delivered U.K. (less 2½ per cent. monthly account).

The rate of exchange between chemical houses and manufacturers of chemical sheet lead for the old lead in pig lead shape to be £8 per ton net for sheet lead and £8.10s. per ton for load pipe, the manufacturer paying cost of delivery of the old lead; the sheet lead or lead pipe to be delivered United Kingdom.

Red Lead and Litharge —£42 per ton, less 2½ per cent. monthly account, in 5 cwt. casks, delivered United Kingdom.

The usual trade extras and allowances apply in above cases.

* * * *

Problems of the Electrical Industry Mr. H. W. Clothier, chairman of the Electrical Committee of the Newcastle Chamber of Commerce, stated at the meeting last week that he was convinced that it was within the sphere of the Committee, representing as it did the local technical and commercial works, to exert a powerful influence upon the general welfare of the electrical industry in this country.

Mr. Clothier said that Newcastle had ever been a leader in engineering matters, and its electrical men, as in the past, were taking a live part in the great development measures. They had the advantage of the advice of the local section of the Institution of Engineers and other learned societies, and, based upon recent discussion, he suggested the following as among the subjects which came within the scope of the Committee:—(1) The general uplifting of British ideas in relation to origin of design and production. Assistance in any movements tending to maintain and to identify as British a high standard of quality. (2) The encouragement of greater attention to the needs of scientific research. (3) The consideration of simplified system of weights and measures. (4) The consideration of recognised ways of computing the depreciation of plant. (5) The development of means for removing restrictions and difficulties in the way of spreading the service of electricity to national industries and the convenience of men. (6) Improvements in telephones and the possibility of machine switching and automatic telephone gear. (7) The consideration of the welfare of men in the industry who have suffered by the war.

A discussion took place on the question of the employment of disabled sailors and soldiers in electrical work, and it was resolved to hold another meeting on the 20th inst.

* * * *

Government Contracts, &c. Much has been written about the need for encouraging Empire industries. Various and divergent suggestions have been made as to how this desirable end should be effected, but we think that the proposal of the Sydney (N.S.W.) Chamber of Commerce is one of the most practical that we have come across.

The Sydney Chamber proposes that all Government departments, municipalities and other public bodies should purchase Empire-made goods and place all contracts with British firms where possible. The principle is already largely in force in the Commonwealth, and the Chambers of Commerce in Australia have already taken steps to carry the principle still further. The Association of Chambers of Commerce of South Africa and the Chambers of Commerce in India have also taken steps in connection with trade after the war. They strongly advocate the extension of the system by which Government departments and local authorities give preference to British goods, and that local authorities should only use other than British goods if actually forced to do so by considerable advantage in favour of such foreign goods.

* * * *

Depreciation of Plant. At the recent meeting of Wm. Jessop & Sons (Ltd.), the chairman (Mr. A. J. Hobson) said that the position of affairs with regard to the future of business in general was very grave.

Mr. Hobson pointed out that the cost of capital expenditure for any trade that it might be desired to push after the war had risen to a point at which for every sovereign of value that could be put into balance-sheet nearly two sovereigns would have to be spent now. To some extent that was met by a special depreciation given by the Ministry of Munitions, but it was only given for work for war purposes, and not for after-war or peace, purposes. Firms were hampered in making plans for the future by the fact that anything they might want to do entailed heavy expenditure at a time of great inflation, and if they could not retain the profit of that time of inflation to write down that expenditure, the disadvantage of spending was very great. From the national point of view he thought these circumstances ought to be met by the Government. A very large number of workpeople would be thrown out of work the moment it was decided to close down the manufacture of munitions, and it was extremely necessary that there should be some provision and forethought for the time when the strain of the war ceased.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Aylesbury.—The Council recently decided to apply to the L.G. Board for permission to borrow £6,000 for additional generating plant in order to meet the increasing demand for electric power.

Burton-on-Trent.—The L.G. Board have refused to sanction a loan of £25,000 for additional electric generating plant, on the ground that the work was not necessary for war requirements.

Londonderry.—An inquiry will be held to-day (Friday) into the application of the Council for sanction to a loan of £35,500 for extensions of the electricity supply undertaking.

Sheffield.—Cables are to be extended to supply Matthias Spencer & Sons at a cost of £130 and also to Attercliffe Common for distribution purposes at a cost of £500.

Subject to the approval of the necessary Government departments, plant No. 3 at Neepsend is to be increased from 4,500 kw. to 6,000 kw. at a cost of £19,450. The expenditure is to be defrayed out of the renewals and special expenditure fund.

Twenty electric lights are to be fixed on tramway standards at important street junctions, and a sub-committee is to report upon a scheme for lighting all the tramway routes in a similar way.

Mr. A. W. Bush, canvassing engineer in the Sheffield installation and motor department, has resigned.

GENERAL.

Battersea (London).—The Electricity Committee has discontinued the issue to the tenants on the Council's housing estate of carbon lamps free of charge.

Belfast.—The chairman of the Tramways and Electricity Committee reported at the last meeting of the Corporation that, as a result of Sir John Snell's report, the Committee had granted applications for supplies which had been held up for several months, and though they could not supply current freely they were prepared to supply new demands in moderation.

Sir John Snell, however, had made it clear that they could not do this unless their plant were kept in perfect order, and, following his advice, they proposed to appoint a mechanical engineer to take entire charge of the plant at £500 a year.

Bradford.—The Corporation have increased the salary of the City electrical engineer, Mr. Thos. Roles, by £100 per annum to £900, and that of the deputy electrical engineer, Mr. J. H. Shaw, by £100 per annum to £450.

Increased Charges for Electrical Energy.—The charges for current are being increased at the following places:—

Kendal Corporation is increasing its charges from April 1. The charges for lighting will be: Up to 20 units per quarter 13s. 4d., 80 to 1,000 units per annum 7½d. per unit, 1,000 to 1,500 units 6½d., over 1,500 units 5½d.; for power, 20 units per quarter 13s 4d., 80 to 1,000 units per annum 3½d. per unit, 1,000 to 2,000 units 2¾d., 2,000 to 8,000 units 2½d. over 8,000 units 2d.

Lancaster Council has increased its charges for lighting and power by 22 per cent. and for tramways and motor buses by 12½ per cent.

Colne Electricity Committee has increased its charges as from April 1. The lighting flat rate is increased from 4½d. to 5d., and the m.-d. system is 6d. (as before) for the first hour and 3d. (instead of 2½d.) afterwards. The power rates are 3d. (instead of 2d.) flat, and 3d. and 1d. instead of 4d. and 1d. on the m.-d. system.

Bristol Electrical Committee recently increased its rates by 7½ per cent. for lighting (making 22½ per cent. on the basis price), 15 per cent. (total increase 45 per cent.) for power or 12½ per cent. on the combined rates (total increase 37 per cent.).

Reigate Electric Lighting Committee has increased its rates by a further 18½ per cent. as from April 1, making the total increase 33⅓ per cent.

Ilford Council is increasing its charges in June next. On the ratable value system the charge will be 12½ per cent. on ratable value, plus ¾d. per unit. On the m.d. system the charges will be 6d. and 2d., slot meters 4½d. per unit, power on m.d. system 2½d. and 1½d., heating 1½d. per unit. For vehicle charging, bulk supply, &c., the charges are increased 25 per cent. For lighting (rate B) 1,000 units or less per annum will cost 4d. per unit, and the rates vary down to 3½d. per unit for over 5,000 units, while rate F for power varies from 500 units per quarter at 2½d. to 10,000 units and over at 1¼d.

Stretford.—The Council has granted increases of salaries to the following members of the staff of the electricity department: Messrs. T. W. Taylor (chief clerk), C. Wright, A. H. Smith, C. A. James and R. E. Livesley, shift engineers, and to G. Murgatroyd, electrical inspector.

ELECTRIC TRACTION.

Bournemouth.—The Tramway Committee is to consider the employment of female conductors.

Bradford Tramways.—During the year ended March 31 the Corporation tramcars carried more persons than in any previous year, and the receipts were also a record.

Though the car-miles run were less than the previous year, the wages bill was considerably greater. The receipts (traffic and parcels department and rail-less system) were £348,162, against £334,315 in 1916 (increase of £13,847, or 4 per cent.), and number of passengers carried was 76,869,642, against 74,082,612, an increase of 2,787,030, or 3·76 per cent. The car-mileage was 6,086,515, or a decrease of 113,067, the receipts per car-mile being 13·72d., an increase of 0·78d. There was an increase of 0·028 in the number of units per car-mile, the figures being 2·018 and 1·990 respectively, and total units showed a decrease of 12,729 in the respective totals of 12,422,950 and 12,435,679. The total wages paid were £158,155, an increase of £19,234, or 14 per cent., and the bonus paid was £22,087, against £7,125, an increase of £14,962, whilst allowances to dependents of men serving with the Forces increased from £8,338 to £14,376.

Coventry.—The Council have decided to postpone for 12 months the question of the construction of new streets and the widening of some of the narrow streets of the city, but the Tramways Committee has been given power to introduce a scheme of their own if thought advisable.

Metropolitan Tramway Service.—Southgate Council has passed a resolution calling upon the Middlesex and London County Councils to hold an inquiry into the unsatisfactory tram service.

Norwich Electric Tramways.—The Board of Trade has extended for one year from July 31, 1917, the time limited by the Norwich Electric Tramways Act, 1914, for compulsory purchase of land, &c.

Salford.—It is proposed to introduce halfpenny fares on the tramways for children under 12 years of age.

Stoke-on-Trent.—A sub-committee of the Electricity Committee recommends that, instead of a steam tractor, an electric battery vehicle of the Orwell type be purchased from Messrs. Ransomes, Sims & Jefferies, at an estimated cost of £990, including electric tipping gear.

Willesden-Watford Electric Railway.—The extension of the Bakerloo Railway from Willesden Junction to Watford will be opened on Monday.

After coming to the surface at Queen's Park, the Bakerloo trains will run over the electric line of the London & North-Western Co. to Watford, via Willesden Junction new station. The extension has increased the length of the Bakerloo run to over 20 miles, and there are 12 stations on the line of route. It opens up a large area of new residential districts, and directly connects the northern suburbs with the central, west-end and south-eastern districts of London. In addition, it will give passengers using the London & North-Western system a choice of new terminal stations in London, connecting with main line railways, for the new line joins up Paddington (G.W.R.), Marylebone (G.C.R.), and Waterloo (L.S.W.R.), with Willesden Junction and Watford. Other main line railways can easily be reached by Bakerloo passengers. By changing at Oxford-circus they can travel to Liverpool-street (G.E.R.); a change at Piccadilly-circus enables them to get to King's Cross (G.N.R.), and the Trafalgar-square station is only a minute's walk from Charing Cross (S.E. & C.R.).

LIGHTING AND INDUSTRIAL POWER.

Salford.—Subject to an order of the Board of Trade being obtained, the Manchester Ship Canal Co. will be supplied with e.h.t. energy for their Irwell Park Wharf upon the following conditions:—

1. The company to guarantee a minimum payment of £500 per annum for 10 years for current consumed; (2) the company to indemnify the Corporation against loss in the event of the company discontinuing the use of the cable proposed to be laid; (3) and the sub-station building, transformers, converters and switchgear required shall be provided and maintained by the company.

York.—The Electricity and Tramways Committee has deferred the proposed scheme of electric lighting for workpeople's cottages, as it is impossible to undertake the wiring work at present, owing to shortness of staff and the withdrawal by the L.G. Board of their sanction to expend £500 on the wiring.

Digitized by Google

TELEGRAPHY AND TELEPHONY.

Telephony in India.—"Indian Engineering" announces that a telephone exchange is to be erected adjoining the Commercial Secretariat buildings, Calcutta.

The exchange is expected to be in operation by January, 1918, and Messrs. Gill & Cook are to superintend the equipment of the exchange.

U.S.A. Radio Stations.—President Wilson has ordered the seizure of all wireless stations on American territory. The Government will operate those needed for naval communication and close the others.

IMPERIAL NOTES.

Australasia.—The "Australian Mining Standard" says the Hawthorn (Victoria) Tramways Trust is experimenting with a new air brake. The air compressors are worked by independent electric motors.

The chief engineer for construction in the Victorian railways department (Mr. M. E. Kernot) expects that cars will be run on the electric street railway between Sandringham and Black Rock early next year. Power, which is to be obtained from the surburban electrified railway, is not yet available owing to the war.

Wollongong (N.S.W.) Council has received from the Works Department a revised plan of an electric supply scheme. The plant in the Works Department's power house at Port Kembla is being extended. to provide power for the dam-making machinery on the Cordeaux River

A new power house is to be erected at Newcastle (N.S.W.) in order to provide power for the new electric cranes on the basin wharfs and the wheat elevators, which will be built shortly, and to supply additional power to works served by the present power house. It will also provide the currnet when the steam tram system is electrified.

The engineer and manager of the Prahran and Malvern (Victoria) tramways (Mr. H. S. Dix), in collaboration with Messrs. Pryor & Coffey, has produced a speed detector and alarm, of which a trial was made lately on one of the trust's cars. When 20 miles an hour is exceeded a gong is sounded, and continues ringing till the speed is lessened. The invention has been patented.

At the last quarterly meeting of the Hobart Chamber of Commerce, Mr. H. W. Gepp, general manager of the Electrolytic Zinc Co. of Australia Propty (Ltd.), said that before the war Australia had been producing large quantities of ores, which had been taken by Germany and treated mostly in Belgium. The British Empire produced 25 to 30 per cent. of the zinc ore of the world, out of which some 250,000 tons of zinc were made by Belgians and Germans. England was using from 160,000 to 200,000 tons a year, and making only 60,000 tons, so that the balance of her requirements was made in Belgium and Germany and sold to England by the Germans. It was necessary that we should produce our own zinc inside the Empire. The Allies were purchasing 600,000 tons of zinc a year, worth probably £40,000,000. They could not induce industries to come there unless they were given attractive conditions. They would have to carry nearly all their production of betw n 30,000 and 40,000 tons of zinc to Europe, costing from 25s. to 30s. per ton, and they would have to bring a great deal of the raw material by water; consequently there must be attractive terms. Their proposal was perfectly feasible; experiments were carried out in California to a successful issue, and any local difficulties would be overcome.

The Public Works Committee (Sydney) has received a report from Mr. E. M. de Burgh, chief engineer of water supply, on a scheme for hydro-electric development on the Murrumbidgee River at Burrinjuck dam. Mr. de Burgh estimates that at Burrinjuck 1,400 kw. can be generated after transmission over 100 miles. 938 kw. would be available for the towns of Goulburn, Yass, Harden, Cootamundra, Junee, Wagga, Gundagai, Tumut and the Federal capital, Canberra. The estimated cost of the construction and equipment of the power houses, transmission cables, &c., is £100,000. The estimated annual charges are £9,095, and annual receipts £11,686. Mr. de Burgh says the transmission line could be extended to Griffith and Leeton to supply electricity for use in connection with the cultivation of the land.

Melbourne Tramways Award.—Mr. Justice Cussen has made his award in the arbitration proceedings to determine the amount to be paid by the new Tramways Board to the Melbourne Tramway & Omnibus Co. for certain items not included in the leases granted to the company by the original Tramway Trust. The company claimed £469,000, but during the proceedings this was reduced to £438,000. His Honour, however, reduced it in his award to £335,000, but he directed that interest be paid as from June 30, 1916, the date on which the leases expired, and on which the lines and such other properties fell into the hands of the Tramway trust. In arriving at the amount of compensation the arbitrator acted upon the following principles:—

He had had regard to June 30, 1916, as the date in relation to which the value was to be ascertained. In respect of many of the things, including rolling stock, he fixed their values by considering them as things in situ, capable of earning a profit, and in many cases that necessitated fixing values practically by reference to structural cost, less a proper deduction for depreciation. In fixing these values he had not regarded the possibility or probability of the cable tramway system being converted into an electrical tramway. In the case of the Royal Park tramway and the buildings connected therewith, he allowed the company only for the loss of its rights under the lease of such tramway.

FOREIGN NOTES.

Argentina.—The Government recently gave permission to the Compañia Sansinena de Carnes Congeladas to instal an electric crane of 2½ tons' lifting capacity on the south side of the Riachuelo, facing the frigorifico La Negra.

Brazil.—The American Consul-General at Rio de Janeiro reports that there is a good market in Brazil for magnetos, which have in the past been chiefly obtained from the Continent of Europe.

Chili.—Señores Sougarret Hnos. y Cia. have been given permission to instal an electric lighting system, by means of overhead cables, in the town of Ercilla.

Don Luis E. Silva has been given permission to instal electricity supply works for the towns of Llolleo and San Antonio.

Don Eugenio Cibié, concessionaire of a mechanical tramway system between Santiago, Barrancas, El Resbalon and Cerro Navia, has been granted permission to construct and work branch lines between Barrancas and Pudahuel and betwen El Resbalon and the town of Lampa. The length of the first branch will be about 3½ miles and of the second nearly 14 miles.

Italy.—The Sangritana Railway Co. has presented a scheme to the Ministry of Public Works for the electrification of about 93 miles of railway and for utilising the water power of the River Sangro.

The scheme is still under consideration. Meanwhile the Ministry are encouraging any enterprise on the part of Italian railway or other companies for the development of the electrical power of the country and economising its coal supplies.

Madrid Underground Railway.—The Compania Metropolitana Alfonso XIII. has published the following particulars of its scheme for an underground electric railway system for Madrid.

Although the project embraces the construction of four lines, only the Norte-Sur line, from the Cuatro Caminos to the Plaza del Progreso, will be put in hand at present. The Norte-Sur line will be about 2½ miles, and there will be nine stations, at an average distance apart of 500 metres. The general type of the tunnelling, which will be of double track, similar to that of the Paris Metropolitan Railways, although the dimensions will be rather smaller. The maximum gradient will be 4 in 100, and the minimum radius of curves 100 metres. The total cost of the Norte-Sur line is put at 8,000,000 pesetas (£320,000), including 4,079,775 for underground works, 979,231 for work on the surface, and 1,640,000 for rolling stock. Working expenses are estimated at 647,865 pesetas (£25,913), including power 127,545 pesetas; labour 280,320, administration 100,000, and repairs, &c., 140,000.

Maranhao (Brazil).—Our local correspondent informs us that Santos Sobrinhos, general merchants, are the only dealers in electric lamps, fittings, machinery, &c., in this district, but they deal principally with the U.S.A., there being no British firms represented at present. There is a small electric lighting plant owned by the Maranham State Government, who supply public buildings and private houses, by courtesy of the Governor of the State. They charge 12 milreis per month for every 100 c.p. lamp in use. Wiring is done by individuals with no proper electrical engineering status.

Russia.—Mr. L. D. Wilgress, Canadian Trade Commissioner at Omsk, Siberia, has compiled a list of some of the principal lines of hardware for which there appear to be openings in Siberia.

These include bell pushes, bolts and nuts, builders' hardware, drills, electric light fittings, files, hammers, lamps, lanterns, wire, pulleys, hand pumps, radiator fittings, scales, screws, tools of all kinds and valves.

MISCELLANEOUS.

Controlled Establishments.—The total number of controlled establishments is now 4,802, an increase of 32 since the last announcement.

Enemy Firms Wound Up.—Up to date the Board of Trade has ordered the winding-up of 440 businesses controlled by alien enemies.

The latest list includes the United Machine Tool Co. (Ltd.), Hop Exchange-buildings, 24, Southwark-street, London, S.E., dealers in machine tools. (Controller: E. W. Lean, 19, Coleman-street, E.C.) Wedmore Engineering Co., Wedmore-street, Upper Holloway, London, N., manufacturers of machine tools. (Controller: E. W. Lean, 19, Coleman-street E.C.) Ramsay Marine Engineering Co. (Ltd.), 11, Long Acre, London, W.C., dealers in marine inventions. (Controller: T. D. Hawkin, Whitehall House, Charing Cross, S.W.

The Controller of Bohler Bros. & Co., Styrian Steel Works, Renton-street, Sheffield, has applied for a release. Objections to the Board of Trade before April 14.

Imports and Exports.—We have been compelled to discontinue our weekly records of imports and exports, owing to the Board of Customs and Excise having ordered that until further notice particulars of the countries from whence imports are shipped or consigned or to which exports are destined shall not be published.

Presentations.—Mr. Joseph Furze, who has retired from the position of manager of the Commercial Cable Co. at Liverpool after 33 years' service, was recently fêted by his friends, including several who are prominently associated with the submarine cable service.

Among the large company present were Messrs. J. Wilkinson (superintendent of the Commercial Company, London), W. Steventon (assistant

Digitized by Google

manager, Liverpool, and successor to Mr. Furze), R. W. Budden (superintendent, Manchester), and J. W. Simpson (assistant superintendent, Liverpool); also the following from the Western Union Telegraph Cable system: Messrs. J. Hamilton (Liverpool district manager), J. Dunn (assistant superintendent), R. Williams (assistant superintendent), J. W. Graves (late superintendent, Glasgow), and T. Healey (late superintendent, Liverpool). The Eastern Telegraph Company were represented by Messrs. G. Mackenzie (manager, Liverpool), Geo. Crick (assistant superintendent), and Walter Bolton (late manager). Letters, telegrams and cablegrams from all parts of the globe conveying appreciation and congratulations to Mr. Furze were read.

The chairman (Mr. Wilkinson), proposing the health of the chief guest, said he regarded Mr. Furze as one of the landmarks in the cable service. They had been associated for 30 years past, and he (the speaker) could testify from his experience that it had been good to know Mr. Furze. In presenting to Mr. Furze a silver tea and coffee service on an engraved salver as a mark of esteem from the staff of the Commercial Cable Co. at Liverpool, he referred in enthusiastic terms of the kindly relationship which had always existed between Mr. Furze and the staff. Mr. Furze was a man who had done wonderful work in a wonderful business. Forty-eight years ago he first adopted the profession of a telegraphist by entering the old Electric Co., being transferred to the Post Office a year later when the State took over the telegraphs. In 1871 he entered the service of the Eastern Extension Co., in which he remained for four years, when, better prospects presenting themselves, he became attached to the Direct United States Cable Co., with which he served nine years. Thirty-three years ago, when the Commercial Cable Co. was originated, Mr. Furze was appointed manager of the Liverpool station, and there he continued until that day, when he commenced his retirement. Having referred to the great development which had taken place in submarine cabling during recent years, he added that people sometimes thought that the charge of 1s. a word charged for messages transmitted across the Atlantic was an exorbitant sum, but it should be understood that the cost of laying and maintaining submarine cables was enormous. It had been feared that the advent of the "wireless" would damage the prestige of the submarine cable, but up to the present those fears had not been fulfilled. The wireless had achieved great results in the spheres to which it had been adapted, but the submarine cable still held its own.

Mr. Furze expressed his gratification at the mark of esteem shown him by the staff. He thanked them for their co-operation, without which he could never have experienced the success which had attended his efforts. During the 33 years he had been in control not a man had been dismissed, and he had never kept back promotion from anyone.

A walking-stick, subscribed for by officials of the Western Union Cable Co., was also presented to Mr. Furze.

At a meeting of the Association of Municipal Electrical Engineers of Lancashire and Cheshire on March 27 a presentation, consisting of a combined "Luncheon and tea" basket, was made to Mr. C. C. Atchison, as a token of esteem and recognition of the valuable work he did for the association as honorary secretary.

Mr. J. A. Robertson, of Salford, made the presentation on behalf of the members of the Association, and several speakers referred to the excellent work Mr. Atchison had done in helping forward the Association. In fact, it was pointed out that he was really its originator, and that through his efforts the Association of Municipal Electrical Engineers of Lancashire and Cheshire was formed.

Registration of Business Names.—A useful guide to the Registration of Business Names Act of 1916 has recently been prepared by Mr. Kenneth Brown, solicitor.

The guide gives concise information as to who must register, the particulars required, penalties for failure to register, the requirements as to trade catalogues, circulars, &c. The published price is 1s. net, and the publishers are Isaac Pitman & Sons (Ltd.), Amen Corner, E.C.

Theft of Cable.—At Otley Police Court last week, Sidney Harold Bill was charged with stealing a quantity of electric cable, of the value of £110, the property of Ilkley District Council.

Mr. F. S. Eckersley, clerk to Ilkley Council, prosecuted and said the defendant was appointed in October, 1914, as clerk of works, and on the erection of the plant he was appointed engineer and manager at £250 a year. In June last he joined the Navy, and Mr. J. Senior was appointed as his substitute. The Council had purchased a quantity of cable, but it was not until January last that they had any reason to suspect a shortage. The Western Electric Co., from whom the cable was purchased, made application for the return of two empty drums, which could not be found. Later it was found that two drums of cable had been sent by accused from Ilkley to the Workington Iron and Steel Co. On inquiries being made of them they stated that they had purchased them through a gentleman in Glasgow, who stated that he had not purchased them from Ilkley Council, but through an advertisement.

After evidence had been called, accused pleaded "Guilty." It was urged that accused had offered himself for active service in August, 1914, but was rejected because of a bullet wound in the leg, received during manœuvres. In 1915 he received the offer of a commission in the Royal Engineers, but the Council refused to allow him to leave. Later, however, on undertaking to provide a substitute, he was allowed to join the Navy, and he was appointed an electrical engineer on board a boat. Afterwards his commanding officer advised him to join the Flying Corps, but he was too old, and therefore under promise of a commission he joined the Royal Field Artillery as a private.

The Chairman said that but for the fact that defendant had done his best to serve his country they would have passed the maximum sentence of six months, but he would have to go to prison for two months.

TENDERS INVITED AND ACCEPTED.

Induced Draught Fans, Mechanical Stokers, Boiler Feed Pump, &c.

Hammersmith (London) Borough Council invite tenders for Induced Draught Fans, Mechanical Stokers, Boiler-feed Pump, Centrifugal Pump for condenser water and strainer for condenser cooling water. Full particulars and forms of tender from the engineer and manager of the electricity department, Mr G. G. Bell, 85, Fulham Palace-road, W.C. Tenders to the Town Clerk, Town Hall, Hammersmith, by 4 p.m. of April 25. *See an advertisement.*

Internal Combustion Engine and Generator, &c.

Aylesbury Corporation require tenders for the installation of a 200 kw. direct-coupled internal combustion engine and generator, with fuel plant and accessories. Specifications from the Electrical Engineer.

Aberdare.—The tender of the Tudor Accumulator Co. has been accepted by the Urban Council for the supply, erection and setting to work of a battery of accumulators, complete with charging booster, switchgear, copper rods and cable.

Cardiff.—The tender of the General Electric Co. has been accepted for six months' supply of electric lighting sundries to the Welsh Metropolitan War Hospital, at £135. 8s.

Derby.—The tender of the British Thomson-Houston Co. for extension of switchboard (at £340) has been accepted by the Council.

An order for an electric tip wagon has been placed with the General Vehicle Co., at £1,260.

Hammersmith (London).—For the supply of draw boxes for 12 months the Borough Council are recommended to accept the tender of W. Lucy & Co., at £434. There were four other tenders, varying from £749 to £880.

Sheffield.—The City Council has accepted the tender of C. Robson & Sons for 18 dustproof coal measurers.

APPOINTMENTS VACANT AND FILLED.

Birmingham Corporation Electric Supply Dept. require a junior shift engineer for the new temporary station at Nechells. Commencing salary £130, rising to £200 per annum, plus £10 extra per annum during the war. Applications to the city electrical engineer, Mr. R. A. Chattock, 14, Dale End, Birmingham, by April 24. *See an advertisement.*

A works superintendent is wanted for a small municipal station. *See advertisement.*

London County Council invite applications for the position of electrical engineer in the tramways department, at a salary ranging from £1,200 to £1,500 a year. Applications on official form to be obtained from the Clerk of the Council, County Hall, Spring-gardens, S.W., must be returned by 1 p.m. April 23.

London County Council also require an operation superintendent (£500 to £700 per annum) and a development superintendent (£500 to £800) for the traffic branch of their tramways department. Applications by April 23 for the former, and May 7 for the latter appointment.

BUSINESS ITEMS.

P. R. P. Souper and John T. Callaghan, engineers and agents, Grosvenor-chambers, Deansgate, Manchester, have dissolved partnership. Debts by Mr. Callaghan.

The partnership between Thos. Kirkland, D. S. Capper and T. J. R. Kiernan, consulting engineers, 17, Victoria-street, London, S.W., has been dissolved so far as concerns D. S. Capper, who retires from the business, which will be continued as Kirkland & Capper.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of June 14. *Further particulars are set out in an advertisement.*

BANKRUPTCIES, LIQUIDATIONS, &c.

Saul Stephen Coster (trading as S. S. Coster & Co.), electrical and mechanical engineers, 14, Gladstone-road, West Ham Park, Essex, has been adjudicated bankrupt.

The estates of Hy. Wm. Few, retired Indian Telegraph servant, formerly of Coupar Angus, Edinburgh, and Ruskin Manor, Denmark-hill, London, S.E., have been sequestrated. A meeting to elect trustee and commissioners will take place on April 17 at Dowell's Rooms, 18, George-street, Edinburgh.

Claims against the Adnil Electric Co. (Ltd.), Artillery-lane, Bishopsgate-street Without, London, E.C., are to be sent by April 21 to Mr. J. H. Stephens, 6, Clement's-lane, London, E.C.

Digitized by Google

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Liverpool.—The accounts of the electric supply depot for the year ended Dec. 31, 1916, show total capital expenditure £2,228,711 (increase £2,773), of which £1,366,727 is outstanding.

Revenue was £405.650 and gross profit, after providing for working expenses, special charges and provision for bad debts, was £229,787. Interest required £68,631, sinking fund £57,146, and renewal fund £39.167, and £65,000 is being contributed to relief of rates.

The accounts of the tramways department for the year 1916 show total capital expenditure £2,068,435, and £1,430,360 has been set apart for sinking fund and redemption of debt, while £844,788 has been devoted to reserve, renewals and depreciation. Revenue was £766,576 (compared with £726,078 in previous year) and operating costs were £518,036 (£488,273) leaving gross profit £248,540 (£237,804). Interest and sinking fund required £102,568 (£114,610), and net profit was £145,971 (£123,193), of which £20,971 (£23,193) has been placed to reserve, renewals and depreciation and £125,000 (£100,000) contributed to relief of rates. Car earnings were 13·97d. (13·20d.) per mile, operating costs were 9·798d. (9·240d.) per car-mile, and interest and sinking fund amounted to 1·940d. (2·169d.). Passengers carried were 157,636,595 (150,755,680), and car-miles 12,688,163 (12,682,018). Mr. C. W. Mallins (general manager) says in his report, 1,900 men out of a staff of 2,700 have left to join H.M. Forces, and 100 have given their lives in defence of their country. A priority certificate was obtained, which enabled the department to obtain the necessary material to keep the rolling stock and overhead equipment in good repair. Over 4,000 cars had been dealt with for repairs during the year. Dependents' allowances required £26,247 and war bonus £11,439 during the year, while increased pay to certain employés absorbed £700. When the retirement fund for employés was established it was decided that no calls should be made on the fund for 10 years, which period will be reached early next year. A sum of £30,000 has been accumulated, which should be sufficient to meet all claims.

Salford.—The accounts of the electricity department for the year ended March 31, 1916, show gross capital expenditure £735,393 (increase £21,805), of which £409,715 is outstanding.

Income was £134,678 (compared with £116,299 in previous year), working expenses were £65,252 (£57,627), and current purchased cost £4,888 (£6,414), leaving gross profit £64,538 (£52,258). Capital charges were £47,940 (£43,852), leaving £16,598 (£8,406) net profit. Total working costs were 0·677d. (0·744d.) per unit sold, and interest and sinking fund required 0·454d. (0·504d.). Units generated were 29,117,290 (22,697,653), purchased 1,178,152 (1,885,090), and sold 24,856,435 (20,651,761).

The chief engineer, Mr. J. A. Robertson, says in his report a second 5,000 kw. turbo-alternator was installed at the Frederick-road works during the year, and a third was in course of erection. A sub-station was equipped for the Broughton Copper Co. to meet their increased demand, and a 3,000 kw. sub-station was being erected at the corner of Blackfriars-road and Greengate.

COMPANIES' MEETINGS AND REPORTS.

Chelsea Electricity Supply Co. (Ltd.)

The annual ordinary general meeting was held on April 4, under the presidency of Mr. W. R. Davies, the chairman of the company.

The SECRETARY (Mr. S. J. Cluer, F.C.I.S.) having read the notice calling the meeting and the auditors' report,

The CHAIRMAN said: In rising to move the adoption of the report and accounts I would point out that they show that, after providing sufficient sums to preserve the capital of the company intact at the end of our concession in 1931, and after providing for the debenture interest and for the preference dividend, we have out of the profits of the year sufficient to pay a dividend of 3 per cent. on the ordinary capital. Thus, for the second year in succession, we are faced with a reduction in the dividend, which for the year 1914 was 5 per cent. and for 1915 4 per cent. This reduction is due to two causes—an increase of £3,800 for fuel costs and of current purchased, and of over £3,000 for income tax. The total on the debit side is about £7,800 higher, while the receipts are about £4,500 better, the net result being that we carry to net revenue account over £3,000 less than a year ago. We have suffered from the operation of the Siummer Time Act, which has meant that practically for nearly half the year we have been deprived of an hour's deamdn a day for artificial light, as compared with any previous year of our existence. We have, therefore, been subjected to a double disadvantage—higher costs for fuel on the one hand, and an inroad into the demand of the public for current on the other. These disadvantages have only partially been recouped by an increase in price, which, in conjunction with all other electric light companies in the kingdom, we have been compelled to make. We carried out during the year what I regard as a very important operation, resulting in a great improvement in our financial position, by the purchase and cancelling of £53,212 of our debenture stock, thus reducing the debenture debt from £175,000 to £121,788. By this means we have got rid of the liability to provide in future for the premium of 10 per cent. on the debenture stock of the company when this stock becomes payable, the provision for which for some years has been an annual charge on the profits of the company. With the discount on the stock so purchased and cancelled, and the provision of £815. 11s. 6d. placed to the credit of the debenture stock premium redemption fund in the present accounts, we have now provided a sufficient sum to meet the premium on the balance of stock still outstanding, so that no further appropriation to this fund will be necessary. This transaction was carried out partly by our own surplus funds and partly by a loan of £30,000 from our bankers, which was reduced to £29,000 at the close of the year. I am glad to say that the amount has since been reduced to £14,300, and I expect that after July when some Treasury Bills we hold fall due, that the amount will be further reduced to about £2,000, and that by the end of this year, the whole loan will be wiped off. We have managed to maintain a good service for our customers, and you will readily understand that with a considerably diminished staff this has at times been a very strenuous work as well as a great responsibility. I feel that the thanks of the shareholders are due to the keenness shown by the staff in their work, and I feel sure that you will all join with me when I say that we are greatly indebted to them for their efforts. Sixty-three of the company's employés are on active service, of whom, I deeply regret to say, two have lost their lives and two have been wounded. If the income tax remains at the same rate as at present, the amount chargeable against the profits of 1917 will be about £1,500 less than the amount debited to the present accounts. This, with the elimination of the item of the debenture stock premium redemption fund, suggests that next year's accounts will be better off to the extent of £2,300; but, on the other hand, there is the serious contingency—and, in fact, certainty—that the continued rise in the cost of fuel, both of coal and oil, must inevitably result in a largely increased cost under that head. In addition, the cost of labour and materials continue to rise. I now move that the report and accounts for the year be received and adopted.

Major W. F. WOODS, J.P., seconded the motion, which was at once unanimously carried. Mr. W. R. Davies was re-elected a director, and Messrs. Cooper Bros. & Co. were re-elected auditors.

AMERICAN TELEPHONE & TELEGRAPH CO.—The report for 1916 states that $84,906,000 was applied out of revenue to current maintenance and depreciation. Current maintenance increased $3,752,000. The provision for depreciation of plant was $49,983,000 (increase over 1915 of $5,094,300). Total operating revenues of Bell system were $264,600,000 (increase $30,151,000). Depreciation and maintenance required $84,556,000 (increase $8,797,000), traffic expenses $53,749,000 (increase $7,963,000), commercial expenses $25,699,000 (increase $2,116,000), general and miscellaneous expenses $11,902,000 (increase $853,000). The total taxes were $15,131,000, or 1·70 per cent. on outstanding capital obligations. Non-operating revenues produced $7,080,000. The "total gross income" was $79,353,000 (increase $9,787,000). Out of this $22,114,000 was paid for interest, rents, &c., leaving $35,160,000 for dividends and over $22,000,000 to be carried into surplus. The total capitalisation (including inter-company items and duplications, but excluding reacquired securities of companies of Bell system) is $1,497,760,616. The net earnings of the American company were $44,743,376, or $3,625,889 more than for 1915. Interest charges were $6,730,098, and dividends at the regular rate of 8 per cent. per annum absorbed $31,122,187. Of the resulting balance there was carried to reserves $2,500,000 and to surplus $4,391,090.

ARGENTINE TRAMWAYS & POWER CO. (LTD.)—The gross receipts for the year to Sept. 30 last were $m/n370,092 from the tramways (an increase of $m/n44 041) and $m/n106,654·23 from the light and power department. After making provision for doubtful debts and other charges in Santa Fé the net operating revenue was £12,255, increased by interest from investments, &c., to £13,358. After charging interest and debenture stock, sinking fund and London expenses the balance is £356.

COMPANIA DE ELECTRICIDAD DE LA PROVINCIA DE BUENOS AYRES.—The gross receipts for the supply of light and power for the year ended July 31 last were £189,883, compared with £177,888 for the preceding year. The total receipts amount to £192,239, an increase of 7·50 per cent. The normal expansion of the business has been interfered with by the continued depression in the Argentine and the adverse conditions brought about by the war. The combined cost of operating the individual undertakings in the Argentine was £118,383, an increase of 11·54 per cent., which is entirely ascribable to the higher cost of fuel and materials. The increase on the total operating expense is only 10·07 per cent. The net profit is £62,728, against £61,159. The directors have placed the whole of the available balance of £11,639 to reserve for depreciation and doubtful debts. During the year £10,384 was expended on capital account. The reduction of the ordinary share capital has been utilised in writing off the costs of "preliminary and organisation expenses," &c. An agreement has been made with the Union Anversoise de Tramways et d'Enterprises Electrique.

Digitized by Google

DUBLIN & LUCAN ELECTRIC RAILWAY CO.—At the recent meeting it was reported that the traffic receipts for 1916 showed an increase of £104, but expenditure increased by £481. After providing for debenture interest, the available balance of £313 was carried forward.

EDISON SWAN ELECTRIC CO. (LTD.)—Last week an extraordinary meeting was held for confirming the resolutions passed on March 14 altering the articles of association. The chairman (Mr. C. J. Ford) said he was pleased to be able to announce that the New Issues Committee of the Treasury had now given its sanction to the issue of the 100,000 preference shares mentioned in the scheme of arrangement which had already been passed by all classes of debenture stockholders and shareholders.

The resolutions contained in the notice convening the meeting having been unanimously confirmed, Mr. Ford said there was one other matter he would like to refer to. At the last annual meeting he referred to the outlines of a scheme for the provision of further capital. At that time he had anticipated matters by making application on Oct. 10 to the New Issues Committee of the Treasury for permission to issue £100,000 of preference shares. After somewhat lengthy correspondence with the Treasury, spread over a period of nearly five months, and with the very fullest facts dealing with the situation placed before it, consent to such issue was refused, in spite of it having been explained to the Committee that the necessity for the new capital was brought about in consequence of the general expansion of the company's operations, practically the whole of which were of national importance. It was also pointed out that if the money was not forthcoming the company, although absolutely solvent, would have to cease its operations, realise its assets and pass into liquidation. It was obviously the duty of every British manufacturer to use his utmost endeavours at this grave national crisis to expand in every direction the trade of the country, particularly in those directions where our enemies had, previous to the war, obtained such a hold, and he thought he was right in saying that in the electrical industry the Germans were the most serious opponents to be met with. To all those exhortations the Treasury Committee turned a deaf ear, it apparently being of no interest whatever to it that one of the oldest electrical concerns would pass away for want of what he might almost call a paltry £100,000. He could understand that, in view of the issue or pending issue of the recent War Loan, it was necessary for the Treasury to suspend and possibly refuse to sanction any new capital issues, and he therefore again made a renewed application after the War Loan lists were closed, but still without success. As a last resource he intimated to the Treasury that unless their consent was granted it would be necessary for the directors to give notice to various Government departments that important contracts on hand for such departments could not be carried out. This had the desired effect, and the matter was reconsidered by them, and recently the necessary permission had been granted. He was sure they must all agree that what had happened was eminently unsatisfactory from a national point of view, and if that policy was generally pursued it must inevitably prejudicially affect the whole future position and trade of the country. It went to show that the department in question was not concerned in supporting national trading interests, which, after all, were the life of the nation, and it appeared that it was only when it was put to them that Government needs could not be fulfilled consideration was given to such a request. He had a list of new companies registered at the Joint Stock Companies department since the date of their application, and he found that the capital involved totalled upwards of 19¼ million pounds, which included a very large sum for concerns of no public utility, such as cinemas, &c. "Now," said Mr. Ford, "if half-a-dozen of us round the table choose to register a company for any wild-cat scheme for a million of money, and subscribe this money amongst ourselves, not desiring to make a public issue or to have the shares dealt in on the Stock Exchange, there is nothing to prevent us from doing so, and there is no law enabling the Treasury to interfere." That seemed to him an entirely wrong attitude to adopt.

HART ACCUMULATOR CO. (LTD.)—The profit for the year ended Dec. 31 is £19,555, and with balance brought forward (£16,949) the total is £36,504. After deducting the dividend on preference shares (£423. 10s. 10d.) the balance is £36,080. 5s. 8d. The directors recommend a dividend of 10 per cent. per annum (less tax) on the ordinary share capital, which will absorb £8,706, leaving £27,374 to be carried forward.

HUELVA GAS & ELECTRICITY CO. (LTD.)—The report for 1916 states that in the first week in January the Association of Mineral Exporters in Huelva took over the working of the electricity department on terms which are still under negotiation.

RANSOMES & RAPIER (LTD.)—The disposable balance for 1916 is £31,820 after providing for all outgoings, depreciation, debenture interest, &c. The directors propose a dividend of 10 per cent. on the ordinary shares, tax free, and after placing £5,000 to reserve, £17,423 is to be carried forward.

SALISBURY ELECTRIC LIGHT & SUPPLY CO. (LTD.)—Including £2,289 brought forward, the gross profit for 1916 was £7,174. After paying debenture interest (£868) and writing £87 off investments, a dividend of 6 per cent. for the year has been declared on the ordinary shares, £2,000 being placed to depreciation and reserve and £2,118 carried forward. The units sold for private lighting were 360,086, for power 225,578 and for public lighting 1,020, a total of 586,684 units sold. At Dec. 31 last 128 motors of 436 H.P. were connected to the mains.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—Mr. W. Gasgoigne Dalziel, who presided over a recent meeting of the debenture stockholders, said that after meeting all prior charges, including interest on prior lien debenture stock and depreciation on a scale agreed with the debenture agent, they had been able to pay current ordinary debenture interest for the third successive half-year. There was still a balance to credit of suspense account, which would, if need be, go towards payment of ordinary debenture interest for the current half-year. They had not yet reached the position of actually earning the full amount of the current interest, but the prospect of doing so was steadily improving. Last year's results were not as good as they would have been if prospective new consumers and the power company had not experienced extraordinary delays in completing the necessary plant and mains. Nevertheless, the results were in all respects a record to date. Revenue was now being earned from the expenditure of part of the new capital. The chief consideration of the power company's board had been the development of the company, and the increase of output from seven million units, when they took control in 1908, to over 30 millions in 1916 gave proof of their desire to extend the business.

TRAMWAYS & LIGHT RAILWAYS ESTATES CO. (LTD.)—The total revenue for 1916 was £804. After deducting expenses, the surplus was £619, which, with £558 brought forward, makes £1,178. The directors propose to reduce goodwill account by £100; to pay a dividend at rate of 3 per cent. for the year (£451), and to carry forward £626.

NEW COMPANIES, MORTGAGES & CHARGES.

"ECLIPSE" CARBORUNDUM & ELECTRITE CO. (LTD.) (146,853).—Private company, reg. March 24, capital £10,000 in £1 shares, to acquire and carry on the business carried on as the United Carborundum & Electrite Works (Ltd.) and the Vincit Co. (Ltd.). First directors are J. F. Beale, S. R. Beale and T. E. Fowler.

HOLLAND, GRIFFITHS & CO. (LTD.) (146,884).—Private company. Reg. March 26, capital £500 in £1 shares, to take over the business carried on as Holland & Griffiths & Co., and to carry on the business of electrical and mechanical engineers, &c. First directors are: J. Harrington, G. W. Knight and J. H. Williams.

LODGE FITTINGS CO. (LTD.) (146,987.)—Private company; reg. March 30, capital £1,000 in £1 shares, to take over the business of manufacturers of electrical fittings, &c., carried on as the "Lodge Fittings Co." Reg. office, 57, Albert-road, Aston, Birmingham.

NICHOLSON & CROCKETT (LTD.) (146,743).—Private company, reg. March 21, capital £500 in £1 shares, to take over the business of manufacturers of and dealers in electrical and scientific instruments carried on as Nicholson & Crockett at Luton. First directors are: J. N. Clark (chairman), L. C. A. Aylett and J. P. G. Aylett. Reg. office: 116, Dallow-road, Luton, Beds.

SURREY ENGINEERING CO. (LTD.) (146,943).—Private company. Reg. March 28, capital £1,000 in 1,000 10 per cent. cumulative preference shares of 10s. each and 500 ordinary shares of £1 each, to carry on business as electricians, mechanical and general engineers, &c. First directors are: J. A. Hughes, F. N. Pickett and J. Cameron. Reg. office: 34, Surrey-street, W.C.

FOREIGN COMPANY.

WILSON-MAENLEN CO. (LTD.) (1,548F.)—Particulars filed March 22, 1917. Reg. in New York Dec. 28, 1914, to carry on the business of manufacturers of and dealers in electrical, pyrometric and scientific apparatus, &c. Capital stock: $60,000 in shares of $100 each. British address: 2, Myron-place, Lewisham, S.E. A. H. Holloway, 118, George-street, Lewisham, S.E., is authorised to accept service. Directors: Charles T. T. Wilson, Carolyn E. Wilson and Cuthbert F. Brown, all of New York.

MORTGAGES AND CHARGES.

BIRMINGHAM ELECTRICAL ACCESSORIES MFG. CO. (LTD.)—Debenture dated March 2, 1917, to secure £150, charged on the company's undertaking. Holder: G. Garrett, 8, Devonshire-road, Handsworth.

BRILLIANT ARC LAMP & ENGINEERING CO. (LTD.)—Assignment of proceeds of munitions contract, dated March 28, 1917, to secure all moneys due or to become due from company to London and South-Western Bank.

ELECTRICAL INSTALLATIONS (LTD.)—Memorandum of satisfaction to extent of £300 was filed on March 26, 1917, of debentures dated Dec. 5, 1906, securing £2,000.

CITY NOTES.

MEMORANDA.—(April 10).—Consols, 55⅛. Consols Pay Day, May 4. Stocks and Shares Ticket Day, April 26. Pay Days, April 13 and 27. Price of Silver, 36⅞d.

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—The directors recommend a dividend on the ordinary shares at the rate of 10 per cent. for the year ended Dec. 31 last.

PRITCHETT & GOLD & ELECTRICAL POWER STORAGE CO. (LTD.)—Dividends for 1916 of 15 per cent. on the ordinary A shares and 10 per cent. on the ordinary B shares have been declared.

TORONTO RAILWAY CO.—A quarterly dividend of 2 per cent. has been declared for the quarter ended March 31.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—The net earnings (including those of the Rand Mines Power Supply Co.) for the quarter ended Dec. 31 last were £215,179.

Digitized by Google

THE ROUND TABLE.

By "KVA."

Event of the Week.—Mr. A. F. Berry encourages his shareholders, who he says are mere endorsers of dividend warrants, both to try "Tricity" cooking and heating methods, but also to recommend them to their friends.

* * * *

AT LAST! Your lamps will cost you more!

* * * *

My old friend J. F. Shipley is asking for the whereabouts of old Finsbury Technical School men, and I am sure there must be many of them readers of The Electrician. I hope they will make a point of replying to his advertisement which will be found among the "small ads." at the front of this issue. It is just as well, even in war time, that old friends should keep in touch.

* * * *

The weather—ugh! I believe the electric fire makers have been making Shakespeare's line their constant prayer: "Blow, blow, thou winter wind." And it's doing it, and my meter, with thousands of others, keeps on ticking off the "Norwich" units! But the station engineer does not want to tick off the Clerk of the Weather!

* * * *

Callender's have opened a canteen for their workers at the Anchor Cable Works, Leigh. Where are the references to electric cooking? Surely the kitchen is not being run by gas? Lancashire "hot-pot," electrically cooked, would be so delicious that the lads and lassies would have nothing else! "T. O." what do you say?

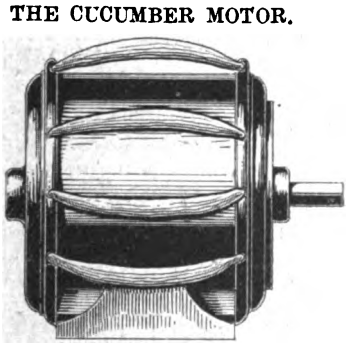
* * * *

Under the arrangements whereby "our" Institution building is being made use of by the Government, the lecture theatre is to be boarded over to provide a floor level with the entrance doors. Surely this will be regarded as a triumph for those who always complained that the lighting arrangements in the theatre were too far away to be useful? Truly war is the great leveller not only of men but of institutions!

* * * *

A correspondent thinks that in these days of agriculture on the intensive system and having regard to the scarcity of metal, there is an opening for a combination of motor manufacturers and cucumber growers. He has roughly embodied his ideas in a sketch of a motor design, which in the national interest he

THE CUCUMBER MOTOR.



"As Cool as a Cucumber."

has refrained from patenting. He thinks that Lord Devonport will not raise the slightest objection to this employment of an indigestible gourd to the needs of industrial power users. I am pleased to give this valuable information to the world at a time when it is in need of "keeping cool."

A contemporary in a headline to an announcement says: "National Economy and Advertising Waste." Obviously the two go together; we can't help economising, and if anyone has any waste why not let him advertise it?

* * * *

A correspondent calls my attention to the following in a daily paper:—

A girl of 23 years of age who had been engaged for some time in electrical wiring in a large battleship in a north-east coast shipyard, was doing overhead work one day when a drill came through from the deck and entered her head. The girl jumped from the trestle from which she was working, but the effect of the drill was to draw off a small portion of the scalp and a good deal of hair. She was attended to in the firm's first-aid room and sent home.

We may expect to see lady "wiremen" fitted with drill-proof helmets when the matter has been brought to the notice of the Union which deals with these things.

SHANGHAI MUNICIPAL ELECTRICITY DEPARTMENT.

This undertaking continues to make excellent progress, notwithstanding the difficulties with which our readers are familiar. At the end of 1916 the total connections were equivalent to 40,166 kw., and there were 18,064 consumers.

The capacity of the plant was 19,600 kw., but an additional 25,000 kw. of plant is being installed at the Riverside station, including one 10,000 kw. Parsons, one 10,000 kw. G.E.C. (New York), and one 5,000 kw. Fraser & Chalmers-Vickers turbo-alternators, with six Babcock & Wilcox marine-type boilers of 40,000 lbs. evaporative capacity per hour. When the extension scheme is completed there will be 27,000 kw. of Westinghouse transformers (6,600/22,000 volts) and 3,000 kw. of British Electric Transformer machines (22,000/350 volts). The British Thomson-Houston Co. are supplying the 22,000 volt switchgear, and the 22,000 volt three-phase split conductor trunk cables are by the British Insulated & Helsby Cables (Ltd.).

THIRTY-SEVEN YEARS AGO.

[From The Electrician, April 10, 1880.]

The Wire Age.—The Boston "Journal of Chemistry" calls the present epoch the "wire age," from the multitude of wires to be found in the world for telegraphic and other purposes. The part played by wires is indeed important, and our American contemporary has the merit of recognising it in a distinct manner.

The Drachenfels.—As an experiment the German Postal and Telegraphic Department is about to open for use during the coming summer a telephone connecting the top of the Drachenfels with the charming riverside resort of Königswinter, on the Rhine. The wire is laid along the footroad by way Hardtberg and Kuckstein to the refreshment house beneath the ruins. The project which was started some time ago of a railway up the Drachenfels, like that on the Rigi, is given up for the present, if not entirely abandoned. We are unable to see the use of the telephone in such a position. It is hardly to be expected that visitors will require to send messages, and they will not care to use the telephone as a curiosity.

An Automatic Sentry.—An American journal gives a description of a life-size automaton which, on being duly wound up, paces to and fro, rifle on shoulder, and with an unexceptionable military stride. In the interior there is an electric apparatus which administers a severe shock to any one who meddles with the figure. The great difficulty encountered by the inventor was in making the figure halt and return on its beat. During the preliminary experiments it bolted "as if bound for the home of the setting sun," as the journal poetically expresses it, and the owner had to mount a "living young mustang" and chase the flying Hiawatha. The mechanism requires to be wound up every two hours, and is lubricated in all parts by pouring oil down its throat, a trait which the inventor has avowedly copied from "thirsty" Christians. What the object of such a sentry is the American organ does not say. He might be usefully employed in keeping ignorant journalists out of laboratories and workshops.

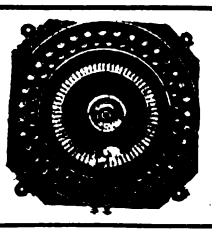
No. 350-3. Rear-of-Board Pattern.

'IGRANIC' CONVERTIBLE PLATE FIELD REGULATORS for MOTORS and DYNAMOS.

OVER 160 CAPACITIES. NUMBER OF STEPS, 26 to 130.

LARGE STOCK FOR QUICK DESPATCH.

IGRANIC ELECTRIC Co LTD 147, Queen Victoria St., London.

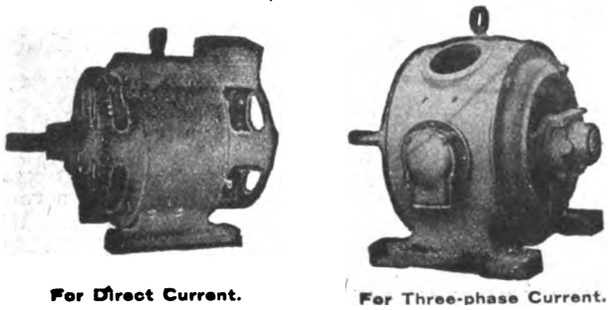


No. 350-1. Front-of-Board—Open Type.

Digitized by Google

SIEMENS

STANDARD
ELECTRIC MOTORS

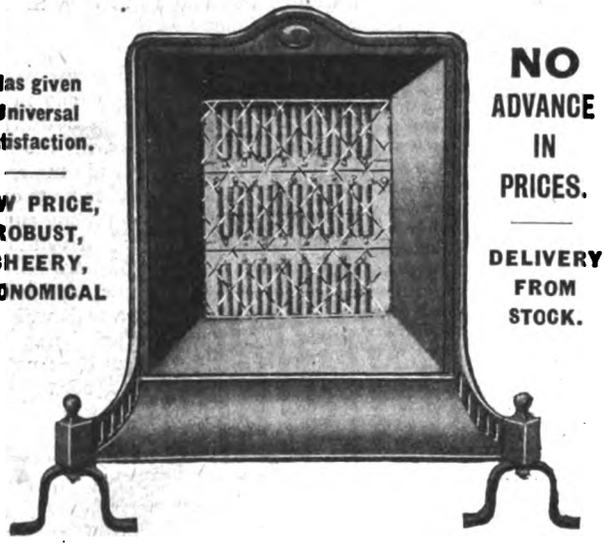


For Direct Current. For Three-phase Current.

for
ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
Head Office: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: Western 6349. Telegrams: "Siembralos, Kens, London."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: City 5350. Telegrams: "Siemotor, Cent., London."
HOME BRANCH ADDRESSES:
Birmingham—Central Ho., New St. | Manchester—196, Deansgate.
Bristol—30, Bridge Street. | Newcastle—64-68, Collingwood
Cardiff—89, St. Mary Street. | Sheffield—22, High St. [Bldgs.
Glasgow—66, Waterloo Street. | Southampton—46, High Street.
Branches in Principal Towns Abroad.

— THE —
ARORA
ELECTRIC
FIRE



Has given Universal satisfaction.

LOW PRICE, ROBUST, CHEERY, ECONOMICAL

NO ADVANCE IN PRICES.

DELIVERY FROM STOCK.

Write for LIST G (Fires and Cookers),
to Sole Manufacturers—
THE ARORA CO., LOUGHBOROUGH.

COAL CONVEYOR PLANT AT PORT NATAL.

A new coaling plant of the belt conveyor type was recently put into operation at the Bluff, Port Natal. The dumper has a lifting capacity of 5 tons on each load, and is so arranged that it can deliver coal either to the incline belt or to the buckets for use in connection with the old transport apparatus.

In operation, the coal is carried in trucks to the elevator, where the trucks are raised by means of the dumper, and the contents tipped into a concentrating pan. The load is then delivered to the incline belt by means of a chute. The incline belt then lifts the coal and delivers it into a three-way chute, whence it may be discharged either on to the existing horizontal tripper direct to the travelling tower, or to a further horizontal tripper belt. The main belt is 525 ft. long, and the small incline belt 230 ft. long and 48 in. wide. The main belt travels at a speed of 450 ft. per minute, and the incline belt has a variable speed, so as to feed vessels according to requirement. The horizontal belt is equipped with a travelling tripper, which can be automatically traversed to the position opposite the point at which the travelling tower is required to deliver coal into the steamer's bunkers. The tripper unloads the horizontal belt at this point, and delivers the coal on to a telescope cross-conveyor belt mounted on the travelling tower. This belt dicharges its load directly into the steamer's bunkers, through the telescopic chute, which is fitted with an "elephant's trunk" for distributing the coal, and so eliminating the necessity of hand trimming.

The whole plant is electrically driven, and when the plant is once started, it continues automatically until the whole of the contents of the truck are discharged into the concentration bin. Care has been taken in the construction of the plant to avoid any undue breakage of the coal, and this result has been attained by eliminating the direct fall of coal, the chute being so arranged that the coal is lowered more or less gradually. The plant is designed for a capacity of 600 tons an hour, but it is capable of handling even greater quantities, and under favourable conditions it has been estimated that 1,000 tons of coal can be dealt with per hour.

There are three 150 h.p. Westinghouse motors controlling the dumper, by means of a modern pattern contact or control gear. There are other motors—seven on the tower to operate the jib, and two 65 h.p. motors controlling the big belt. All motors, except the dumper motor, are controlled at the top of the travelling tower, so that the belts can be started and stopped by one man, who is in a position of observation of the working.

ELECTRICITY SUPPLY POLICY OF INDIA.

In a recent issue "Indian Engineering" pointed out that the importance of a public electricity supply was increasing to such an extent that it was questionable whether the system of management and operation adopted at present should not be very carefully considered and revised.

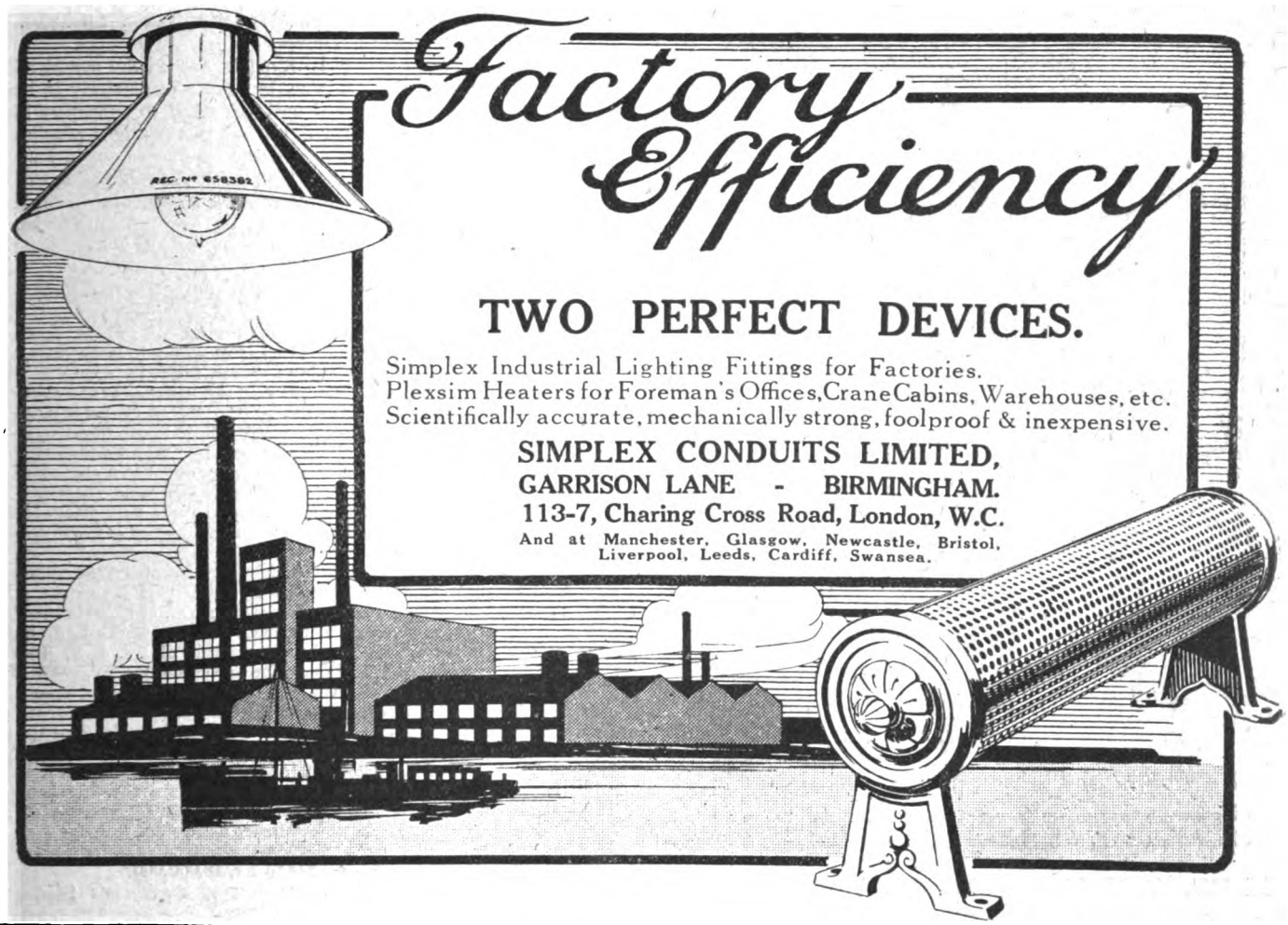
The procedure adopted by private supply companies is (according to our contemporary) probably the most satisfactory, because in this case the policy of the company is controlled by experts in all its branches; they have a free hand and possess entire control, and are consequently not influenced by anything but the interests of the concern. The engineering staff consists of experts whose services are retained by the company in accordance with the ability of the individual; and the finance and business management of the company is also controlled by experts who realise their responsibilities. With a municipal-controlled concern the case is different, as the Committee's decision in matters of both engineering and economic developments is to a great extent governed by the policy of the party to which the majority of its members happen to belong. This defect in municipal control of electric supply undertakings is very noticeable in India, where Government officialdom plays so great a part In fact, everything appears to depend on the personality of the President, for the time being, of the municipality. There are not very many municipal-controlled supply undertakings in India, while there are many Government experts in electrical engineering in the country, and we consider that Government should insist on all municipalities that run a supply undertaking having at least one expert on the Board. In elected committees Government could appoint their own man and in nominated committees a seat should be reserved for one man whether he be a Government official or not. This arrangement would result in the same efficiency of operation as is maintained by private supply companies in so far as development on modern lines is concerned. In fact, the Government should insist on all municipal supply undertakings operating on a dividend-paying principle.

CANADIAN NICKEL.

The Government Nickel Commission recently submitted its report to the Legislature.

The Commission finds that nickel can be refined in Ontario, preferably by the electric process, and that the present method of taking 10 per cent. of the profits is better than Government expropriation. The operation of the mines and plants in the Sudbury nickel district, which costs approximately £20,000,000, could be doubled. The report states that the Province has power to prohibit the export of nickel and that Ontario nickel could meet all the Imperial requirements.

Digitized by Google



Factory Efficiency

TWO PERFECT DEVICES.

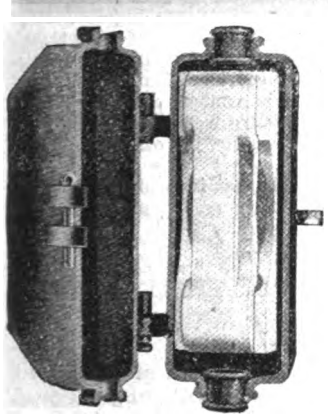
Simplex Industrial Lighting Fittings for Factories.
Plexsim Heaters for Foreman's Offices, Crane Cabins, Warehouses, etc.
Scientifically accurate, mechanically strong, foolproof & inexpensive.

SIMPLEX CONDUITS LIMITED,
GARRISON LANE - BIRMINGHAM.
113-7, Charing Cross Road, London, W.C.
And at Manchester, Glasgow, Newcastle, Bristol, Liverpool, Leeds, Cardiff, Swansea.

M·E·M

IRONCLAD SWITCH & FUSE GEAR

When requiring "HIGHEST QUALITY" Switch and Fuse Gear—remember to buy from the firm which guarantees this—the "M.E.M."



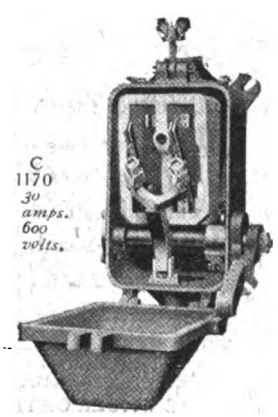
F 1159 (*pat.*).

We specialize on QUALITY—with experienced designers concentrating on greatest DESIGN-SIMPLICITY and EFFICIENCY. Note here another selection from the extensive "M.E.M." range:—

F 1159. **The Patent "KANTARK" Fuse. Made to H.O. Regulations; Standardised and Interchangeable Units; Best English Vitreous Porcelain Base; Extra strong Contact Blocks—easily renewable; Patent Arcing Chamber of utmost capacity—amply ventilated; All "live parts" fully protected; Non-arcing absorbent material permits repeated blowing of fuse without damage; fewest connections (readily accessible); Case of best quality soft grey iron.**

C 1170. **The "CAMLOC" Ironclad Switch. Our "quick-make" Switch—the special feature of which is: the positive "QUICK-MAKE" is effected independently of the spring. Made to H.O. Regulations; breaks to Glasgow Corp. Rules; Best English Vitreous Porcelain Base; has Interlocking Handle; Exceptionally High Insulation, guaranteed to withstand 2,000 volts alternating current; Standard size detachable glands to facilitate easy wiring, tapped standard electric thread; Asbestos-packed gaskets on lid to make waterproof; Silicate enamelled inside case.**

We are now placing this switch on the market. Write for sample and quotation.



We give the PROMPTEST DELIVERIES in the Trade.

Get in touch with us to-day. Our Catalogue and "KANTARK" Folder fully describe products.

The MIDLAND ELECTRIC MFG. CO., Ltd.,

Head Office & Works: - - - - BARFORD STREET, BIRMINGHAM.
'Phone: Mid. 671 & 672. *'Grams: "Kilowatt, B'ham."*

Branches:

Lon: 2, Gresham Bgs., Basinghall St., E.C. 'Phone: Lon Wall, 723. 'Grams: Tribord, Lon.
Manch'r: 4, Carr St., Blackfriars. 'Phone: City 1391. 'Grams: Conduits, Manch'r.

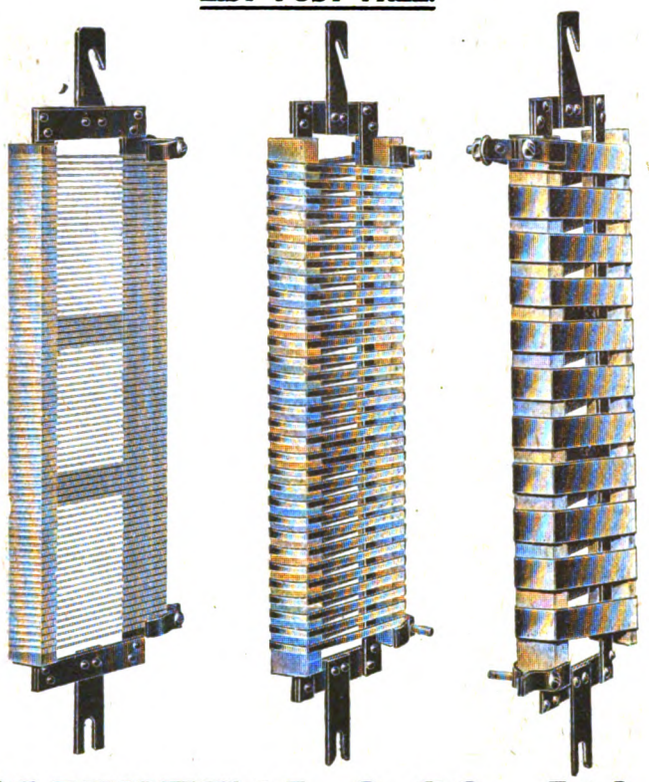
-the QUALITY products

R.H.S.

Digitized by Google

RHEOSTATS

LIST POST FREE.



ISENTHAL & CO., Ltd.

(DEPARTMENT 4)

DENZIL WORKS, WILLESDEN, LONDON, N.W. 10.

Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, &c.

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite—Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1912 to 1917.

ATTWATER & SONS,

Telegrams: Attwaters, Preston. Telephone No. 1045 (2 lines).

Hopwood St. Mills, PRESTON.

Established 1868. Codes: 5th Edition A B C & Western Union.

THE SWEDISH ELECTRICAL INDUSTRY IN 1916.

Like most neutral countries, Sweden has made considerable industrial progress during the war, but more particularly in engineering. The Swedish electrical industries had to encounter keen German competition in pre-war days, but this has now practically disappeared, and a large new field has been opened up in Russia, where the Germans were formerly supreme. An interesting sketch of the progress made by the leading Swedish electrical firms in 1916 is given in the last issue of the "Journal of the Swedish Chamber of Commerce for the United Kingdom," from which we extract the following particulars:—

It is pointed out that the Swedish electrical industry is not very old, and that it has often had great difficulties in asserting itself in face of the incessant competition by German firms. To foreign markets, Swedish electrical articles have found their way only in later years, and to a very small extent. The leading German firms, by means of their Swedish branch offices, had a great share in the business of the electrical industry of that country, and one of them (the A.E.G. Co.) also intended to build a large factory at Malmö, the metropolis of South Sweden, where a well situated industrial site for that purpose had been purchased. The project had to be set aside when the war broke out, but a great menace is waiting here for post-war days, and it has become necessary for Swedish firms to strengthen their position in order to hold after the war what they have conquered in the last two or three years at home, as well as in foreign markets.

The principal electrical firms of Sweden have long been the Allmänna Svenska Elektriska A.-B., Verteras, the Nya Förenade Elektriska A.-B., Ludvika, and the Luth & Roséns Elektriska A.-B., of Stockholm. The first-named company was formed in 1890, but the works had already existed for some years. Under the directorship of Mr. J. S. Edström the company had always held its position as the foremost concern of its kind in Sweden, and it is also the only one with branch companies in other countries. At the beginning of 1916 the company purchased the majority of the shares of the Nya Förenade Elektriska Co., and the two companies are now almost amalgamated. The last-named company had a share capital of Kr. 2,753,500, and was second in rank in the electrical industry. The Allmänna Co. also purchased the Surahammars Bruks A.-B. and the Svenska Turbinfabriks A.-B. Ljungström at Finspong, near Norrköping. More expansions are expected, and among others a china manufactory is to be erected. The share capital of the Allmänna Svenska company amounts to Kr. 18,000,000.

Recently the four companies, Aktiebolaget Stockholms Glödlampsfabrik (Glow Lamp Factory), Tungsten Wire Works Aktiebolag, Svenska Batterifabriken Electra (Electric Battery Factory), and Svenska Isoleringsflaskfabriken Thermos (Vacuum Flask Factory) were amalgamated into the Aktiebolaget Elektroindustri, with a capital of 3,000,000 kronor. This company will become a branch of the Allmänna Svenska Co.

The Luth & Rosén Co. also made great progress in 1916, and strengthened its position. Already the company owned the Ludvigsbergs Mekaniska Verkstad in Stockholm, and in 1915 it purchased the Söderbloms Foundry at Eskilstuna, and recently bought a large building site at the same place for a workmen's village and further expansions. The company's share capital is now Kr. 7,440,000.

Other electrical firms have met with marked success, and are now projecting extensions. The Ecks Motorfabrik at Partille, near Göteborg, which started in 1908, and whose output in 1914 was of the value of Kr. 700,000, increased to Kr. 3,200,000 in 1916. The company's share capital is Kr. 4,000,000.

The capital necessary for all expansions has always been easily found, and at every increase of capital the sums subscribed have much exceeded those projected. Therefore, it seems (says the "Journal") as though this branch of industry has now reached such a position that Swedish electrical productions must be taken into consideration on the international market, and it should be worth remembering that electrical materials of all kinds are nowadays obtainable from Sweden at prices comparing favourably with those prevailing in other industrial countries.

It would appear from the above sketch that it is highly probable Swedish electrical engineering firms will form an important factor in international competition in future.

TESTING ACID RESISTANCES OF ENAMELS AND VARNISHES.

In connection with investigations in the production of an improved "acidproof" enamel, Messrs. Jenson & Nicholson (Ltd.), of Goswell Works, Stratford, E., claim to have evolved a new and rapid, as well as a simple and reliable, method of testing the acid resistance of enamels, paints and varinshes.

The principle of the test is that of the voltaic cell. Plates or rods of dissimilar metals, say copper and zinc, are coated with the enamel or material to be tested and immersed in dilute acid, when if they are unable to withstand the corrosive action of the acid a breakdown occurs, galvanic action setting in is recorded by suitable instruments, and its intensity forms the basis of comparison of the acid resisting properties of the coating. The firm have prepared a folder giving particulars of the method, and copies may be obtained by those interested in acid-proof enamels and insulating varnish.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

GOULAH! GOULAH! GOULAH!

Thus the abracadabra of certain Oriental Conjurers who produce Sand Lizards from 10 centime pieces, and other weird feats of legerdemain.

The wonder evoked by these and others, such as the Basket and Mango Tree Tricks, has been recorded in reams of writing: but who devotes any reflection to the infinitely greater marvel of the transmutation of gross matter into the Perfect Cable, as performed daily, without spectacular incantations, in the workshops of the B. I.?

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Viamaster, Sowest London.

"THOR" High Grade Specialities
CASING and CAPPING CONDUIT CABLES
CABLE CONNECTORS
COMMUTATOR COMPOUND
WATERTIGHT FITTINGS
AND ALL ELECTRICAL ACCESSORIES.
WRITE FOR PRICES & DISCOUNTS.
HASLAM & STRETTON, Ltd., Windsor Place, CARDIFF & Bristol Bridge, BRISTOL.

Digitized by Google

BELLING FIRES GRILLERS BOILERS OVENS

ALSO ALL KINDS OF SPECIAL ELECTRICAL APPARATUS FOR MUNITION WORKS & MANUFACTURING PURPOSES

BELLING & CO.,

ELECTRIC HEATING & COOKING SPECIALISTS,

Derby Road Works, Montague Road,

UPPER EDMONTON, LONDON, N.

FOR

High and Low Tension

SWITCHGEAR

THE

NEW SWITCHGEAR CONSTRUCTION CO., Ltd.

SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

Electrical Engineers and Manufacturers

The House for Electric Heating.

Special Offer of "Quead" and "Ensign" Fires from Stock. Be Patriotic and Save Coal.

Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.

Telephone: Gerrard 7601 (2 lines)

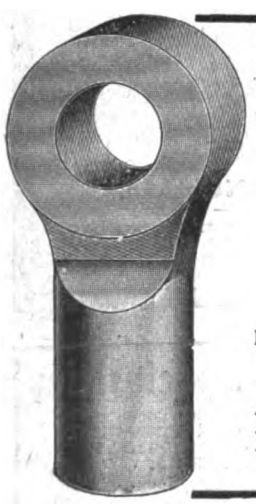
Petrol Engine Sets.

Manufactured in sizes from 2 kw. to 20 kw.

Quotation for larger sizes on application.

F. HUSBAND Ltd

CRAVEN HOUSE KINGSWAY LONDON



E. SHOWELL & SONS, LTD.,

STIRCHLEY, BIRMINGHAM.

Cast Cable Sockets.

Suite E74. Made in all Sizes.

Type A.—Straight.
" B.—Offset.
" C.—Right angle.

Illustrated Dimensioned Showcard for Drawing Office use supplied free on application.

Sole Agent for the Electrical Trade:—

LIONEL ROBINSON, 3, Staple Inn, London, W.C.

Telephone: *Holborn* 6323.

ELECTRIC VEHICLE RUNNING COSTS.

The deputy borough engineer of Dover (Mr. R. H. Crummack) recently prepared a report on the Council's experience of electric vehicles for scavaging and other work. The Council has now got six 2-ton Edison vehicles.

The report stated that besides the ordinary work of refuse collection, the electric vehicles (since they commenced running in August, 1915) had been engaged in carting coal, street sweepings and ashes. In 15 months they had travelled 30,000 miles and had carried 12,741 tons of house refuse, or 849 tons per month. Maintenance of the vehicles worked out at 0·968d. per mile and the tyres at 0·56d. per mile. The revenue from the removal of trade refuse was £32. 13s. 1d. and from the removal of ashes from the docks and carting, &c., for other departments. £65. 18s. 11d., a total of £98. 12s. Of the £65. 18s. 11d. only £38. 13s. 6d. was credited to the vehicles, the balance going to private works account. The quantity of refuse removed showed an increase for the 12 months of 2,326 tons, to remove which it would have been necessary to employ five extra horses and carts per day, which, at 11s. 8d. per day per horse and cart, represented £17. 10s. per week or £910 per annum. The Corporation also claimed £79. 9s. 6d. for the removal of refuse from soldiers' billets. If the £98. 12s. and £79. 9s. 6d. were added together, the revenue from the electrics would be £178. 1s. 6d. The cost of refuse collection and disposal for the 15 months under review was as follows :—

Wages paid	£1,177	0	8
Proportion of foreman's wages	37	6	9
Wages of man at tip	48	15	0
Rents of tips (one at £50 per annum, the other at £25 per annum) = £29. 3s. 4d. and £31. 5s.	60	8	4
Repairs and maintenance, 28,825 miles at 0·968 of a 1d. per mile	116	5	2
Stores and sundries	12	15	4
Tyres, 28,825 miles at 0·56d. per mile	67	5	2
Vehicle costs: p.c. £1;126 each gives £135 per annum per vehicle for five vehicles in use from seven to 15 months	606	10	0
Current consumed, 44,678 units at 1½d. per unit	279	4	9
Insurance	36	0	0
Total	£2,441	11	2

The tons collected were 12,741, and the cost per ton was 3s. 9·98d., the previous cost per ton being 6s. 2d.

ELECTRIC LOCOMOTIVES FOR CHILI.

According to "Engineering" the General Electric Co., of America has recently shipped three 120-ton electric locomotives to the Bethlehem-Chile Iron Mines Co., at Tofo, Chile. The parts of a single locomotive occupied eight freight cars, and although one package alone weighed 23 tons the shipments were put aboard vessels without mishap and made the 40-day voyage to Cruz Grande. Each complete locomotive is equipped with four G.E.-253, 1,500-volt to 3,000-volt motors, having a normal one-hour rating of 240 H.P. each at 2,400 volts. The locomotives are geared for a speed at a rated load of 12·2 miles per hour., and are capable of exerting a tractive effort of 42,000 lb. at the hourly rating. Each locomotive is equipped with Sprague General Electric type "M" multiple-unit control and regenerative electric-braking apparatus.

The company's railway is 15 miles in length—from the port of Cruz Grande (about 300 miles north of Valparaiso, Chile) to the mining village, about 4 miles inland at Tofo. The iron mine at this point is located about 2,200 ft. above sea-level, and consists of two hills of iron ore, which is removed somewhat after the manner of trap-rock quarrying. There is a uniform grade of 3 per cent. for 14 miles and for about 1 mile near the mines of 1 per cent. The trains will consist of an electric locomotive and from 12 to 20 50-ton ore cars. On account of the elevation of the line all the loaded cars come down grade. The regenerative braking control will permit the locomotives to descend the grades with ordinary loads without the use of air brakes, thus returning power to the system and also making an appreciable saving in wear on brake-shoes, wheels and rails. The air-brake equipment will enable the locomotive to descend with a greater load than can be held back by the regenerative braking equipment alone. The cars are provided with an empty and loaded brake to secure the maximum braking power on each car, whether empty or loaded. The trains will descend at about 12 miles an hour, at which speed, with a trailing load of 1,500 tons, the locomotive will return approximately 1,000 kw. to the line.

FOR EFFECTIVE IMPREGNATION USE **"LACWATT"** *Black or Golden Brown*

JENSON & NICHOLSON LTD *Insulating Varnish Dept* GOSWELL WORKS. STRATFORD. E.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,031. [Vol. LXXIX. No. 3.] FRIDAY, APRIL 20, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 97
Arrangements for the Week 99
Wayleaves. By C. Vernier 100
Range of Wireless Stations. By Capt. R. Chenevix Trench, R.E. Illustrated 102
The London and North-Western and Bakerloo Electrification. Illus. 106
A Tuning-Fork Recorder of Complex Wave Forms. Illustrated.. 107
Voltage Regulation of Rotary Converters.—*Discussion* 108
Characteristics of Iron in High-Frequency Magnetic Fields. By R. Bown 109
A QUESTION FOR THE BOARD OF TRADE COMMITTEE 110
REVIEWS 110
Some Details of Westinghouse Steam Turbines. Illustrated 113
Some Points in Connection With Engineering Specifications.—*Discussion* 116
CORRESPONDENCE 117
Electrical Trades Benevolent Institution 120
LEGAL INTELLIGENCE 120
Patent Record 120
COMMERCIAL AND INDUSTRIAL SECTION 123
Electricity Supply 124
Tenders Invited and Accepted 126
Financial Matters 128

NOTES.

The New President of the I.E.E.

WE have received a letter from Mr. L. L. ROBINSON, which we publish in our Correspondence Columns this week, in regard to the nomination of Mr. C. H. WORDINGHAM to the Presidency of the Institution of Electrical Engineers. We have also received a communication from the Honorary Secretary of the Associated Municipal Electrical Engineers of Greater London, of which Mr. ROBINSON is the President. The latter communication states that at a meeting of the A.M.E.E., which was held last Monday, disappointment was expressed at the nomination of Mr. WORDINGHAM "in present circumstances, especially in view of possible negotiations with Government Departments, he being a Government official." Mr. R. A. CHATTOCK was consequently asked to accept an alternative nomination, but he felt unable to act in the matter. There is apparently a feeling that Mr. WORDINGHAM, as an Admiralty official, will not be able to represent the electrical industry adequately in taking up questions with other Government Departments, more particularly in connection with legislation which is likely to result through the deliberations of the Board of Trade Committee and possibly other Committees. We cannot help thinking that this is an exaggerated view. Most engineers are personally pledged along certain directions, but that does not prevent their taking a broad-minded view of things as a whole, or from expressing the views of the Council as a whole. For example, the present President is concerned with electricity supply as conducted by private enterprise; but would that make him prejudiced against municipal undertakings when acting as President of the Institution on behalf of the electricity supply industry? We do not think so. The same argument applies in other directions. Indeed, it is probable that a Government official would receive more attention at the hands of other Government Departments than an engineer in an independent position.

The Education of Apprentices.

ELSEWHERE will be found a letter from Mr. R. W. PAUL commenting on our recent leading article on the above subject. From this it appears that Mr. PAUL, in his introductory paragraphs, thinks that the complete adoption of our proposals would probably be dangerous and detrimental, and in his concluding paragraphs advocates a scheme similar to the one we had in mind when we wrote the article. "Boys entering the works," says Mr. PAUL, "are commonly handicapped by loose habits of thought and a tendency to form strong opinions on insufficient information; as a corrective, they need to be taught the laws of natural science." We do not believe that the teaching of the laws of natural science to boys will enable more than 10 per cent. of the boys to reason things out for themselves, and we are of the opinion that the learning of such laws will not be beneficial to the majority of the boys. We can well imagine that the learning of drawing—"machine drawing," we suppose—was recently made compulsory in a Government factory, and had the boy rebelled because the subject was unlikely to be of the slightest use to him in his work we should have admired the boy. The teaching of the honourable nature of productive employment; of the guiding principles for the conduct of life; of the history of our country and language; of the principles of Government; and of the things which, alone, make life worth living, are to be preferred to fragments of raw science doled out by overworked and underpaid schoolmasters to a Board of Education syllabus. It is perhaps unfortunate that Mr. PAUL should give TURNER as an example of what a hard worker can accomplish. TURNER'S work, at least, did not make him a happy man, nor, we believe, did it make him love his neighbour as himself. Equally unfortunate is the statement that "boys enter a shop where the code of honour consists in getting the maximum pay for the minimum effort, and naturally drift into the habits of the crowd." To our knowledge in many cases boys are taken into the works at a penny, or less, per hour, and no attempt is made to teach them a trade, with the result that they become little better than unskilled labourers after a long term of years, during which little wage has been paid. If the code of honour amongst the boys at Mr. PAUL'S works is no higher than this, it is highly discreditable to the boys, for Mr. PAUL is one of the few who have worked hard to improve the facilities for the trade teaching of boys during their apprenticeship.

Light Railways v. Motor Omnibuses.

ATTENTION has once more been called to the destruction caused by the running of motor omnibuses on country roads which were never intended to carry heavy traffic of this character, and at the meeting of the Gloucestershire County Council it has been suggested by Sir ASHTON LISTER that the roads should be widened with a view to leaving sufficient space for a light railway in certain districts, thus eliminating the motor omnibus. In a proposal of this kind there are several points of view that have to be considered. First it must be remembered that the motor omnibus is extremely flexible and adaptable as to the route that is selected. A

Digitized by Google

light railway could very well be run alongside roads in the open country, but difficulty at once occurs when a town or large village is approached. The motor omnibus does not suffer from the inconvenience of requiring a certain space to be provided; it can be run into the heart of any town and can thus provide direct communication with any outlying parts. Moreover, very restricted services, or a frequent service, can be run as desired, depending upon the traffic to be handled, without very greatly affecting the financial results. But if it becomes necessary to lay down track, then a suitable return on the capital cannot well be earned unless there is a considerable volume of traffic to be handled. We think, therefore, it would be necessary for most light railway schemes to receive municipal support, and we are glad to note that Sir Ashton Lister suggests that this course should be adopted, the railways being provided by the county, and that the Council should either run the traffic themselves and make a profit or give a franchise to that class of people who are at present running the motor omnibuses. Against the expense incurred there would, of course, be a credit in the shape of lower maintenance of the roads. Undoubtedly light railways have not been developed in this country to the extent they should have been, and it is quite possible that under present conditions light accumulator motor coaches might show financial advantages over systems which have hitherto been used.

Business as Usual.

In a note in another column, on the control of electric winding engines, is given a short account of a Paper read before the South African Institute of Electrical Engineers. The Paper calls to mind the fact that electrical engineering firms at home have been singularly unsuccessful as regards the South African market. Readers need not be told that South Africa is the home of electric winding. Some years ago we published a list of winders in use, and from this it appears that in South Africa German firms secured orders for upwards of 100 winders, while home electrical firms secured little of the business. No fault can be found as far as the mechanical side is concerned, because a considerable volume of the trade was handled in this country. We believe that many firms are now prepared to undertake the manufacture of the special motors used, but we are not at all certain that sufficient attention has been given to the question of control. Suppose, for example, that a new and heavy winder is required. There are at least half-a-dozen firms able to undertake the design and construction of the mechanical portion; another half-a-dozen or more able to design and construct the dynamo electrical machinery; and perhaps one, or at most two, firms experienced in the design of the control gear. Of these two firms, one may not be in a position to quote. It will be cruel irony if after the war we are compelled to go to Germany for such gear because there is nowhere else to go. Mr. Ewing, in the Paper referred to above, foreshadows further developments in this important field, and it would be well for home firms to be well prepared.

Discussions at the Institution.

In our last issue we commented upon the desirability of knowing how to write English. At the same time we might very well have called attention to the importance of knowing how to *speak* English, for the lack of this facility has an effect which is often noticeable and one that is a great handicap. We believe it was in the discussion on Mr. McBerty's Paper before the Institution of Electrical Engineers that something like half-a-dozen speakers read their remarks instead of speaking from notes, and the same feature was noticeable in the discussion on Mr. Vernier's Paper. The reading of a Paper is bad enough, but when it comes to reading supplementary Papers as contributions to a discussion the case is even worse. There used to be a rule that contributions in this way were not permissible, but this rule has a way of lapsing at intervals. We hope the Council will see the great desirability of enforcing this rule once more during the next session. It is not encouraging to junior members to avoid this bad system of reading remarks if the older members are allowed to carry it on without comment.

A Ribbon-filament Incandescent Lamp.—In a recent United States patent Mr. F. G. Keyes describes a method of increasing the illuminating power of tungsten filaments by forming them into crimped ribbons. Such filaments use a low pressure, but a current up to 50 amperes. It is claimed that lamps of exceptional strength and lasting power and very high candle-power are thus obtained.

A 210,000 kw. Buffalo Steam Station.—The "Electrical World" describes what at first sight seems a curious anomaly—the erection of a large steam station close to Buffalo. The initial installation is to consist of three 20,000-kw. horizontal turbo-alternators, and the ultimate capacity in view is 210,000 kw. The necessity for a steam-driven station arises from the vast demands now made upon the hydro-electric supply and the limitations imposed on the further use of water-power at Niagara by both the United States and Canadian Governments.

Institution of Electrical Engineers.—At last week's meeting the president, Mr. C. P. Sparks, said the Institution of Civil Engineers had kindly placed their reading room at the disposal of the Institution whilst it was in temporary premises. The books in the lending library of the I.E.E. will be circulated as usual, on application to the Secretary, but the other books in the I.E.E. library will not be available. The president also announced that a Paris Premium had been awarded to Mr. C. Vernier for his Paper read that evening on "Wayleaves."

Iron and Steel Output.—The supervisor of the statistical bureau of the Iron, Steel and Allied Trades' Federation (Mr. G. C. Lloyd) has issued a preliminary report on the output of pig-iron, puddled iron and steel in 1916.

The production of pig iron was 9,047,983 tons, against 8,793,659 tons in 1915, but the imports were less by about 40,000 tons, and after deducting exports the amount available for home consumption was somewhat less than in 1915. The steel output is a record, and for the first time exceeds that of pig-iron. The total is 9,244,457 tons, of which 187,669 were castings and 49,256 were made by the electric process. In 1915 only 20,000 tons of ingots and 2,000 tons of castings were produced in the electrical furnaces, but last year the figures were 30,968 tons of ingots and 18,288 tons of castings. Throughout the year there was a marked tendency to put in electric furnaces, and no doubt the output for this year will be largely in excess of that of 1916. This general growth of the electrical process is a war-time development.

Diesel Engine Users' Association.—At the March meeting of the Diesel Engine Users' Association, Mr. John Milton gave some particulars concerning a curious case of failure of the high-pressure air delivery, which occurred in a compressor attached to a Diesel engine at High Wycombe. Apparently the trouble was caused by the introduction of a new high-pressure delivery valve, but the actual fault could not be discovered, and it was found necessary to replace the high-pressure delivery valve formerly in use before the air compressor could be got to work again satisfactorily. Mr. Napier Prentice suggested that if the cover of the high-pressure valve were screwed up too tightly the valve spring might be distorted and might hang up. Mr. R. W. Lyle drew attention to a blast regulator which could be fitted between the compressor and the engine, and which rendered the use of a blast bottle unnecessary.

Dilution of Labour.—A circular letter has been issued by the Incorporated Municipal Electrical Association informing members that a deputation consisting of representatives of the Institution of Electrical Engineers, the Incorporated Municipal Electrical Association and other bodies concerned with electric power supply was received by the Reserved

Digitized by Google

Occupations Committee on the 28th ult. Various points were emphasised by the deputation, such as the great importance of the electricity supply industry, the difficulties and dangers of substitution, and the fact that women labour is employed in some instances to the extent of 25 per cent. or more. The Chairman stated that the recent de-badging was carried out upon the order of the Cabinet direct, and Tribunals should appreciate the fact that it was not, and is not intended to be, a mandate that all de-badged men are to go into the Army, but that it is still for the Tribunals to consider the circumstances of each case, and that a reasonable time should be given for the provision of substitutes. The Chairman stated that the Committee were fully alive to the position and importance of the electricity supply industry. It was not their intention to interfere with skilled men.

Comparison of Electric Winding Systems.—Before the South African Institute of Electrical Engineers, Mr. S. E. T. Ewing read a Paper entitled "Comparison of Electric Winding Systems."

Sufficient experience is now available with both alternating-current and Ward-Leonard winding plants to make it evident that either type can economically and safely carry out all the present requirements of main winding engines, and that under given conditions each type may have technical and commercial advantages over the other. The principal operations which main winding engines are required to perform are shaft sinking, winding from one level; winding from several levels; raising and lowering men, materials and supplies; dead-slow winding for shaft and rope inspection and repairs. All these operations are normally carried on in balance. Operations which usually necessitate out of balance running—*i.e.*, with one drum unclutched—are taking off, turning end for end, or renewing main and tail ropes; adjustments for stretch of ropes; and alterations of rope lengths for drawing from different levels. The author dealt with the two systems of electric winding as applied to shaft sinking; winding from one or more levels; raising and lowering men; lowering timber and materials; dead-slow winding and working with one drum unclutched. In conclusion, problems in new deep shafts were briefly considered. At the present time several deep level shafts are being sunk, and in the course of the next year or so no doubt several more will be begun under conditions which call for reconsideration of the principles underlying present designs. The new deep-level shafts will attain depths considerably over 4,000 ft. At such depths it is difficult to secure the minimum requisite factor of safety in ropes, and therefore the subject of two-stage winding is again likely to come under discussion. Furthermore, the additional power required tends to place the single large direct-connected induction motor out of credit owing to excessive size and low power factor. Mechanical reduction gearing for these large motors is, as far as Rand practice is concerned, quite untried. Altogether, therefore, it may be assumed that a new and highly-interesting series of problems still lies before the designers of electric winding plants, and that finality in size and design has by no means yet been reached. The following summarises such of Mr. Ewing's remarks as refer to direct comparison of the alternating-current and Ward-Leonard systems under different conditions :—

Conditions.	A.C.	W.L.
1. Shaft sinking	Equally effective on all points at approximately equal capital cost.	
2. Rock winding from one level—		
(*a*) With tail-ropes	Relative economy dependent on frequency of winding. Lower capital cost. Equal safety and ease of handling.	
(*b*) Without tail-ropes.....	Lower capital cost	Superior economy over all. Easier to handle.
3. Rock winding from several levels	Lower capital cost	
4. Raising and lowering men ...	Lower capital cost	
5. Lowering supplies	Lower capital cost	
6. Dead-slow winding	Lower capital cost	

OBITUARY.

S. Tolver Preston.—The death is announced of Mr. S. Tolver-Preston, D.Phil., the author of various works and Papers on physics and mathematics. Deceased was an old subscriber to The Electrician and was one of the oldest Fellows of the Physical Society of London.

Mr. Preston, who was educated at the old Gymnasium School and at the University of Aberdeen, was articled to a London firm of civil engineers and was employed in testing an Atlantic cable while being laid by the cable ship "Hooper." Mr. Preston retired from practical engineering early in life, preferring the study of abstract science, particularly physics and mathematics. At first he visited Paris, and subsequently he went to Germany, where he settled, his last visit to England being about 18 years ago. He died in hospital at Altona in March after a short illness. One of his works, "The Physics of the Æther" was published in 1875 by Messrs. Spon, and he also made various contributions to The Electrician, the "Philosophical Magazine," and other scientific journals.

Emile Harlé.—The "Revue Générale de l'Electricité" announces the death of M. Emile Harlé, a well-known French electrical engineer and principal partner of Messrs. Harlé et Cie, electrical manufacturers, of Paris. M. Harlé was a past-president of the Société Internationale des Electriciens and of the Syndicat Professionnel des Industries Electriques.

Deaths on Active Service.—The following deaths on active service are reported :—

Lieut. Harry Butler, 30 years of age, who has died in action, formerly held a responsible position at Messrs. Dick, Kerr & Co.'s works at Preston.

Sec.-Lieut. H. V. Hobbs (Manchester Regt.), who has been killed, was in the Manchester Corporation tramways service prior to the war.

Lieut. C. H. Treglown (R.F.A.), aged 21, who was killed on March 30, was educated at the Imperial College of Science and Technology.

Sec.-Lieut. E. R. H. Grantham (Northumberland Fusiliers), aged 20, who has died of wounds received on March 31, was educated to follow his father's profession of civil engineer, and in his third term at Cambridge passed the qualifying examination for the Mechanical Tripos.

Lieut. C. H. Avery (Essex Regt.), aged 23, who has died of wounds, was educated at Southend Technical School and was a B.Sc. of London University. In 1911 he took a scholarship in engineering at London University, was bracketed first for a mathematical exhibition in 1912, and took an engineering research scholarship in 1913.

Capt. S. J. Snowden (Middlesex Regt.), aged 25, who was killed on March 26, was trained as an electrical engineer at Faraday House and was afterwards in the service of the L. & N.W. Railway Co.

Pte. F. Pollitt (L. N. L. Regt), who has been killed, was formerly a conductor on the Bolton tramways.

Pte. S. Squires (R. Warwickshire Regt.), aged 30, who has died on active service, was formerly a motorman on the Birmingham tramways.

Gunner J. S. Jenkins (R.F.A.), formerly of the electric light department of the India Rubber, Gutta Percha & Telegraph Works Co., died on March 22 from wounds received on the previous day.

PERSONAL.

The Hon. J. D. Connolly, M.L.C., has been appointed Agent-General for Western Australia, in succession to Sir Newton Moore.

Dr. John C. McLennan, Professor of Physics at the University of Toronto, has accepted a seat on the British Board of Inventions.

Mr. H. A. Greaves, assistant mains engineer at Sheffield Corporation, has been presented with a roll-top desk by his colleagues upon leaving to take up a position with Messrs. T. H. Watson & Co. The presentation was made by the general manager (Mr. S. E. Fedden), who took the opportunity of thanking the staff for their work during the excessive war period.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, April 20th (to-day).

Institution of Mechanical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, S.W. General Meeting. Presidential address to be delivered.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, Westminster, S.W. Paper on "Gas Turbines," by Mr. S. E. Hutson.

MONDAY, April 23rd.

Royal Society.

4.30 p.m. At the Royal Society, John-street, Adelphi, W.C. Howard Lecture on "Works Organisation and Efficiency," by Prof. W. Ripper, D.Eng., D.Sc. (Lecture I.)

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, S.W. Paper on "Some Applications of Radio-Activity," by Prof. H. T. Davidge, B.Sc.

WEDNESDAY, April 25th.

Birmingham Local Section, Institution of Electrical Engineers.

7 p.m. At the University, Edmund-street, Birmingham. Paper on "High-Tension Overhead Transmission Lines," by Mr. G. V. Twiss.

Yorkshire Local Section, Institution of Electrical Engineers.

7 p.m. At the Philosophical Hall, Leeds. Annual General Meeting. Discussion on "Wayleaves," with Introductory Paper by Mr. C. Vernier.

THURSDAY, April 26th.

Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, S.W. Paper on "High-Tension Overhead Transmission Lines," by Mr. G. V. Twiss.

Digitized by Google

WAYLEAVES.*

BY C. VERNIER.

The question of securing facilities by legislation for carrying electric mains over and upon private land has frequently been referred to in discussions before the Institution and elsewhere.

After the war the need for efficiency and economy will be seriously accentuated, both in regard to a more efficient utilisation of our seriously depleted capital and also in regard to the conservation of our natural resources, of which in this country coal is unquestionably the most important. The present Paper is concerned with securing to the fullest possible extent the advantage of the economies in capital cost which can be effected by the use of overhead wires for interconnecting, transmitting and distributing mains across open country, and the no less important economies which can be obtained by laying underground mains wholly or partly on private property whenever the use of such mains is found desirable; overhead wires in towns and villages stand in a somewhat different category. On 20,000-volt mains the saving in capital cost which can be effected over an equal length of route by the use of overhead wires as against the use of underground cables is in the neighbourhood of 50 per cent., excluding the cost of wayleaves in each case. At higher voltages it is yet greater; while by using cross-country routes for underground mains, instead of keeping strictly to public roads, a saving in capital cost of 30 per cent. is not uncommon on routes of several miles, and even more on shorter lengths, as the result of shortened routes and cheaper reinstatement of the ground. Moreover, although the Board of Trade are willing to allow extra-high-pressure overhead lines on public roads, subject to strict requirements regarding public safety, practical considerations usually render this, if not quite impracticable, at least extremely undesirable, and therefore all such lines must ordinarily be placed on private property.

In the near future, much higher transmission pressures will probably be employed, and this cannot in the present state of the art be satisfactorily dealt with (if at all) by underground cables. The difficulties already referred to in the use of overhead wires for extra-high-pressure transmission, fall conveniently under two heads—viz., "Consents" and "Wayleaves."

Consents.

In considering the Electric Lighting Acts it is necessary to differentiate between the various classes of undertakings—viz., statutory municipal and statutory company undertakers, and non-statutory undertakers. The Acts compel statutory undertakers to obtain the consent of the local authority to the erection of overhead mains everywhere outside their own premises. This consent is obviously unnecessary in the case where a local authority are themselves the undertakers, and such consent in the case of a local authority would only be required in the exceptional case of a municipal undertaking wishing to erect overhead wires for giving a supply outside the area scheduled in the Order and in the district of a neighbouring local authority under powers conferred by sec. 6 of the Electric Lighting Act, 1909.

For a statutory company undertaking, the consent of the local authority is in every case essential, and further, there can be no appeal from the decision of a local authority in this matter, which may refuse its consent without assigning any reason. There is only one usual exception to this procedure—*i.e.*, in the case of the Power Acts, where an appeal to the Board of Trade is allowed in the event of a consent by a rural district council being unreasonably withheld.

The anomaly of the position will be better appreciated when it is pointed out that any private individual or company who cares to undertake the transmission or distribution of electricity without statutory powers—which can be and is commonly done, for example, by colliery and quarry owners and others, as there is no restriction placed upon it so long as electricity supply to consumers is not the chief business of the undertaker†—is perfectly free to erect overhead wires over private land without the consent of the local authority, and can quite well carry such wires across public roads and footpaths, provided the local authority are not the owners of the land on either side of the road and that care is taken not to contravene any by-laws which the local authority may have adopted,‡ and, further, in the absence of special by-laws that the highway is not itself interfered with or broken up, and that its ordinary use is not restricted in any way.

Examples are cited by the author to show the difficulties and delays resulting from the application of the present Acts in the case of statutory company undertakings.

Many local authorities have but the haziest idea of why they stand possessed of the powers conferred in the clauses of the Acts already quoted. It is essential that a right of appeal to the Board of Trade should be allowed in all cases, and that while the local authority should have the right to be heard, it should have no absolute veto on such questions. All powers of interference in technical questions, such as design and questions of the public safety, without a reference to the Board of Trade, should be absolutely taken from them.*

A time limit should further be determined, say, one month, as in the case of works on public roads, during which a local authority must either signify or refuse its consent, failing which such consent will be deemed to have been given.

If there be any insuperable objection to extending the right of appeal in the somewhat special case of county boroughs, it should nevertheless be applied to urban district councils as well as to rural district councils.†

Many urban areas, at least in industrial districts, partake of the character of rural districts in their sparsity of population, and quite a large part of an industrial county, and often just that part where overhead wires are most needed, may comprise a number of contiguous urban areas.

Wayleaves.

Electricity supply, also gas and in some cases water, undertakers are precluded by law ‡ from laying their mains in private lands without special consent, and this is only possible by a complete agreement for an easement or wayleave with the owner and occupier. The above restrictions have been found to be a source of serious inconvenience and unnecessary expense.

Cases of absolute refusal to grant an easement or wayleave are fortunately of rare occurrence, but it is otherwise with the imposition by landowners of unnecessarily oppressive conditions, chiefly the exacting of outrageously exorbitant rents, having regard to the use which is made of the land and its value to the owner. Some examples are given. Thus, a charity trust, whose meetings were only held quarterly, was applied to for a wayleave. After repeated inquiries, and nearly seven months later, a reply was obtained to the effect that a sub-committee had been appointed, who would report at a meeting to be held two to three months later. Ultimately a reply was received that the wayleave would be granted, provided the applicants would undertake to give a supply of electricity to one of their institutions in another part of the district. After a long delay, while terms for this supply, which necessitated a special main, were being arranged, and 12 months from the date of the original application, it was stated that certain lessees of the land challenged the right of the trustees to grant this wayleave. Negotiations then took place between the parties, which took up another six months, and it was fully 18 months before the permission could be obtained to start work. The line was nearly 20 miles long and all other wayleaves had been granted some nine months before this last consent could be obtained.

In another case, a colliery company owning land in various parts of the district held up wayleaves in two places on overhead lines some 30 miles long, taking advantage of the opportunity offered to negotiate favourable terms for a supply of electricity to a colliery.

Cost of Wayleaves.—Compensation for an easement or wayleave is almost invariably given in the form of an agreed annual rent, based either on a fixed sum per pole or per yard of route, or an annual lump sum payment to cover a particular stretch of route between fixed points.

Rents have steadily risen during the past seven years and especially since the war began.

For obvious reasons, I must only speak of the cost of wayleaves in general terms, but the following examples may serve to indicate the measure of the extortionate demands which are exacted:—

1. At the present time, ignoring for the moment the formidable difficulties in renting land just when and where it is required, it would be more advantageous, on financial grounds alone, to electrical undertakers in some parts of the country to rent a strip of land wide enough for many a London street for the whole length of an overhead line at the same rents per acre as landowners secure from their tenants for some of the very best of the agricultural land in this

* Abstract of Paper read before the Institution of Electrical Engineers

† Electric Lighting Act, 1909, sec. 23.

‡ For the model form of by-laws approved by the Board of Trade, *see* the "Electrician Electrical Trades' Directory, 1916," p. 109.

* A local authority under sec. 6 of the Electric Lighting Act, 1882, may make by-laws for the safety of the public, but these by-laws must always be confirmed by the Board of Trade.

† This has already been allowed in a few cases in power companies' Acts—*e.g.*, Kent Electric Power Act, 1906, sec. 22.

‡ Waterworks Clauses Acts, 1847, sec. 29; Gasworks Clauses Acts, 1847, sec. 7; appendix to Electric Lighting (Clauses) Act, 1899.

Digitized by Google

country, and such that even if this strip of land were put to no other use the landowner would suffer no pecuniary loss.

2. Alternatively, and subject to the same assumption, it would in many cases be a satisfactory business proposition from the point of view of the undertakers, to rent the whole area of specified fields along the route, on agricultural tenant's terms, provided the right to sub-let again for agricultural purposes were allowed.

The iniquity of these charges can be further appreciated when it is mentioned that only approximately one-half of 1 per cent., on a liberal estimate, of the land mentioned in paragraph (1) is actually diverted from its ordinary use in connection with an overhead line on arable land, and less than one-quarter of 1 per cent. on grazing land.

If these charges may fairly be termed iniquitous in the case of overhead lines, what should be said of the same rents which are now frequently asked for wayleaves for underground cables? Underground cables when once laid generally require no further attention for many years, and do not obstruct or interfere in any way whatever with the ordinary use of the land; in fact, their very existence is usually forgotten by everyone except the undertaker and the grantor of the wayleave when he receives his rent.

In order to prevent any misunderstanding, let me add that rent is not the only compensation, and that additional compensation has to be paid to the landowner, tenant or occupier for all damage to crops, grass, roads, lands, drains, fences, trees, &c., occasioned in the laying down or erection of the work, or its subsequent repair and maintenance, while invariably there is a clause in the agreement for the diversion of the main at short notice at the sole cost of the undertaker.

No reasonable person would quarrel in principle with the payment of this further compensation, and although something might also be said on this subject, considerations of space do not permit of this in the present Paper.

In addition to the landowner's rent, the tenant or occupier (if any) has also an interest in the land, for which he should receive compensation.

Compulsory Powers for Expropriation.—There are two points of view from which the question of electricity supply undertakers being granted compulsory powers for carrying their mains over or through private land may be regarded. These are briefly, on the one hand, that such undertakings afford a valuable public service, and that any source of unnecessary expense in furnishing such service is ultimately a serious handicap to industry and production, and consequently contrary to the national interest. The other is that these undertakings—I refer here to company undertakings—are a source of private profit, and any saving of expenditure merely increases profits to shareholders.

The latter is undoubtedly the view that weighs chiefly in the minds of the majority of individuals and private and public bodies when they have the power, as in this case, to exercise their absolute discretion in granting or refusing a concession.

Compulsory powers for expropriation for works of public utility, or, as is better known in the United States, the power of eminent domain—*i.e.*, the sovereign right of a State to appropriate private property to public uses, whether the owner consents or not—exists in most European States, including Italy, Switzerland, France, Norway, Spain, Holland, Belgium and possibly other countries, and also in the United States.

In Italy, Switzerland and France further enactments on expropriation have been applied to the carrying of electric mains (either overhead or underground) over or through private land, while in Norway the general law on expropriation is available for this purpose.

In every case it is necessary to satisfy the authorities—*i.e.*, either the Crown, the Legislature or a Government Department—that (*a*) the undertaking or (*b*) the proposed main is one of public utility, before these powers can be applied.

In the United States under a recent law, easements for rights of way over public and national lands can be granted by the State. Owing to the comparatively low cost of land in many parts, however, it is quite a common practice for electric light and power undertakings to purchase a strip of land for at least their most important lines, and elsewhere to use the public roads as far as possible, even for extra-high-pressure overhead lines.

The United Kingdom and Germany are the only two large European States which, having reached a high state of industrial development, have not yet adopted compulsory powers for expropriation for electric mains on private property.

In this country, with a few exceptions, which I shall shortly describe, and excepting the extraordinary war-time procedure under the Defence of the Realm Acts, the only statutory powers which are at all analogous to the right of expropriation or of eminent domain, are the compulsory powers for the purchase of land under the procedure laid down in the Lands Clauses Acts.

We are not here, however, concerned with the purchase of land for routes for our mains, nor should this be at all necessary. The present procedure for the compulsory purchase of land is altogether too clumsy and costly to render its adoption practicable for such a purpose.

There are, however, interesting precedents in our own legislation which affords to certain authorities the right to secure compulsory easements over private land. The Public Health Act, 1875, and the Telegraph (Construction) Act, 1916, are cited in this connection. So far as I am aware there is not a single case in which the powers conferred by the Telegraph Acts of 1892 and 1908 have been exercised, and the working of the more recent Act of last year will be watched with great interest. In India the telegraph authority is entitled to place telegraph lines and posts in or upon any immovable property.

The Land Inquiry Committee's Report.—In 1912 the then Chancellor of the Exchequer (Mr. Lloyd George) appointed a small private committee to inquire amongst other matters into the "nature and workings of the existing systems of ownership, tenancy and taxation and rating of land and buildings in urban districts and the surrounding neighbourhoods, and their effect on industry and the conditions of life." The report of this committee was subsequently published in two volumes, one of which refers to the question of wayleaves in the following terms:—

"Public bodies are often called upon to pay large sums for such easements, and private firms are affected similarly when they are unable to get consent to the laying of pipes for the service of necessary water or electrical power. By sec. 29 of the Waterworks Clauses Act, 1847, and sec. 7 of the Gasworks Clauses Act, 1847, water and gas companies are expressly precluded from laying pipes or any other works on private lands without the consent of the owners, though by the same Statutes they are allowed to lay pipes, and examine and replace them from time to time under public streets. These provisions enable owners to demand large sums from such companies for wayleaves. Modern developments of the use of electricity to supply power at a distance from the spot where it is generated have given increased importance to this question. Wires have to be carried across country, and here, too, each owner whose land it is proposed to traverse is enabled to hold the scheme up by demanding an excessive price for permission to carry the wire across his land. In some cases he is enabled to prevent it altogether. . . . We believe that the State should exercise the power of compelling the grant of easements and wayleaves of all kinds.

"Recommendations.

"Therefore, we recommend:—

"1. That the Government Department authorised to give such sanction should have the power to make an order for the compulsory acquisition of easements or wayleaves for any purpose.

"2. That in all cases where any such order is made the terms should be fixed by the Judicial Land Commission.

"3. That in all cases: (*a*) The local authority and the landowner should both be enabled to appear before the Government Department and the landowner before the Commissioners. (*b*) The amenities of the neighbourhood and the interests of the landowner should be considered, and injured as little as possible. (*c*) The term 'landowner' should include all who have substantial interests in the property." The report also deals with such matters as Tribunals, Procedure and Costs.

The adoption of the committee's recommendations would go far to overcome satisfactorily most of the present difficulties in connection with obtaining wayleaves.

It will probably be known that the report formed the basis of the land reform proposals outlined on behalf of the Government by Mr. Lloyd George at Bedford and Swindon in October, 1913, which included the formation of a Ministry of Lands and the appointment of Judicial Land Commissioners.

Owing to the war, these proposals have had to be abandoned, whether permanently or temporarily remains to be seen, but I believe that the war will have facilitated the adoption of these or similar measures to an extent unthinkable in pre-war times.

It is obvious that no new legislation of this nature can be considered by Parliament during the period of the war and for some time after, but I suggest that the Council of the Institution would do well to formulate proposals and consider without delay the best means of securing their adoption.

In the event of the Government showing no intention of proceeding within a reasonable period after the declaration of peace with the former proposals for a Ministry of Lands, and the constitution of Judicial Land Commissioners or other new proposals, I submit the

Digitized by Google

following for discussion, which utilise existing machinery and are not inconsistent with precedents in our present legislation :—

(*a*) That, failing agreement between a stautory electricity supply undertaker and a landowner or occupier for a wayleave for electric mains on private property, or if a landowner or occupier refuses to give a consent or fails to give a reply in writing within one month from the date of application, the Board of Trade be authorised, after inquiry, to make an order for a compulsory wayleave within a further period not exceeding two months. In all cases the undertakers would have to satisfy the Board of Trade as to the commercial and other considerations which render this course necessary.

(*b*) That, failing agreement between the parties as to the annual rent to be paid by way of compensation, this be determined by one of the following methods : (i.) By a single arbitrator (who should be an expert) appointed by the Board of Trade, counsel and expert witnesses being excluded from the arbitration proceedings. The Board of Trade with the concurrence of the Lord Chancellor to be authorised to fix a scale of costs and disallow costs unnecessarily incurred. (ii.) By the valuation of two surveyors, one of whom shall be appointed by one side and one by the other side, and in the event of their not being able to come to an agreement, by a third surveyor appointed by two justices or a stipendiary magistrate.

In fixing the wayleave rent, regard should be had to the average annual rent (if any) received from the land under consideration during the previous seven years, and a reasonable percentage should be added to cover permanent damage, disturbance or inconvenience which may arise from the proposed works, and for the right of entry upon the land. This percentage would obviously be greater for overhead wires than for underground cables. The arbitrator or valuer should not be allowed to take into consideration any saving in expenditure which is afforded to the undertakers by the grant of wayleave, but should apportion the rent equitably between landowners, tenants, and occupiers, and all who have a beneficial interest in the land.

Any of the parties, failing agreement, should have the right to apply for a revision of the rent once in every seven years. Damage to crops, &c., caused in the execution of the work should be settled separately and in the usual manner.*

(*c*) That in cases of urgency, the undertakers be authorised to enter upon the land and commence the execution of the work as soon as an order has been made by the Board of Trade and before the assessment of the compensation, upon serving a notice, making a satisfactory deposit, and giving bond.

(*d*) That a right of appeal to the Board of Trade be allowed in all cases where a landowner or occupier demands the removal or diversion of a main at the cost of the undertakers which, in the opinion of the undertaker, is unreasonable or unnecessary.

The success or failure of any proposals such as these would obviously depend upon the degree of "public utility" which might be attached by the Government department concerned to the various kinds of electrical services, but even if compulsory powers were only granted in important and difficult cases, the mere existence of such powers and the possibility of the grantor of a wayleave having to justify his demands would, I believe, exercise such a moral effect that in many cases an agreement would be possible without putting into operation the machinery created. It would materially assist in this very desirable consummation if undertakers were enabled to secure a declaration from the Board of Trade of the public utility of a proposed main for which wayleaves are required before negotiation is entered into with landowners and others, in all cases where the Board is satisfied that the public interest justifies such a declaration.

Suitable rules could be drawn up to preclude applications on trivial grounds.

Considerations of space have not permitted the investigation in detail of other questions, such as wayleaves for the laying of electric mains, along, over, or across railway and canal lands, over and under railway bridges, and in private roads. Most of these questions, while of importance, are not so urgent as the main question dealt with in the Paper, a solution for which could not fail to assist in removing other disabilities such as these.

RANGE OF WIRELESS STATIONS.

BY CAPT. R. CHENEVIX TRENCH, R.E.

Summary.—The author introduces modifications into the Austin-Cohen empirical formula for the range of wireless stations so as to take into further account the effect of actual working conditions. The results obtained are illustrated by means of a number of curves, and the use of these curves is finally illustrated by the working out of certain empirical examples.

I. The following Paper is an attempt to arrange in a practical form some relations connecting the range of wireless stations with the various factors that determine it. It is based primarily on an examination of the well-known Austin-Cohen empirical formula.

The principal factors determining range are :—

1. Height of aerials.
2. Power of sending plant.
3. Wave-length.

And these alone will be considered in the curves to be given. There are, however, other factors which affect the range profoundly, such as :—

1. Nature of intervening surface.
2. Nature of aerial.
3. Nature of earth connections.
4. Type of sending apparatus.
5. Type of receiving apparatus.
6. Time of day.
7. Atmospheric conditions.
8. Degree of reliability required.

With regard to the above, the following assumptions of fair normal conditions are first made for the sake of arriving at a concrete result. The effects of variations from these conditions will be considered later.

Assumptions.

1. *Surface.*—Transmission is taken to be over sea.

2. *Aerial.*—The aerial is considered to be of flat top, non-directive type, of capacity sufficient to take the power employed without brush discharge.

3. *Earth.*—The earth connection is assumed to be good and made according to recognised methods in favourable soil.

4. *Sending Apparatus.*—This is taken to be modern musical spark apparatus, having the charging circuit in approximate resonance with the alternator frequency, such as may be expected to give from 25 to 50 per cent. efficiency between the alternator output and the power developed in the aerial.

It is assumed that only one wave-length is radiated, due either to rapid quenching of the spark or to loose coupling between the aerial and the closed circuit.

5. *Receiving Apparatus.*—This is assumed to be good modern apparatus for telephone reception, without amplifiers or relays.

6. *Time of Day.*—Daylight sending is assumed.

7. *Atmospheric Conditions.*—Allowance is made for communication through considerable atmospheric interference, but not for abnormal conditions.

8. *Degree of Reliability.*—Throughout this Paper, the range means the distance at which a regular traffic of several thousand words a day can be relied on, not the extreme distance at which one may expect with ordinary luck to get messages through.

It is assumed that the power required in the receiving aerial is 64 times that which would give a just audible signal. This figure includes a large allowance for atmospheric conditions, minor bad adjustments, interference, &c.; it might be described as a "reliability factor."

II. With these assumptions take the result arrived at by L. W. Austin in his experiments in sending from Brant Rock to U.S. cruisers in the Atlantic in 1909-10.

A large shore aerial was used in one series of tests at varying ranges to find the variation of the received current with the range. In another series of tests smaller aerials of varying heights were used to find the variation of received current with height of aerial. The wave-lengths were varied in both cases.

* Electric Lighting Act, 1882, sec. 17.

Digitized by Google

The results arrived at were tested within the following limits: For ranges up to 1,850 km.: for wave-lengths between 300 m. and 3,750 m.; for heights between 30 ft. and 130 ft. They apply to daylight working with flat-top non-directive aerials over sea, and are embodied in the following formula, known as the Austin-Cohen formula:-

$$I_2=4{\cdot}25\frac{I_1h_1h_2}{\lambda x}\varepsilon^{-0{\cdot}0015x/\lambda} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where I_1 = sending current (R.M.S.) at foot of aerial in amperes.
I_2 = receiving current (R.M.S.) at foot of aerial in amperes.
h_1 = height of sending aerial in kilometres.
h_2 = height of receiving aerial in kilometres.
λ = wave-length in kilometres.
x = range in kilometres.
Let P = alternator output in watts.
P_1 = power developed in sending aerial in watts.
P_r = power radiated by sending aerial in watts.
R_1 = total resistance of sending aerial in ohms.
R_r = radiation resistance of sending aerial in ohms.
R_e = Resistance in ohms of sending aerial due to earth and all other sources except radiation, so that $R_1=R_r+R_e$*.
P_2 = Power delivered to receiving aerial in watts.
R_2 = total resistance of receiving aerial in ohms.
λ_n = natural wave-length of sending aerial.
T = ratio, length of roof/height of sending aerial.

Now, in a hertzian oscillator it has been shown that

$$P_r=790\frac{l^2}{\lambda^2}I_1^2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)*$$

where l is the total length from pole to pole, l and λ are in any like units, and I_1 is in amperes.

And $$P_r=I_1^2R_r\dagger$$

$$\therefore \quad R_r=790\frac{l^2}{\lambda^2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Any aerial may be considered as the top half of a hertzian oscillator of length l, where $\frac{1}{2}l$ is the height above ground at which the distributed capacity of the aerial may be considered (for our purposes) to act as a concentrated capacity. We will call $\frac{1}{2}l$ the effective height of the aerial. Formulæ (2) and (3) may then be applied to any aerial of which we know the effective height. We must remember, however, in considering an aerial as half a hertzian oscillator that only the top half of the oscillator radiates energy, so the values of P_r and R_r in equations (2) and (3) must be multiplied by 0·5.

For a vertical aerial l is about $0{\cdot}8h$, or the effective height $0{\cdot}4h$. By adding a roof we increase the effective height, and for an aerial with a large roof area l closely approaches $2h$ in value. The matter may be treated with approximate accuracy as follows:—

Consider a single wire aerial of T or inverted L shape. Then the horizontal part can be divided into T elements, each equal in length to the vertical part. Call each element one unit of capacity, so that the horizontal part gives us T units of capacity acting at a height h. The capacity of the vertical part may be considered as acting at a height $0{\cdot}4h$, and at this height it has a capacity slightly greater than I unit, but which may be considered I unit for all practical purposes. So we have the total capacity acting at the centre of effect of T units at a height, h, and I unit at a height $0{\cdot}4h$. That is

$$\tfrac{1}{2}l=h\left(0{\cdot}4+0{\cdot}6\frac{T}{T+1}\right). \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

This formula is applicable to any L or T aerial of which the horizontal and vertical members have the same number of wires at the same distance apart.

Where the vertical wires are fewer or closer together than the horizontal wires their capacity may be considerably less than one unit, and the following formula gives more accurate results:—

$$\tfrac{1}{2}l=h\left(0{\cdot}4+0{\cdot}6\frac{T}{T+0{\cdot}5}\right). \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Where the vertical wires spread out fanwise to a wide roof their capacity is not only less than one unit, but it acts at a greater height than $0{\cdot}4h$, and we have approximately

$$\tfrac{1}{2}l=h\left(0{\cdot}6+0{\cdot}4\frac{T}{T+0{\cdot}5}\right). \quad . \quad . \quad . \quad . \quad . \quad (6)$$

In an umbrella aerial, or one with a large square or circular flat top, $\frac{1}{2}l$ may be taken as equal to h, where h in an umbrella aerial is the height to the middle of the ribs.

The ship's aerial used in the Austin tests consisted of a network of wires 116 ft. by 40 ft., 130 ft. above water. The capacity of the vertical part would be about 0·2 times that of the network, and we have approximately

$$\tfrac{1}{2}l=h\left(0{\cdot}4+0{\cdot}6\frac{1}{1{\cdot}2}\right).$$

$$\therefore \quad l=1{\cdot}8h.$$

Assuming the land aerials to have about the same value for l, and allotting it in equation (2), while allowing for only half the oscillator to radiate energy, we get

$$P_r=\tfrac{1}{2}790\frac{(1{\cdot}8h_1)^2}{\lambda^2}I_1^2$$

$$=1{,}280\frac{h_1^2}{\lambda^2}I_1^2, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)*$$

or $$h_1I_1/\lambda=\sqrt{P_r}/36.$$

Substituting this value of $h_1I_1\lambda$ in equation (1) we get

$$I_2=\frac{4{\cdot}25}{36}\sqrt{P_r}\frac{h_2}{x}\varepsilon^{-0{\cdot}0015x/\sqrt{\lambda}}$$

$$=0{\cdot}118\sqrt{P_r}\frac{h_2}{x}\varepsilon^{-0{\cdot}0015x/\sqrt{\lambda}}. \quad . \quad . \quad . \quad . \quad (8)$$

Now $P_2=I_2^2R_2$, and we are told that in the Austin experiments $R_2=25$ ohms.

$$\therefore \quad I_2=\sqrt{P_2}/5.$$

Substituting this in equation (8) we get

$$\sqrt{P_2}=0{\cdot}6\sqrt{P_r}\frac{h_2}{x}\varepsilon^{-0{\cdot}0015x/\sqrt{\lambda}}. \quad . \quad . \quad . \quad . \quad (9)$$

This equation gives the power received in terms of the power radiated for any range and wave-length. It shows that, for any value of P_r, the greater λ is the better. We must now investigate the relation between P_r and P_1.

Of the power developed in the aerial, the proportion radiated is $R_r/(R_r+R_e)$; that is

$$P_r=P_1\frac{R_r}{R_r+R_e}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

Now $R_r \propto (l^2/\lambda^2)$, and if the wave-length is constant, $R_r \propto l^2$. Thus it is evident that of two aerials of the same natural wave-length, radiating their natural wave, the one with the longer vertical and shorter horizontal part will radiate more efficiently than the other, and a long low aerial is a very inefficient radiator.

It is stated that the radiation efficiency of an aerial with a good earth may reach 50 per cent.†; and as an aerial radiates most efficiently at about 1·5 times its natural wave-length, we will take the 50 per cent. efficiency to apply to this wave-length—that is, $R_r=R_e$ and $P_r=P_1/2$. Long low aerials will

* Hertz, Lodge.

† The general practice is here followed of taking the radiation resistance R_r as that quantity whose product into the square of the R.M.S. current at the foot of the aerial gives the power radiated. In order to conform to this resistance rating the "wasting" resistance R_e is here taken as that quantity whose product into the square of the R.M.S. current at the foot of the aerial gives the power dissipated through all other sources. The total resistance R is considered from the same standpoint.

We are not, therefore, concerned with any allowance for variation of current amplitude throughout the length of an aerial.

* From equation (2) or (7) it follows that for any form of aerial on its natural wave-length, where h_1/λ_n is a constant depending on the shape of the aerial, we have $P_r \propto I_1^2$. That is, for any one form of aerial the power radiated on its natural wave depends only on the aerial current and is independent of the height.

† L. W. Austin.

Digitized by Google

not attain this efficiency, but we may take it to apply to any flat-top aerial with a good earth, which has a value of T not greater than 2.* For values of T between 0 and 2 it is approximately correct to say $\lambda_n=5l$. That is, for such an aerial at 1·5 times the natural wave-length, $R_r=R_e$; and since $R_r \propto l^2$ for other forms of aerial at $1{\cdot}5\lambda_n$ we have

$$R_r=R_e\left(\frac{5l}{\lambda_n}\right)^2$$

for an aerial of any shape at $1{\cdot}5\lambda_n$.

Substituting this in equation (10) we get

$$P_r=P_1\frac{(5l)^2}{\lambda_n^2+(5l)^2}.$$

This equation assumes that R_e remains constant throughout. In reality R_e increases as the aerial gets longer and lower owing to induced earth currents and the difficulty of making an earth connection of great area, so that the value of Pr for higher values of λ_n than $5l$ is less than that indicated above. It will be sufficiently accurate to say that

$$P_r=P_1\tfrac{1}{2}(5l/\lambda_n)^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

for any shape of aerial at 1·5 times λ_n.

Also, since $R_r \propto l^2/\lambda^2$, any increase of λ above $1{\cdot}5\lambda_n$ results in a reduction of R_r, and if the total resistance R_e+R_r remained constant the proportion of power radiated would vary inversely as λ^2. In practice, however, the total resistance R_1 increases at the longer waves, so the radiation efficiency on these waves is rather less than it would be if it varied inversely as λ^2. An example is quoted in which an aerial at a wave-length rather greater than the natural radiated 46 per cent. of the energy imparted to it; at about twice the natural wave-length, 14 per cent.; and at about three times, 4 per cent. This great loss is partly compensated for by the smaller decrement and greater persistence of the wave trains on the longer waves, and it will be sufficiently accurate for a practical estimate to say that above 1·5 times the natural wave-length the effect of the power radiated varies inversely as λ^2.

At waves shorter than 1·5 times the natural R_r increases, but R_1 also increases rapidly. The radiation efficiency R_r/R_1 is rather less at the natural wave length than at 1·5 times that wave-length, but between these limits the difference is not great.†

So we have for wave-lengths above $1{\cdot}5\lambda_n$

$$P_r \propto \left(\frac{1{\cdot}5\lambda_n}{\lambda}\right)^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

Combining this with equation (11) we get

$$P_r=P_1\,\tfrac{1}{2}\left(\frac{5l}{\lambda_n}\right)^2\left(\frac{1{\cdot}5\lambda_n}{\lambda}\right)^2$$

$$=2{\cdot}8P_1l^2/\lambda^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

for any shape of aerial with a good earth at any wave length.

This implies that the radiation efficiency of all aerials of the same effective height, on the same wave-length greater than $1{\cdot}5\lambda_n$, with equally good earths, is the same. In general, an aerial of larger roof spread will gain in having its natural wave-length nearer to the radiated wave, while it will lose by being a less efficient radiator owing to its shape. The larger roof spread will, of course, allow more power to be employed without loss through brush discharge.

Equation (12) applies to wave-lengths of $1{\cdot}5\lambda_n$ and upwards. As already explained, there is generally some decrease in efficiency below $1{\cdot}5\lambda_n$, but not much, whereas if (12) were applied to these wave-lengths it would show an increase of efficiency. To allow for this on wave-lengths between λ_n and $1{\cdot}5\lambda_n$ we should multiply the value of P_r obtained from equation 13 by $\left(\frac{\lambda}{1{\cdot}5\lambda_n}\right)^2$. The question of sending on wave-lengths below λ_n is not here considered, as the efficiency depends much on the type of shortening condenser used.

In equation (13) we can substitute for l the very common value of $1{\cdot}8h$, and make allowances later for special cases of different values of l. This gives us

$$P_r=P_1\frac{91h_1^2}{\lambda^2}.$$

And by assumption (4), taking 25 per cent. as a fair efficiency for general purposes, we have $P_1=P/4$.

$$\therefore \quad P_r=P\frac{23h_1^2}{\lambda^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

Substituting this in equation (9) we get

$$\sqrt{P_2}=2{\cdot}88\sqrt{P}\frac{h_1h_2}{\lambda x}\varepsilon^{-0{\cdot}0015x\sqrt{\lambda}}$$

or

$$h_1h_2\sqrt{P}=\frac{\sqrt{P_2}}{2{\cdot}88}\lambda x\varepsilon^{0{\cdot}0015x\sqrt{\lambda}} \quad . \quad . \quad . \quad . \quad . \quad (15)$$

To complete the formula we must allot a value to P_2. During Austin's tests, just audible signals were obtained with a current at the foot of the receiving aerial of 10 microamperes. As the receiving aerial resistance was 25 ohms this gave a power of $I_2^2R_2=2{\cdot}5\times10^{-9}$ watts. In subsequent tests in 1913, with improved receiving apparatus, just audible signals were obtained with a current of 5 microamperes at the foot of an aerial of 25 ohms resistance. This entailed one-quarter of the previous power, or $0{\cdot}625\times10^{-9}$ watts, and we will say

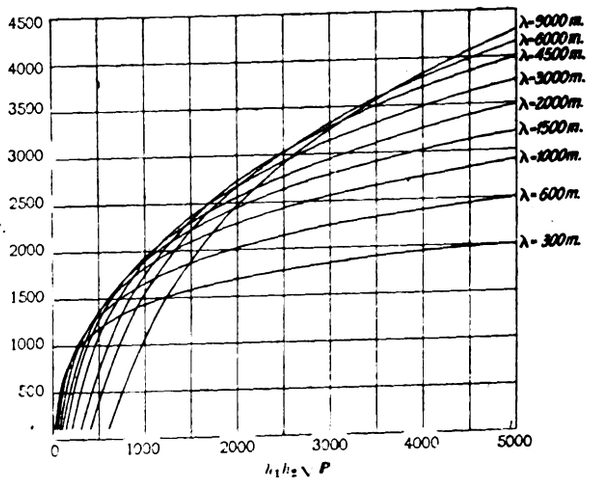


Fig. 1.—Over Sea.
h_1h_2 in metres. P in watts. x in kilometres.

that $0{\cdot}6\times10^{-9}$ watts is the power required with modern receiving sets without amplification to give just audible signals.

Then by assumption (7)

$$P_2=64\times0{\cdot}6\times10^{-9} \text{ watts}$$
$$=38\times10^{-9} \text{ watts.}$$

Substituting this in (15) we get

$$h_1h_2\sqrt{P}=6{\cdot}5\times10^{-5}\lambda x\varepsilon^{0{\cdot}0015x/\sqrt{\lambda}},$$

or expressing h_1 and h_2 in metres for greater convenience

$$h_1h_2\sqrt{P}=65\lambda x\varepsilon^{0{\cdot}0015x/\sqrt{\lambda}}. \quad . \quad . \quad . \quad . \quad . \quad (16)$$

Equation (9) shows that, for any power radiated, the greater the wave-length the better the result, and the greater the range the more marked is this advantage of long waves. We have seen, however, that for any aerial the longer the wave above $1{\cdot}5\lambda_n$ the less power is radiated. This indicates that for every set of conditions there is a best wave-length, and this conclusion is confirmed by equation (16). This equation shows that for every value of x there is a best value for λ, at which $h_1h_2\sqrt{P}$ is a minimum; this value is given by the condition

$$\lambda=\tfrac{1}{4}(0{\cdot}0015x)^2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

* The above applies to a T aerial. In an inverted L aerial the same limit is reached when the top arm is equal to the height.

† The value of λ_n for most aerials is approximately given by taking 4·5 times the combined length of the height and the distance from the top of the vertical to the end of the horizontal part.

Digitized by Google

and assuming this best wave-length to be employed, equation (16) becomes

$$h_1h_2\sqrt{P}=27\times10^{-5}x^3. \quad . \quad . \quad . \quad . \quad . \quad (18)$$

At short ranges the wave-length given by equation (17) is too small for practical purposes. For instance, for 50 km. range it is only 140 cm., and it is not until the range exceeds 800 km. that the ideal wave-length over sea exceeds 300 m. Moreover, 300 m. is the shortest wave for which the authors of the Austin-Cohen formula verified their conclusions in practice. Accordingly, 300 m. is the shortest wave considered in the following curves, which show the value of $h_1h_2\sqrt{P}$ for any value of x up to 4,000 km., at various wave-lengths.

III. The curve tangential to the backs of the curves in Fig. 1 is approximately that given by equation (18) in the form

$$h_1h_2\sqrt{P}/x=27\times10^{-5}x^2.$$

It will be seen that, so long as the range is short for the wave-length employed, the curves approximate to straight lines, and for these short ranges the condition

$$h_1h_2\sqrt{P}/x=Kx+65\lambda \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

is approximately correct, where the value of K depends on the wave-length.

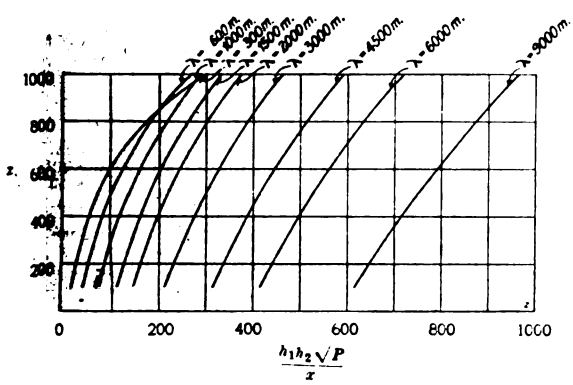


Fig. 2.—Over Sea.
h_1h_2 in metres. P in watts. x in kilometres.

For instance, the curve for 300 m. wave up to 200 km. range may be approximately rendered by

$$h_1h_2\sqrt{P}/x=0{\cdot}05x+19{\cdot}5, \quad . \quad . \quad . \quad . \quad . \quad (20)$$

for 600 m. wave up to 300 km. range by

$$h_1h_2\sqrt{P}/x=0{\cdot}1x+39. \quad . \quad . \quad . \quad . \quad . \quad (21)$$

for 3,000 m. wave up to 500 km. range by

$$h_1h_2\sqrt{P}/x=0{\cdot}2x+195 \quad . \quad . \quad . \quad . \quad . \quad (22)$$

At short ranges Kx is small compared to 65λ, and the shorter the range the more negligible does Kx become. At such ranges, then, we approach the condition

$$h_1h_2\sqrt{P}/x=65\lambda,$$

i.e., $$P\propto x^2 \text{ or } I_2\propto 1/x,$$

which is the theoretical condition for radiation over a perfectly conducting plane surface. At these ranges the earth's curvature is little felt, and for transmission over sea we have the conditions of a well-conducting nearly plane surface.

This conclusion may be reached direct from equation (1) or (16), since the smaller x is compared to λ the nearer does $\epsilon^{0{\cdot}0015x\sqrt{\lambda}}$ approach unity. The figure 0·0015 is the absorption co-efficient; in a perfectly conducting plane surface it would become zero, leaving equation (16) in the form

$$h_1h_2\sqrt{P}=65\lambda x,$$

and equation (1) in the form

$$I_2=4{\cdot}25\frac{I_1h_1h_2}{\lambda x} \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

It is interesting to compare this latter with the theoretical formula for radiation from a hertzian oscillator. This is given in the form

$$F=2\pi\frac{lI_1}{\lambda x}3\times10^{10} \quad . \quad . \quad . \quad . \quad . \quad (24)^*$$

all in C.G.S. units.

Where F=electric force per cm. at distance x.
l=length of dipole.
I_1=effective current.

If we put F in volts per centimetre,
x, l and λ in kilometres as in equation (1),
I_1 in amperes, as in equation (1),
the equation becomes

$$F=2\pi\frac{lI_1}{\lambda x}3\times10^{-4} \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$$

We may consider the earthed aerial as the upper half of a hertzian oscillator as before, of length $l=1{\cdot}8h_1$. And since only the top half radiates energy the value of F is only $1/\sqrt{2}$ of what it would be if the whole oscillator radiated. Hence we have

$$F=\frac{1}{\sqrt{2}}2\pi\frac{1{\cdot}8h_1I_1}{\lambda x}\times3\times10^{-4}$$

$$=2{\cdot}57\pi\frac{h_1I_1}{\lambda x}\times3\times10^{-4} \quad . \quad . \quad . \quad . \quad . \quad (26)$$

The effective height of the receiving aerial is $0{\cdot}9h_2$ km., and if the voltage in the aerial were maintained at the level of F volts per centimetre we should have

$$V_2=F\times0{\cdot}9h_2\times10^5$$

where V_2 is the total impressed force (R.M.S. value throughout successive wave trains).

$$\therefore \quad F=V_2/0{\cdot}9h_2\times10^{-5}$$
$$=I_2R_2/0{\cdot}9h_2\times10^{-5}.$$

And in the Austin-Cohen formula $R_2=25$ ohms, so we have

$$F=I_2/3600h_2.$$

Substituting this in equation (26) we get

$$\frac{I_2}{3600h_2}=2{\cdot}57\pi\frac{h_1I_1}{\lambda x}\times3\times10^{-4}.$$

$$\therefore \quad I_2=8{\cdot}7\frac{I_1h_1h_2}{\lambda x} \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

This is greater than the value of I_2 given in formula (23), because we have assumed above that the voltage in the receiving aerial is maintained at the level of the electric force in the wave field. This, however, is not the case, as it would imply that the power upon which the aerial draws is inexhaustible and that the power collected varies inversely with the aerial resistance, since $P=V^2/R$. The aerial collects a certain amount of power from the passing waves depending mainly on its height, capacity and properties of re-radiation, and the voltage and current developed from this power then depend on the total resistance of the aerial.

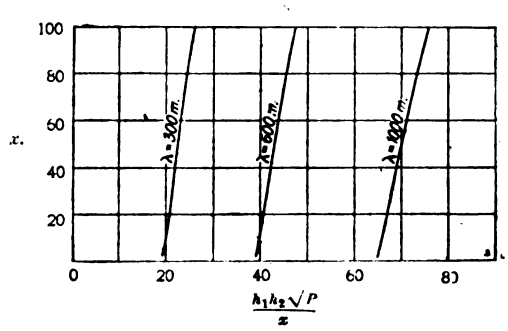


Fig. 3.—Over Sea.
h_1h_2 in metres. P in watts. x in kilometres.

(*To be concluded.*)

* Helmholtz.

Digitized by Google

THE LONDON AND NORTH-WESTERN AND BAKERLOO ELECTRIFICATION.

Last Monday a notable extension was made to the suburban railways of London by opening to the public a new through service on the Bakerloo Tube Railway and the electrified portion of the London & North Western Railway which runs as far as Watford. This will certainly prove a great boon to those living between Willesden and Watford, as it gives direct

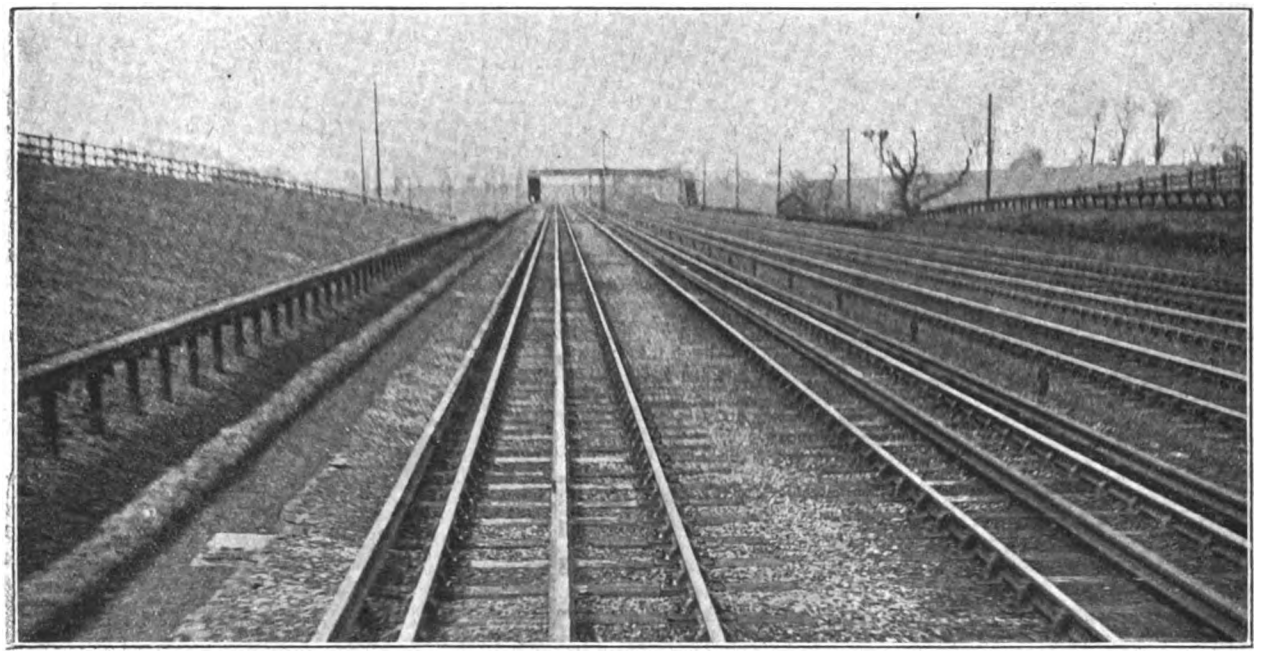


Fig. 1.—View Showing Electrified Tracks.

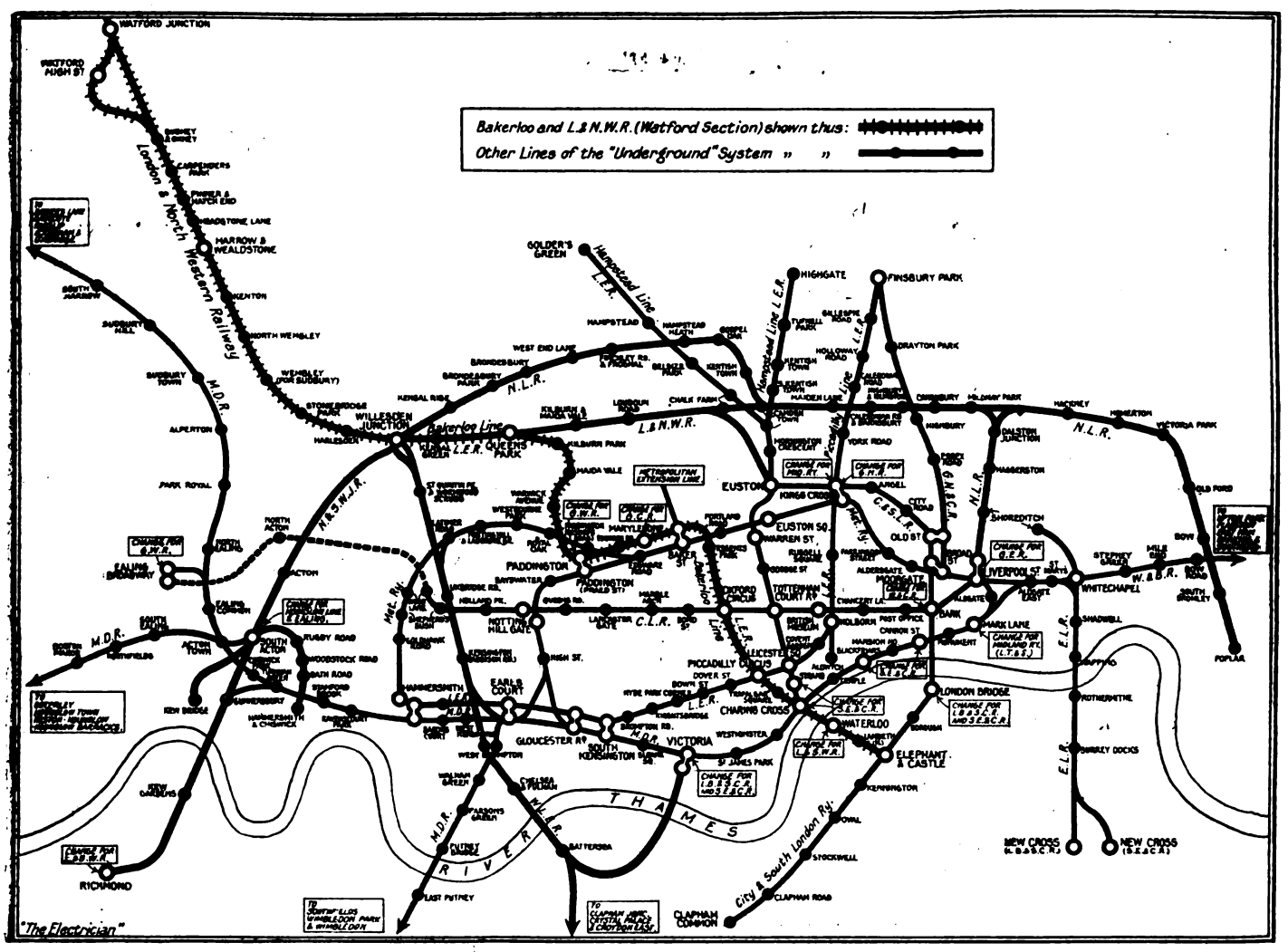


Fig. 2.—Diagram-Map of "Underground" Electric Railway System showing the Watford (L. & N.W.R.) Section.

Digitized by Google

communication with the West End, whereas hitherto it has been necessary to go to Euston and then change into one of the tube railways.

Last Friday we had the opportunity of travelling on one of the new trains from Charing Cross to Watford, and thence to the car sheds at Croxley Green, where light refreshments were

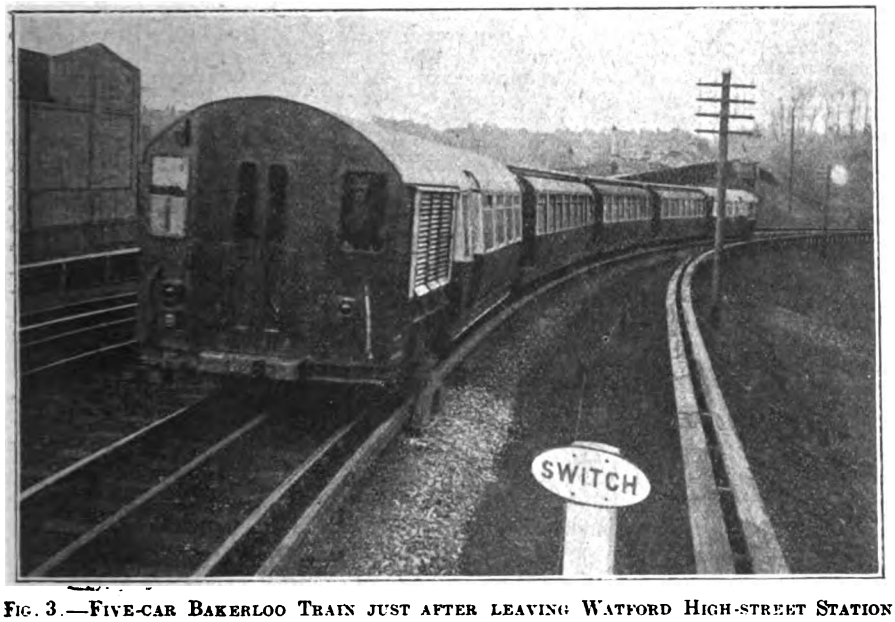


Fig. 3.—Five-car Bakerloo Train just after leaving Watford High-street Station.

provided, and attention was called to the importance of the new service. Owing to the war the gathering was quite informal, but lack of formality has its compensations.

Since its inception there have been five previous extensions of the Bakerloo Railway, these extensions being between Kennington-road (now Lambeth) and Elephant and Castle in 1906; Baker-street and Great Central, 1907; Great Central and

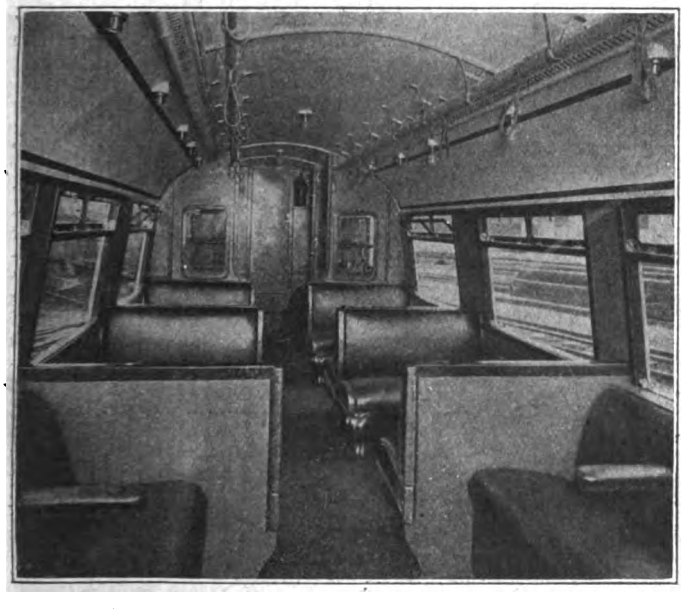


Fig. 4.—Interior of Central London Motor-Coach, Bakerloo-Watford Stock.

Edgware-road, 1907; Edgware-road and Paddington, 1914; and Paddington and Queen's Park and Willesden in 1915.

This new extension of the Underground system will open up a large area of new countryside and residential districts, and will directly connect the northern suburbs with the Central, West-end and South-eastern districts of London. In addition, it will give passengers using the L. & N.W.R. system a choice of something like five new terminal stations in town connecting with main line railways, the new line coupling up Paddington (for G.W.R.), Marylebone (G.C.R.), Charing Cross (for S.E. & C.R.), and Waterloo (for L. & S.W.R.), with Willesden Junction and Watford. It will also mean for the business man a direct linking up with the West-end and Central London areas, with facilities for reaching practically every part of the metropolis.

After coming to the surface at Queen's Park, Bakerloo trains will run over the electric line of the L. & N.W.R. system to Watford, via Willesden Junction New Station. The extension has increased the length of the Bakerloo run to 20 miles 66 chains and added another 12 stations to the line of route. Through ordinary tickets will be issued to and from all the above stations, and also to certain stations on the Piccadilly, Hampstead, Central London and City & South London Railways.

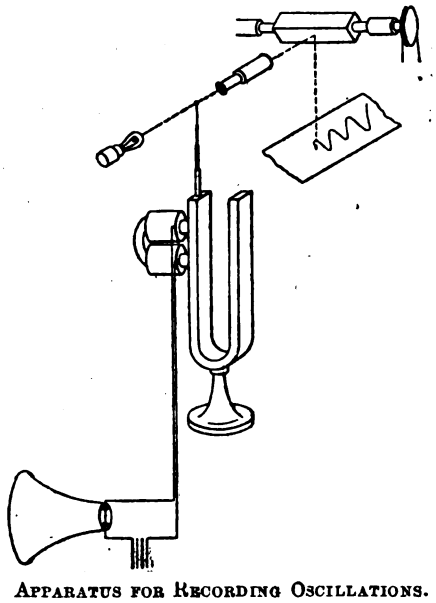
Fig. 1 is a view of the track on the London and North-Western Railway and Fig. 2 shows the relation of this railway to the Underground Railways. Figs. 3 and 4 are views of the joint rolling stock, which at the moment consists partly of stock of the Central London Railway, owing to the difficulty of completing new work.

The throughout journey from Elephant and Castle to Watford will take about one hour, and there will be a quarter-hourly service throughout the day to Watford, the total number of trains in each direction being 72. Third-class accommodation only will be provided on Bakerloo trains.

In our next issue we hope to give some further details.

A TUNING-FORK RECORDER OF COMPLEX WAVE FORMS.

According to the "Electrical World," by suspending a ball member at the end of a series of graduated supports attached to each other in abutting relationship, Mr. A. Behm, of Kiel, has been able to produce a tuning-fork oscillator which can be made to record not only the fundamental of a complex wave form but also any one or a series of harmonics present in the wave. Moreover, by suitably calculating the dimensions and the ratios of oscillations of the separate members of the combination, it is possible to ensure that the measuring member shall come to rest again within a period of 0·02 second in spite of having made a large deflection. This strong damping is brought about not only by the increased air resistance due to the greater length of surface, but chiefly by the vibrations which the separate members perform relatively to each other. Thus the improved tuning-fork is admirably adapted within its range for recording speech wave forms either by the aid of a microphone amplifier or even directly by means of a diaphragm.



Apparatus for Recording Oscillations.

Digitized by Google

VOLTAGE REGULATION OF ROTARY CONVERTERS.

The following is an account of a discussion which took place before the Manchester Local Section of the Institution of Electrical Engineers on Mr. G. A. Juhlin's Paper on the above subject. An abstract of the Paper appeared in The Electrician of March 9th and 16th.

Mr. R. Townend said the adoption of the rotary converter had now become so general that it was most important to understand fully how the conditions involved in the voltage regulation of such machines differed from those in the case of a direct-current generator. The rotary converter was primarily a machine for converting from alternating to direct current with as small a voltage variation as possible, and any increase in the voltage range was accompanied by some sacrifice in the heating efficiency, power factor or cost of the equipment. If the required voltage range was within the limits permissible with reactance control, this sacrifice might be small, but when the voltage range was outside the limit additional apparatus was necessary, and the sacrifice might be considerable. It was, therefore, important that the rotary converter should be designed for the voltage range under which it would have to operate, and, with a view to safety, this range should not be increased. The author had not dealt with the case of voltage regulation with the rotary running inverted—*i.e.*, converting from direct to alternating current. In this case the conditions were quite different when the rotary was running alone and when alternating-current generating plant was running in parallel with it. In the former case any variation in the rotary field excitation would only cause a variation in the speed of the machine, and would not affect the voltage; therefore some form of auxiliary apparatus was essential if it was necessary to have control over the alternating-current voltage. In the case of the rotary running in parallel with alternating-current generating plant a variation in the excitation of the rotary would not change the speed, because the rotary would have to run synchronously with the other machines, and therefore the change in field current caused a change in the wattless current flowing in the rotary, this change being sufficient practically to neutralise the alteration made to the field excitation. The change in the wattless current would, of course, cause variation in the alternating-current voltage, provided there was some reactance in the circuit, exactly as in the case of a rotary converting from alternating to direct current and having reactance control. This variation in the rotary wattless current simply meant that the wattless current carried by the rotary was now carried by the alternating-current generators, or vice versa, and it was, therefore, necessary to take care that this did not result in overloading these generators with wattless current.

Prof. Miles Walker expressed indebtedness to the author for dealing so fully with a most important question. The curves and data given were of great practical value to the designer and operating engineer. The Paper was so thoroughly sound that it was difficult to find important points to criticise; but since it appeared in the past that members were prone to develop too much into a mutual admiration society, the speaker said he would attempt a severe criticism. Whilst the matter was excellent, the manner of presentation left much to be desired. There was a looseness in the employment of terms, which, however justifiable in shop conversation, ought not to appear in important Institution Papers. For instance, the word "reactance" was continually used where "reactance drop" was meant; similarly, "resistance" was used to indicate "resistance drop." Sufficient care had not been taken to make the clock diagrams clear. Every clock diagram should be accompanied by a small sketch of connections showing the directions in the circuit taken as positive by the vectors in the clock diagram. Moreover, where different voltages were dealt with in the problem, which varied their phase difference under changing conditions, it should be definitely stated which vector was taken as standard of phase. Non-compliance with these simple precautions made all the clock diagrams in the Paper exceedingly difficult to interpret. Moreover, in the first figure the scale of vectors was changed without intimation. The reduction of the wattless current required to produce a given voltage variation, when saturated reactance iron was used, was of great interest; but this gain was only possible where the reactance drop was used in pulling down the voltage when drawing a lagging current. Another fact of note was that where the compounding characteristic was of the kind shown in Fig. 4 there was some danger, when a machine was being taken off load, of a sudden slump of load occurring as the load was being reduced, and a heavy reverse current being taken by the rotary before the circuit-breaker came out on reverse current. As an illustration of the improvement which the author might have made in the Paper with little trouble, there was the expression for tan ψ, which was made to equal $(I_w \mp I_m)/I_a$. The $\pm$ sign was very unsatisfactory, and it would have been better to define the sign of the wattless current as, say, positive for the lagging current and negative for the leading current. The expression then became $(I_w + I_m)/I_a$, when not only was the $\pm$ sign avoided, but the correct sign of the angle ψ was given, hence the expression for the power factor on the high-tension side would be cos $(\varphi + \psi_1)$, and the sign of the resulting angle would itself indicate whether the current was leading or lagging.

Mr. Julius Frith endorsed Prof. Walker's comments in regard to the criticism of Papers. The present Paper did not seem to embrace the subject completely, and a comparison between the rotary converter and the motor converter should have been considered. In the case of the motor converter voltage regulation could be obtained with much less tampering with the power factor. There was certainly a looseness of expression throughout the Paper, which made it difficult to understand whether currents were lagging or leading to the rotary. The whole matter might have been considerably simplified if treated from the magnetic standpoint, using the "flux" instead of the "voltage."

Mr. A. G. Ellis said the Paper compared very comprehensively the three possibilities of voltage variation—namely, (1) high reactance transformers, (2) booster generators, (3) booster transformers. In deciding the system most suitable for any particular case, the question of reliability in service was important, and in this connection the primary voltage of the system should be taken into account. In high-voltage transformers the introduction of magnetic shunts between the primary and secondary windings in order to increase the reactance was liable to weaken the transformer from an insulation point of view. Also for low transformer secondary voltage—*i.e.*, low voltage on the direct current side of the converter, large sections of copper would be necessary, which would be more susceptible to parasitic losses due to large leakage field. A reactance up to 10 per cent. could generally be obtained as inherent reactance of the transformer without resorting to the use of magnetic shunts of sheet iron placed between primary and secondary windings, still retaining a rational design as regards material and efficiency. Above this value magnetic shunts were usually necessary and a reactance up to 50 per cent. could be obtained by skilful designing with a short-circuit characteristic not deviating appreciably from a straight line. Such high reactance was not usually necessary for the range of the voltage variation required in practice. This was fortunate as the disabilities as regards parasitic losses, space required for the reactive iron and mechanical rigidity, increased with the reactance. These difficulties were not, however, insuperable even with very high reactance. A wide range of voltage was practically only required in the case of rotaries working on either lighting or traction load for, say, 440 or 550 volts direct current. In such cases the most satisfactory arrangement was to provide a tap for the lower voltage on the low-tension side of the transformer. This was generally a practicable proposition, although it was not always an easy matter to bring out such a tap, especially when dealing with large currents and high primary voltage. It was of interest to note that Continental firms had not gone in for high reactance transformers to such an extent as was usual in England, but had supplied the necessary reactance in the form of a separate choke coil in series with the transformer. This was partly due to the high primary voltage used in Continental systems. Booster transformers, apart from the question of cost, were undesirable on the ground of extra complication—namely, two extra transformers and a voltage regulator. For large rotaries with wide voltage variation limits a large number of steps on the regulator would be required or trouble would be experienced on account of the large number of volt-amperes between contacts. This would lead to a large and expensive regulator and such a fine degree of regulation was not usually required, especially in traction work. The series booster transformers also required special care in construction, as they had to withstand heavy shocks in case of short-circuits.

Mr. J. L. Thompson discussed the methods employing static apparatus—namely, (1) transformer with internal reactance, (2) transformer with external reactance, (3) static boosters and regulators. The adoption of any one method of those outlined for voltage regulation depended upon: (*a*) Efficiency of complete unit, (*b*) cost of complete unit, (*c*) floor space required. For machines transforming power from alternating current to direct current any one of the three types of static apparatus could be used, but for inverted running alternatives (2) and (3) only could be used. Alternative (1) could not be used on account of the excessive voltage drop unless the machine was feeding an alternating current system as outlined by Mr. Townend. Regarding the overall efficiency of the static apparatus, this was about the same for all schemes, although the advantage, if any, lay in favour of that embodying the transformer having high internal reactance. Regarding costs, the following comparison, taking the cost of a transformer of normal reactance as 100 per cent. was of interest. The transformer was a 550 k.v.a., 3/6 phase, 50 period, with standard adjusting tappings such as used for a 500 k.v.a. rotary converter:—

1. Main transformer	100 p.c.	
2. 25 p.c. reactance embodied in transformer, extra cost of	15 p.c.	
3. 25 p.c. reactance embodied in an external reactance, extra cost of	23 p.c.	
4. A static booster and regulator to give 7½ p.c. regulation—*i.e.*, the same as would be obtained with 25 p.c. reactance	33 p.c.	45 p.c.
Additional switchgear involved, extra cost of...	12 p.c.	

These rough estimates showed that the high reactance transformer was by far the most favourable as regards cost, and as regards efficiency it was equal to any other scheme. Floor space was usually very limited, and from this point of view the high reactance transformer was by far the most economical, while the external reactance was better than the static booster and regulator. If inverted running was required, an external reactance which could be short-circuited with adjusting taps on the transformer would be required, or as an alternative the static booster. This condition was most favourable for the static booster and was the only case recommended by the speaker. It was necessary in dealing with a static booster to consider its position with reference to the transformer electrically. When converting from alternating current to direct current the low-tension side was the correct place, whereas converting direct current to alternating current the high-tension side was correct—*i.e.*,

Digitized by Google

whichever conversion was used it should be on the secondary side of the main transformer in order to obtain the highest efficiency. A rotary converter feeding a three-wire direct-current circuit with a booster on the low-tension side would require a six-phase booster, thus boosting equally each side of the six-phase neutral in order to obtain equal direct-current voltages from the middle wire to the outers. This necessity involved further expense and depreciated the value of the scheme still further as regards cost. The author had referred to the reluctance of manufacturers to include more than 30 per cent. reactance in transformers. The speaker agreed to a certain extent, but the higher values were not impossible. If higher reactances were going to assist the rotary converter designers in any way, they could have it, but at extra cost. Such a cost would not be excessive, and would compare favourably with external reactances having the same value. The efficiency also would compare favourably. The speaker had designed transformers embodying 45 per cent. reactance, and these transformers were now in commission and working satisfactorily. The high reactance increased the stray loss, but with scientific design this could be reduced to a minimum. Regarding the author's reference to comparative cost, was this on the converter alone or on the converter plus the transformer ?

Mr. J. S. Peck said one of the handicaps of the rotary converter was that the ratio between the alternating-current and the direct-current voltage was fixed within very close limits, so that if it was desired to vary the direct-current voltage it was necessary to vary the voltage impressed upon the slip-rings. There were several methods of doing this, and from the very first the reactance control method had been extensively adopted, but when it was desired to obtain a greater voltage range than was possible with reactance control, or where power factor control was required as well as voltage control, it was customary to use a method similar to that outlined by the author—*i.e.*, some form of step-by-step control. It was possible that the step-by-step regulator might again become popular on account of cheapness, and improved mechanical construction might make it entirely satisfactory. After the induction regulator came the synchronous booster due to Prof. Walker. This type of control came into use first in this country and then in America, and finally on the Continent, and rapidly superseded all other types. When the synchronous booster was first introduced, commutating poles were not generally used on rotary converters, and the difficulties which had since been encountered in connection with booster control had been largely due to the use of the commutating pole, as explained by the author. With the more extensive use of the commutating pole, the difficulty of obtaining proper commutation using a booster became more clearly recognised, and designers now hesitated to employ the booster except when special conditions made its use essential, but devices had been worked out which neutralised the effect of the booster on commutation. These devices, however, introduced complications which it was desirable to avoid whenever possible, but when the booster was essential it was always possible to make it operate satisfactorily. Careful study would show that reactance control would give perfectly satisfactory service in many places where previously it was thought that booster control was necessary. One point to be emphasised was that with reactance control the power factor of the rotary improved with increase in direct-current voltage, which in general meant that as the load increased the effect of the rotary was to improve more and more the power factor of the system.

Dr. Cramp, in a written communication, remarked that these converters are not used only in connection with sub-station distribution for large districts, but were also installed to supply individual factories. The author spoke of wattless current to the extent of 50 to 60 per cent. of the load current and omitted to take into consideration the very serious effects of such a condition upon the consumer's account. He should remember that in many large towns electricity was charged for upon a k.v.a. basis, and in consequence the purchaser had to pay for every ampere of wattless current whether this was lagging or leading. In such a case the control of power factor was of prime importance and it often paid to expend rather more capital to get control of the power factor rather than to use a converter with reactance control. Another point which was omitted altogether from the paper was the loss in the leads between the transformer and the converter. In the case, for instance, of a converter for 500 kw. and 250 continuous current volts, the distance between the transformer and the converter might easily be so great as to lose ½ per cent. or even more in efficiency at full load on unity power factor, and this would be considerably increased by the extra wattless current which the author admitted might be as much as 60 per cent. of the load current. For these reasons the table on page 11 of the paper was really only a true summary for sub-station conditions. For private plants in general it was more economical and satisfactory to adopt either a booster control or a motor converter. With reference to the comparison between the rotary converter and the motor converter the following figures, which were taken from estimates submitted a short time ago for 500-kw. 460-volt sets, were of interest. The machines were required to operate at voltages varying from 440 to 480 on the continuous side. Under these conditions the figures were as follows :—

420 volts.

Load	¼	...	½	...	¾	...	1	
Cos φ	55	...	80	...	90	...	95	Lagging.

480 volts.

Load	¼	...	½	...	¾	...	1	
Cos φ	55	...	80	...	90	...	95	Leading.

As against the above, the motor converter power factor only varied from 0·93 to unity over the same range of voltage and load. Such figures spoke for themselves and formed a sharp contrast to the statement made by the author. With regard to the comparative efficiency of rotary converters with reactance and transformers as compared with motor converters, the speaker had generally found that in the maker's estimates there was about 1 per cent. difference at full load, but as already pointed out, this might easily be absorbed in the connections to the rotary, especially when heavy wattless currents are being made use of for reactance control.

The Author, in reply to Prof. Walker, said the Paper had been prepared for designers and the average engineer, and was not primarily intended for third-year students. Regarding shop terms, these were used in the Paper as generally understood by engineers. Prof. Walker had referred to the paralleling of several machines, some of which had straight line reactance and some saturated reactance. This point was referred to in the Paper, but not very fully, and, as pointed out by Prof. Walker, it was of considerable importance when installing plant. Mr. Frith thought the Paper would have been more complete with a reference to motor converters. This would have been so, but the title of the Paper clearly stated that it dealt with rotary converters. If such a comparison were made as suggested the rotary would certainly justify itself. Regarding leading and lagging currents there did not appear to be any room for doubt as to their relation to line or rotary. The treatment of the subject from a magnetic standpoint appeared very attractive, but in the author's opinion it would present considerable difficulties ; for example, how would a wattless current be represented when there was no charge in flux ? Replying to Mr. Ellis, transformers of all classes were looked upon as so reliable that all questions of breakdown were of minor importance. The question of primary voltage was undoubtedly of considerable importance ; on the other hand, in America, voltage transformers were used with magnetic shunts. Mr. Ellis had also referred to the booster transformer as a source of weakness and being delicate to control. There were no grounds for fear on this point, particularly with the scheme using a large number of steps. Mr. Thompson had dealt with the position of the booster transformer in relation to efficiency. It was natural to want the maximum out of a given amount of material, but there was the question of the amount of reactance which could be embodied in the transformer. In this matter and also in the case of magnetic shunts there seemed to exist a slight difference of opinion. The costs referred to in the Paper were in terms of the rotary converter alone and did not include the transformer. Mr. Peck's remarks regarding the voltage regulation of converters were exceedingly interesting, and it appeared that the difficulties in connection with the booster converter were becoming more clearly appreciated by engineers.

CHARACTERISTICS OF IRON IN HIGH-FREQUENCY MAGNETIC FIELDS.*

BY R. BOWN.

Not many years ago it was quite generally believed that iron was unable to follow rapid magnetic changes. Experiments which showed an apparent decrease in the permeability of the iron with an increase in the frequency of the magnetic cycle furnished a basis for a theory that iron was magnetically sluggish. Further and more accurate experiments proved, however, that the effects which had previously been ascribed to a peculiarity of the material were in reality caused by eddy currents in the sample. Theoretical calculations were made which demonstrated that eddy currents in an iron test piece increased as the square of the frequency and that for even the lower frequencies it was necessary to use quite thin laminations in magnetic circuits in order to eliminate deleterious effects. Furthermore, it was found that owing to eddy currents and the magnetic properties of iron, the magnetisation in high frequency fields was confined to a thin surface layer of the piece. This "magnetic skin effect" reduced the cross section of the iron which was magnetically active even though the laminations were extremely thin. Careful experimental measurements compared with theoretical calculations proved that the real permeability of iron remained unchanged at frequencies up to about 10^6 and that previous results had been in serious error due to neglect of the factors mentioned. This fact having been established, efforts were made to see what practical use could be made of iron in high-frequency work, and to that end some extensive experimental investigations of the saturation curves and core losses were made upon specimens laminated as thinly as was commercially practicable. The resulting data have furnished a basis for design.

It is a demonstrated fact that the permeability of all metals is unity for the magnetic cycles imposed upon them by heat and light waves. In the region between frequencies of about 10^6, where the true permeability of iron is practically the same as at zero frequency, and frequencies of about 10^{10} where the true permeability of iron approaches unity, the experimental values of μ decrease smoothly with the frequency. What happens to μ in the range of frequencies between the longest heat waves and the shortest Hertzian waves which have yet been made is a question which has many interesting features but which has not yet yielded to the experimenter.

* Abstract of a Paper in the "Journal" of the Franklin Institute.

Digitized by Google

The Electrician.
FRIDAY, APRIL 20th, 1917.
Editorial and Publishing Offices:—
1, 2 & 3, SALISBURY COURT, FLEET STREET, LONDON, E.C. 4.
Telephone: City 4698-9. Telegrams: "Electrician Newspaper London."

A QUESTION FOR THE BOARD OF TRADE COMMITTEE.

The subject of wayleaves, which was raised by Mr. C. Vernier before the Institution of Electrical Engineers last week, is not actually an engineering question, but it is, nevertheless, one of great importance to those who are responsible for public services, such as electricity supply. This is particularly the case in rural districts, where overhead lines are one of the features of a power scheme.

We suppose it is a natural characteristic of the inhabitants of a free country to object to interference in any way with their property. Consequently, when the suggestion is made that an overhead line should be run across the field of some particular citizen he objects strongly to any such procedure; the pasture land was not acquired by him for such a purpose, and the power company, so long as it is not supplying power to him, may take another route by someone else's property. On the other hand, if the company still desires a wayleave, a good price must be paid for the favour that is conferred. We can quite understand this frame of mind, which is largely due to lack of knowledge and to lack of appreciation of the fact that the power company is doing something of general utility. This excuse, however, cannot be urged equally by a local authority. Presumably, every councillor has some knowledge of what is being done in his neighbourhood and of the advantages of electric power. It is, therefore, not so easy to understand why objection should be raised by a local authority; but, nevertheless, obstruction is only too frequently caused by municipal councils. This state of mind may be due to the long-standing idea that a company is created for the purpose of making money, and thereby robbing the public for the benefit of the shareholder, and that if any concessions are made which render the work less costly the advantage so given merely means more money in the pocket of the shareholder. We need not proceed to controvert this idea, and to show that the prosperity of the shareholder is not incompatible with the public good.

Mr. Vernier gives some examples of intolerable delay when the consent of local authorities has been asked. In two of these cases nine months elapsed before consent was finally given. It should surely be evident to any Council that delays of this kind are not merely harmful to the company concerned, but also annoying to those whom the company is trying to serve, and who suffer loss through not being able to obtain the power they require.

In some cases it is stipulated as the price of "consent" that the line is to be taken underground if a road or footpath is to be crossed; in other words, those giving the consent take it upon themselves to decide that an overhead crossing is not safe for the public, although stringent safeguards have already been laid down by the Board of Trade for this purpose. In the discussion on Mr. Vernier's Paper a case was mentioned in which it was stipulated that the overhead wire must be covered with insulation!

In 1912 the Land Enquiry Committee mentioned the question of wayleaves in their report, and made recommendations that a Government department should have the power to make an order for the compulsory acquisition of wayleaves for any purpose; but so far nothing has been done, and during the last three years the war has necessarily interfered with rearrangements of this kind. Mr. Vernier, lays down some suggested means of dealing with the matter, and we think his suggestions might well form the basis of definite action. It is ridiculous that private individuals or local authorities should have the power to stop or impede progress in this country. In regard to local authorities, not only has this been noticeable in their dealings with private enterprise, but also in dealing with each other. Thus, the London County Council found difficulty in completing their tramway system on this account, and it is often noticeable that local authorities will not work in with one another.

Under present conditions, we find the non-statutory company in some respects better placed than the company with statutory powers, and that progress for the power company is much more easy in the United States, India, Switzerland and Italy than it is in Great Britain. We hope that the whole question will be taken up by the Committee recently appointed by the Board of Trade to deal with electricity supply, and that the present antiquated restrictions will soon be eliminated.

REVIEWS.

Discovery: or the Spirit and Service of Science. By R. A. Gregory. (London: Macmillan & Co., Ltd.) Pp. viii.+340. 5s. net.

This eminently readable book by one who, by his writings, shows that scientific inquiry is worth while for its own sake, can be recommended to readers of every class. Those who have discovered that we owe our existence to applied science would do well to turn to the biographical index and count the names which are familiar to them. By so doing they will see that in the main the great men of the centuries have lived in obscurity, while the honours have for the most part been showered upon those conspicuous for everything but talent.

Although "discovery" is not peculiar to engineering one would nevertheless like to see mentioned the names of some of the great engineers. Every telephonist would name Pupin as worthy of a place. Electrical engineers would suggest Tesla and Hopkinson. Railway men would wish to include Westinghouse. Mechanical engineers would unquestionably vote for Whitworth. Civil engineers would nominate a few candidates worthy of a position, as also would the textile manufacturers. But no individual is competent to prepare such a list, and as it stands the biographical index is a most useful one.

With many of our leading scientists engaged in straightening out the muddle into which the country has been placed by her politicians, we think that the moral of the following is worth taking to heart:—

Lecky, in the introduction to his "Democracy and Liberty," says that the whole great field of modern scientific discovery seemed out of the range of even such a scholar and statesman as Mr. Gladstone, and that when Faraday was endeavouring to explain to Gladstone and several others an important new discovery in science, Gladstone's only commentary was, "But, after all, what use is it?" "Why, sir," replied Faraday, "there is every probability that you will soon be able to tax it!"

Prof. Gregory's book abounds with such stories, and they lead one to the conclusion that before the importance of science is recognised by the community, the scientists will have to be represented in Parliament. This representation will be secured on the day when the manufacturer recognises the influence of science on industry. The book appears at the right time and deserves a wide circulation.

Digitized by Google

SOME DETAILS OF WESTINGHOUSE STEAM TURBINES.

In the Westinghouse steam turbine the high-pressure stage consists of a velocity compounded wheel on the impulse principle. This requires steam at high velocity. For the low-pressure end, stages requiring a lower steam speed are used. For this purpose the Rateau impulse wheel is suitable, as with the Rateau blading the steam speed need be only about one-half that required for the velocity compounded element. At the same time the clearance may be made amply large, since no expansion takes place in the moving blades.

The distribution of pressure, temperature and velocity is shown in Fig. 1. It will be seen that the velocity wheel is very desirable, in

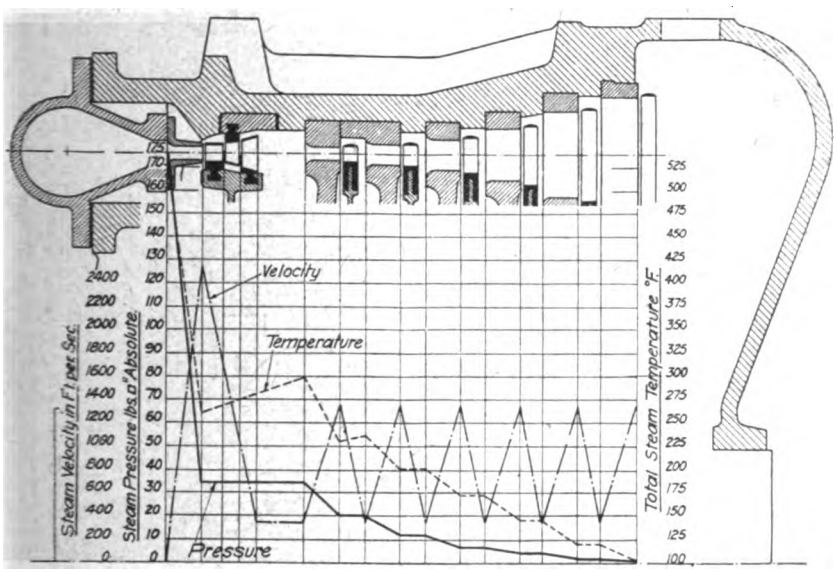


Fig. 1.—Half-longitudinal Section showing Pressure, Temperature and Velocity in the various stages.

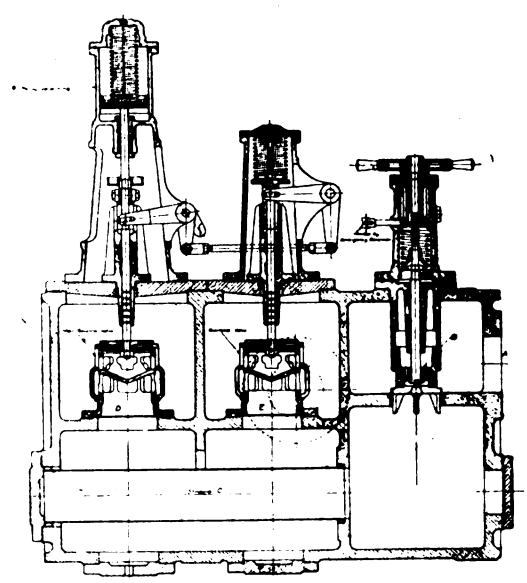
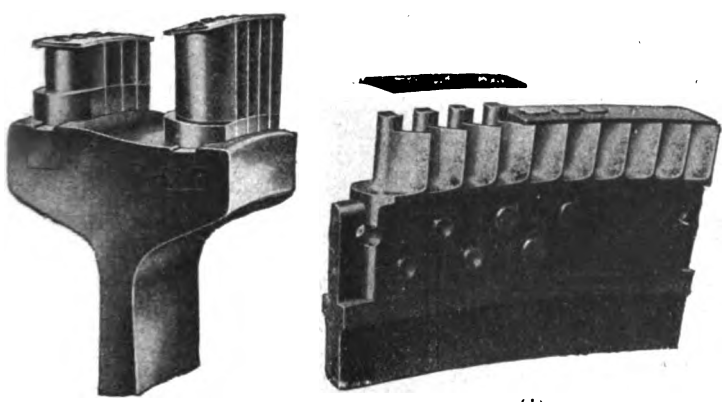


Fig. 3.—Section through Steam Chest for Large Turbine.

that the steam pressure is reduced to 35 lb. per square inch absolute and the temperature to 265°F. before being admitted to the cylinder proper. With the pure Rateau type of machine these figures would be 85 lb. and 415 deg. respectively.

A high-pressure turbine is shown in Fig. 5. Here *m* is the velocity wheel. As already seen, the temperature of the steam inside the cylinder is reduced to litttle more than half its total temperature at the stop valve. The heat value of the steam is converted into work in expanding through the nozzles. After the steam leaves the velocity wheel its expansion is continued in single stages until the



(*a*) (*b*)

Fig. 2.—Showing Methods of Fixing Blades.

exhaust pressure is reached. Each of these stages consist of a diaphragm fixed in the cylinder and a moving wheel on the shaft. The velocity of the steam by expanding through the diaphragm nozzles is completely used up on the moving wheel. The nozzle blocks shown at *e* are generally three in number, one will take up to half-load, two up to full-load and the third is for overload or running non-condensing. Two of these nozzle blocks are generally arranged in such a manner that they may be cut out if desired, when running on small loads for a long time.

The high-pressure nozzles are built up of special forged-steel, machined all over to ensure accuracy. The diaphragms are made of either cast-steel or cast-iron, depending upon circumstances. They are in halves, and provided with spigot and socket joints to prevent leakage of steam from one side of the diaphragm to the other. The split diaphragm gives ready accessibility in examination.

In order to obtain the most perfect type of blade, each one is machined out of the solid bar, each curve being given by a former or matrix fixed to the machine. Two methods of fixing the blades to the wheels are adopted. These are illustrated as (*a*) and (*b*), Fig. 2. The method shown at (*a*) is always adopted for the velocity wheel, as it is naturally more suitable for this than that shown at (*b*). The "Straddle" formation (*b*) is secured by means of rivets (in double shear); while (*a*) is a dovetail, the portion of the blade accurately fitting the groove formed in the periphery of the wheel, which is provided with two "ports" to allow of the blades being put into position. Each blade is finely finished and polished, to reduce skin-friction to a minimum.

The axial clearance between the blades and stationary parts varies from $\frac{1}{8}$ in. in the smaller to $\frac{1}{4}$ in. in the larger sizes, and the radial clearance between the tips of the revolving blades and the cylinders is never less than $\frac{1}{4}$ in.

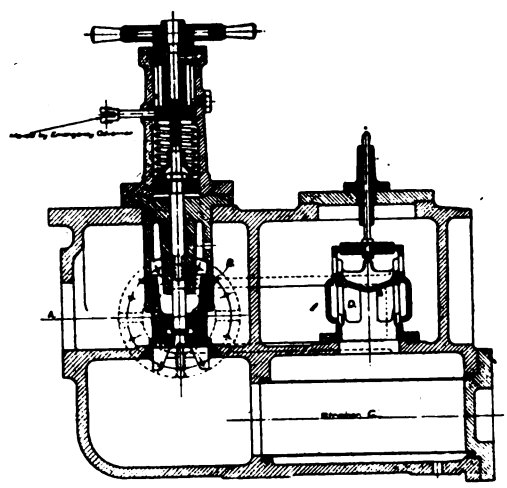


Fig. 4.—Section through Steam Chest for Small Turbine.

A common cause of loss of vacuum with some turbines is due to leakage of air past the glands. Fig. 6 (*b*) shows the arrangement of gland at the high pressure end of the Westinghouse turbine and (*a*) that at the low pressure end. In each case the Westinghouse water gland is used which provides an absolutely airtight seal between the inside and outside of the cylinder under all conditions of load and vacuum.

The water gland consists of an impeller with open curved vanes rotating in a race. The centrifugal force exerted on the water tends

Digitized by Google

to maintain an equal length of water leg on each side of the impeller, but the difference in pressure between the inside and outside of the cylinder forces a difference, *h*. It follows, then, that the centrifugal force on *h* is balanced by the pressure of the atmosphere due to the vacuum in the inside of the turbine casing. If the vacuum changes, the height *h* changes. Water is fed into this impeller race usually from a tank, placed about 20 ft. above the gland. As heat, due to friction, is generated, in this water, the latter boils off (due to the lower pressure on this side—*i.e.*, about 28 in. vacuum, with boiling point about 100°F.) into the inside of the turbine casing, where it mixes with the steam from the turbine, and passes with it to the condenser.

The low-pressure end has a gland of this type only (*a*), but the high-pressure end is somewhat modified as the pressure on the gland is considerably higher. This gland is shown at (*b*).

In this gland (*b*) there is also, in addition to the water gland, a labyrinth gland, which is interposed between the high-pressure chamber (where there is usually about 20 lb. gauge on full-load) and the water gland. The leakage past the labyrinth packing is very small indeed, and is led by a pipe into the exhaust space at the end of the cylinder.

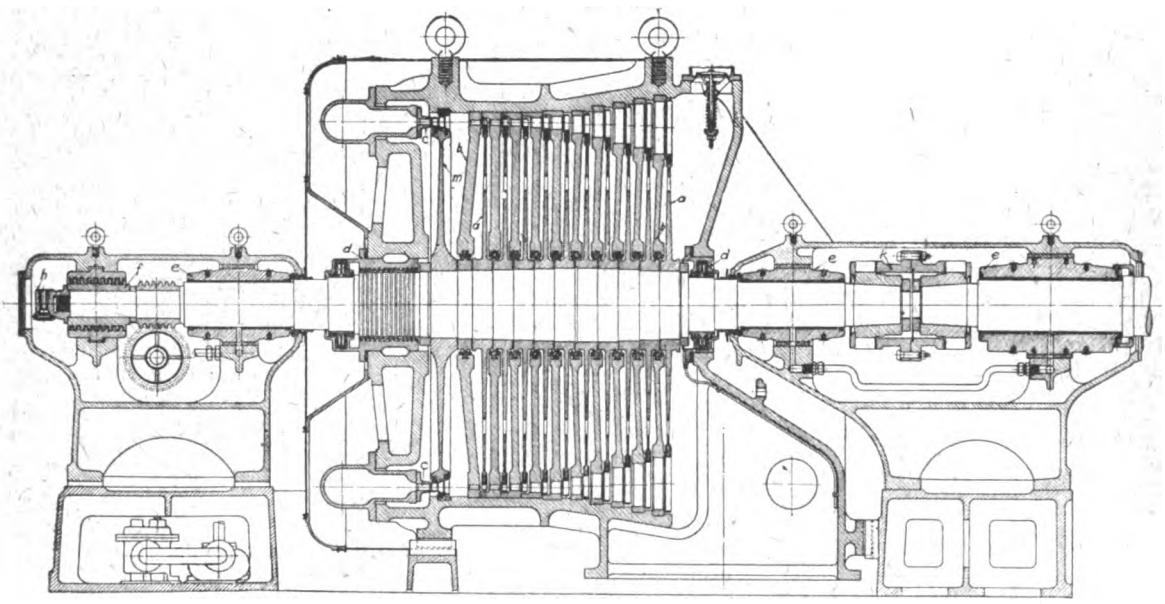
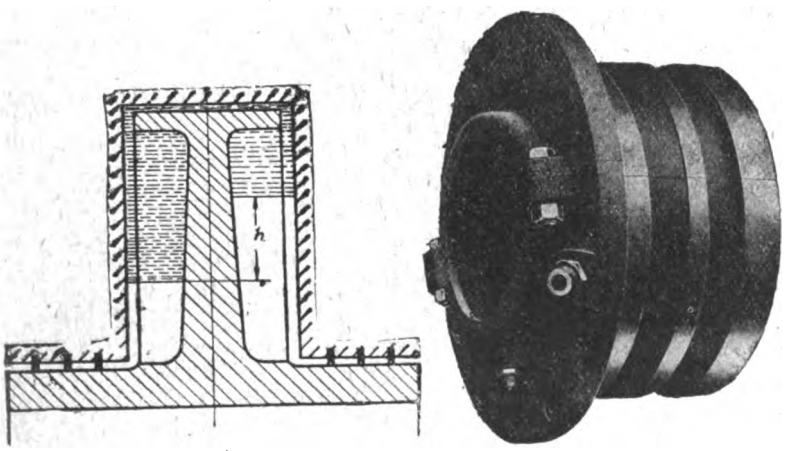


Fig. 5.—Longitudinal Section through High-pressure Westinghouse-Rateau Impulse Turbine.



(*a*) Low-pressure Gland. (*b*) High-pressure Gland.

Fig. 6.—Details of Glands.

The water glands at each end of the cylinder are therefore under exactly the same pressure conditions. Important advantages of these glands are—that they are absolutely air-tight, the bearings are kept cool instead of being heated, no steam escapes into the engine room, and the conditions of operation are not upset by change of steam pressure or vacuum, as is the case with steam-packed glands.

The steam chest is shown in Figs. 3 and 4. A piston operated by oil under pressure controls both the governor valve and the overload valve through a relay. The steam pipe is coupled up at *A*, so that the stop valve *B* controls all steam taken into the turbine. This stop valve is of the balanced type, and is provided with a pilot valve for warming up. This standard design of stop valve has been found perfectly satisfactory after many years' experience. The strainer *C*, through which the steam next flows, consists of a perforated steel cylinder, the steam passing through the perforations to the main governor valve *D*. *E* is the automatic overload valve. Both valves are generally of the same type and size, and interchangeable, so that a spare valve is good for either position. They are of the well-known balanced double-seated engine type, fitted with self-aligning plates, so as to leave them perfectly free on their seats. They are very accessible, both *D* and *E* being held on their seats by a single keep-ring in the upper chamber. Steam from the valve *D*, admitted on the throttle principle, flows direct into the turbine. The overload valve *E* is so arranged that it remains closed until the governor, having sufficiently opened *D* to enable the steam passing to carry full load, begins to lift *H* for further load. The valve rods pass through long frictionless glands. Pipes carry the steam from the valves *D* and *E* to the nozzle boxes or cylinder.

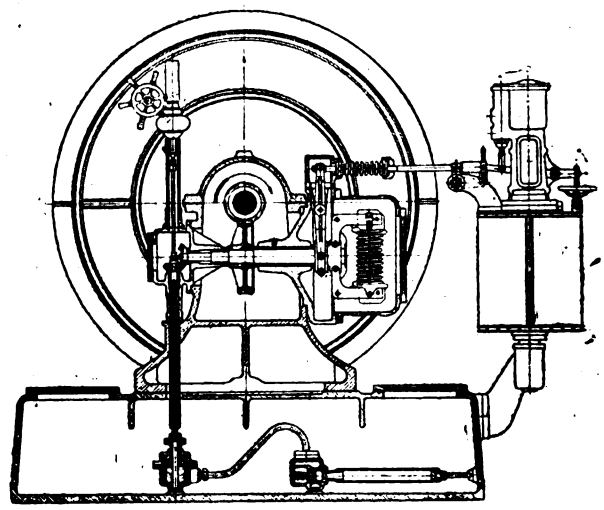


Fig. 7.—Cross-section through Main Governor and Oil Pump.

The Westinghouse steam chest for the smaller sizes (say, up to 1,000 kw.) is shown in Fig. 4. In this case the overload valve on the cylinder is opened by hand. It is not possible for the steam chest or the cylinder to exert any pressure, due to expansion, the one on the other.

The governor, Fig. 8, is specially designed to respond quickly to small variations in the speed of the turbine, while at the same time the parts are of a simple yet robust design. Practically no stress is

Digitized by Google

thrown upon the pins or points as the centrifugal force of the weights is opposed by the springs without the intervention of links or joints. The ends of the springs are threaded through thimbles, so allowing a nice adjustment to be made.

The direct connection by link gear between the governor and governor valves is shown in Fig. 7, and is characterised by simplicity. A speeder spring enables the speed of the turbine to be changed 5 per cent. above or below the normal whilst running.

All Westinghouse turbines are provided with an overspeed device which automatically prevents any injury to either the turbine or the

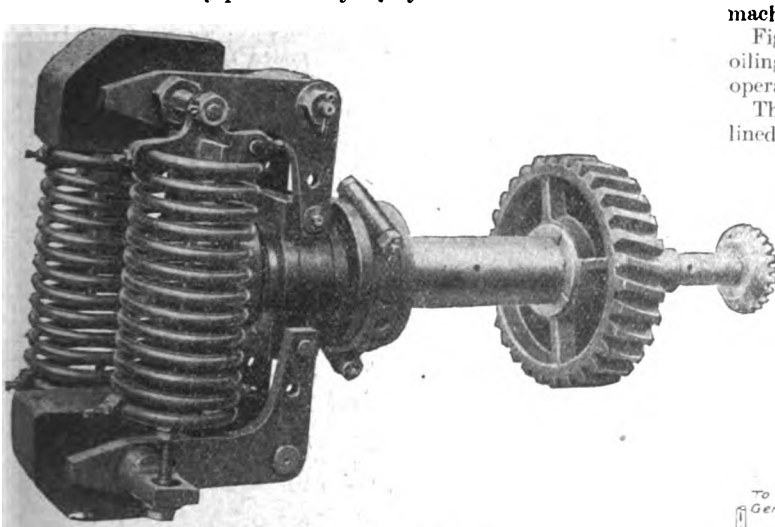


Fig. 8.—Turbine Governor.

generator, in case an accident should have rendered the main governor valve inoperative, thus causing the turbine to exceed its normal speed. Fig. 9 shows a section through this safety governor which is fitted on the end of the main spindle. It consists of an unstable governor in which the weight, having its centre of gravity a small distance from the centre of rotation, is opposed by a spring of such a strength that the force exerted by it is less than the increase in centrifugal force due to the weight moving further from the centre of rotation. Since this form is culminative, immediately the weight begins to move, it flies out to its limit. This brings the rounded end

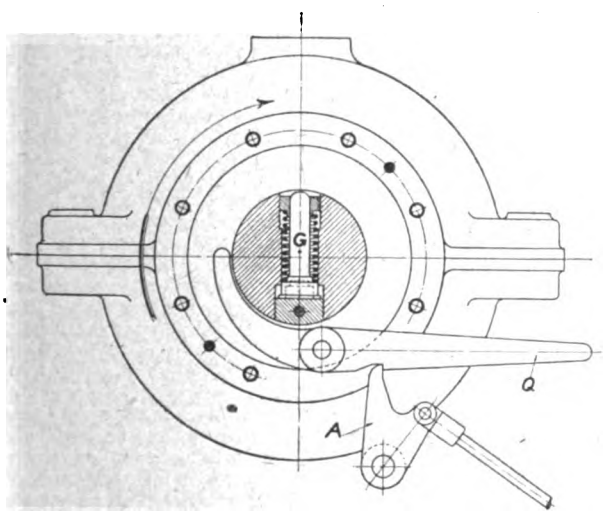


Fig. 9.—Section through Emergency Governor, showing Plunger and Trip Gear.

of the weight into contact with the trigger slipping the catch *A*, so closing immediately the automatic stop valve in the steam chest already described.

The lubrication of the complete set is carried out automatically, the oil being delivered under pressure to all the main bearings and to the various parts of the governor. The small oil pump shown in the bedplate in Fig. 7 is normally drowned and draws its oil through a strainer. It then delivers, through the cooler, to the various bearings, from whence oil returns by gravity again to the tank. The oil pump is of the geared rotary type, so simple as to be practically free from the possibility of breakdown, and the strainer is fitted in such a manner that it can be withdrawn for cleaning purposes while the turbine is running; a small wing type hand pump drawing through a separate small strainer is used until the main strainer is replaced. This auxiliary oil pump used is also for priming the piping and bearings prior to starting up.

The oil pump fitted in the oil tank at the end of the bedplate is operated by means of a vertical shaft and bevel gearing. This shaft is extended upwards and drives direct a tachometer registering the speed of the turbine. This tachometer is immediately in front of the driver, when he is standing at the steam chest, and paralleling the machine.

Fig. 10 shows diagrammatically the arrangement of the complete oiling system of a high-pressure turbine equipped with oil relay operated valve gear

The main bearings, usually made of cast-iron, are in halves and lined with high quality white metal. At each side and on the top

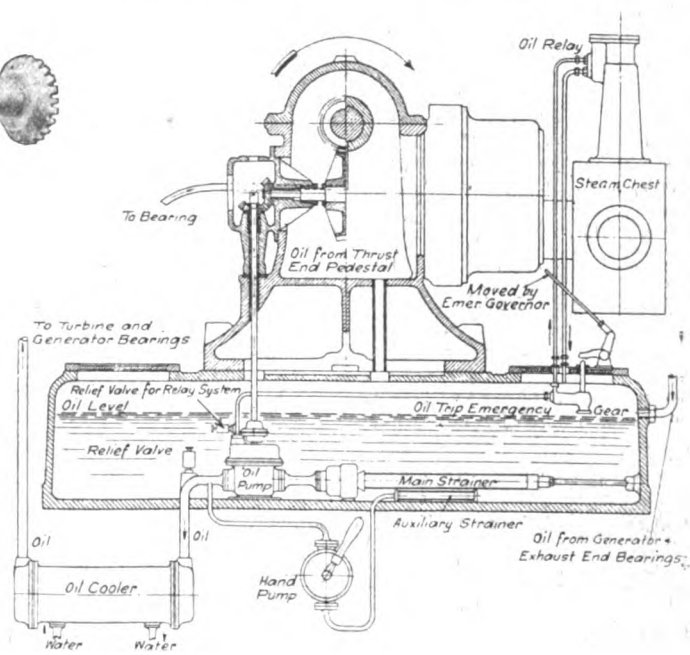


Fig. 10.—Arrangement of Oiling System of High-pressure Turbine.

and bottom a pad of steel is placed, under which is an assortment of liners of varying thickness, thus enabling the main spindle to be moved to a thousandth of an inch in any direction for lining up, or to take up wear. Special straddle gauges are supplied by means of which wear on the bearings can be ascertained at any time in a few minutes. The pads referred to are adapted to give the bearings spherical seating in their housings.

There is really no thrust on the turbine shaft, but some anchoring device is necessary to register properly the position of the shaft in relation to the cylinder, and since this takes the form of a thrust block it has been designated as such. As inadvertently moving this thrust block might wreck the turbine, it is rendered foolproof by locking it after adjustment in its correct position in the cylinder.

After having considerable experience with both rigid and flexible type couplings the British Westinghouse Company has found that the former is preferable for high speed and the latter for low-speed machines.

Notable Performance of a 25,000 kw. Turbo-Generator.—According to the "Engineer," the 25,000 kw. Parsons turbo-generator in the Fisk-street station of the Commonwealth Edison Co. was recently shut down after 77 consecutive days' continuous operation upon the system without interruption. During this time the unit generated 27·6 million kilowatt-hours, which is equivalent to an average of 14,930 kw. per hour during the run. The high load factor over such an extended period emphasises the economy that can be obtained by these large generating units in a modern power plant.

Digitized by Google

SOME POINTS IN CONNECTION WITH ENGINEERING SPECIFICATIONS.

The following is an account of a discussion which took place before the Manchester Local Section of the Institution of Electrical Engineers on Mr. J. Shepherd's Paper on the above subject :—

Mr. S. J. Watson referred to the importance of the author's remarks in regard to fuel, which, from the power station standpoint, represented the largest item in the account; special attention to detail admitted of economies which, although small as a percentage, amounted to a large sum in the course of a year. There were a number of difficulties in purchasing fuel on the calorific value basis. Although several collieries in the Lancashire district had been approached on many occasions, not one would enter into a contract for a supply on this basis. The manner in which fuel was usually brought was not fundamentally sound, and in this connection the author had mentioned moisture and ash losses. Regarding the moisture, the author's remark applied almost entirely to coal which was seaborne. The coal in the Lancashire district was mainly brought by rail, or to some extent by canal; therefore the conditions were not identical. The percentage moisture varied very considerably with the same quality of coal, particularly the "washed fuel" grade. In some cases this figure was about 15 per cent. Coal allowed to remain in railway trucks for some days during summer, for instance, would absorb 7 or 8 per cent. moisture, and this caused differences of opinion between purchaser and contractor. Regarding the grading of fuel on the basis of size, this had a considerable effect on the burning value, and he (the speaker) suggested that the specification should provide for dividing up the fuel into definite sizes, starting, say, with washed fuel at 1½ in. and going down to, say, ¾ in., or even smaller. The speaker endorsed the author's view in regard to ash when he stated that the quality of fuel even from the same colliery varied from wagon to wagon. Turning to the author's comments on laying cable conduits, undoubtedly for thickly populated districts with expensive excavations the "draw in" system was the correct one. In other cases, however, cables laid on the solid system would give better results. The case cited by the author where trouble was met until 14 ft. had been excavated was rather unusual, and any contract of such an extent as this should provide for special work. The author remarked that in a contract such as this it was found advantageous to select, or allow for, certain lengths of extra difficult work to be included in the total contract price, rather than to make provision outside the contract itself by means of a schedule. This was a very valuable suggestion, and worthy of consideration in framing future contracts.

Mr. G. E. Seaton said the best method of drawing up specifications was to define the conditions and results to be obtained, leaving the contractor to meet the requirements with standard products if and when suitable. The lengthy general conditions in some bulky specifications suggested that many engineers were not aware how simply a satisfactory result could be obtained. The author referred to the policy of accepting the lowest tender. Unfortunately, in municipal trading, this rule was more or less rigidly enforced, and adhesion to this policy had been responsible for very serious losses.

Mr. Robertson said he would have liked to have heard more about the methods of purchasing plant, and particularly about the tests to be applied to ensure conformity to specification. No engineer would attempt to issue working drawings or draft close specifications for such as turbo-generators, but it was essential to give a description of such plant and the nature of the tests to be applied in order to prevent misunderstanding. The old-time procedure in regard to the detail in specifications was not at all necessary nowadays. Whilst the speaker did not defend the biased conditions of contract issued by purchasers 10 or 15 years ago, he did not think that state of things justified the manufacturers getting out the B.E.M.A. conditions some four or five years ago. These latter conditions went to the other extreme, and caused a great deal of trouble, which had not been altogether removed by the conditions of contract put forward by the Institution of Electrical Engineers. So far as the speaker was aware, these conditions had not yet been accepted by the "Engineering Association." The author had stated: "If the engineer specifies the conditions and the results required and leaves the manufacturers to offer his standard designs the results will generally be satisfactory if the engineer is allowed to select as his contractor a firm of known excellence and of ripe experience." What was the object of advertising at all, especially in the case of a public body, if only firms of ripe experience were to be selected? If this practice were adopted each class of work would become confined to two or three firms, and the smaller firms would gradually be frozen out. As experience had already proved, such a condition would result in being tied to standard designs and standard prices. Regarding coal, those who had been purchasing coal during the past few years looked upon the idea of purchasing on a calorific basis as a vision quite unattainable at the present time. Engineers were glad to get coal without questioning calorific value or ash. The principle of purchasing on calorific basis was undoubtedly correct, but the market had to be properly educated to it. Some years ago the speaker purchased coal on this basis from about 16 pits, but in due course a coal agent arrived and offered to supply any quantity of coal from the same pits in certain proportions at 9d. per ton less than the colliery proprietor's agents offered, provided the calorific clause was dropped. The experiment was tried and found quite successful. This proved that severe conditions in the specification caused the collieries or agents to put a margin on the price to safeguard themselves. The author's remarks about pipe laying were quite correct, and the position of pipes should be recorded. Some 15 or 16 years ago a pipe system was laid down in a district adjoining Manchester, and in changing from low to high tension, recently, cables and wall boxes had been withdrawn of sufficient value to pay for the new high-tension and sub-station mains. This was mainly on account of the rise in residual values. It was not desirable to give public work on contract where the local authority was also the supply authority. It would probably pay in every case to engage a sufficient number of workmen or call in help from other departments. There was an unknown risk which the contractor had to cover when pricing his tender. With a system of measurement such as indicated by the author it meant constant supervision and checking, and even then disputes arose. The author appeared to have been rather unfortunate with switchgear, as to have to re-build low-tension panels within six months was rather above the rule even under severe conditions. There was still plenty of room for co-operation between purchaser and manufacturer—at least, in standardising ideas. No one wanted to stifle initiative or to keep ideas from being brought into practice, but when in recent tenders two firms quoted respectively 2 in. and 6 in. clearance between live parts and framework on a 6,600-volt system there appeared room for standardisation.

Mr. S. Ferguson said a manufacturer should not be required to read through a lot of superfluous matter when preparing a tender. General conditions, for example, should be standardised on the lines laid down by the Institution of Electrical Engineers, thereby obviating the necessity of special attention. An important point in these conditions was the "terms of payment." Municipalities would help manufacturers considerably if they deleted the 10 per cent. retention money on small contracts, say less than £500. A manufacturer doing a big turnover in relation to his capital could very quickly have a large portion of his capital locked up in retention money. It was interesting to note that for quite large Government contracts for plant, full payment had been made after final test. Regarding the technical requirements, switchboard specifications should be either (*a*) complete in every detail, including drawings or diagrams, or (*b*) a bald statement as to the plant to be controlled, leaving the manufacturer to offer the most suitable gear. With the latter arrangement it was somewhat difficult for the purchaser to compare tenders, but the method was better than an incomplete specification capable of misinterpretation. An important item sometimes omitted from specifications was the current density in current-carrying apparatus, and as different manufacturers offered different current densities the tenders were not comparable. Specifications for oil-break switches rarely specified the inherent reactance of the plant to be controlled, and this was a vital matter. Reactances varied from 2½ to 15 per cent., which meant that the duty imposed upon the former switch was six times that on the latter for the same size of plant. The system of inviting tenders as outlined by the author was not liked by manufacturers on account of the fact that standard apparatus was not usually suitable, the design of the purchaser having to be adopted. This demanded special tools, and, furthermore, it was quite conceivable that purchasers' designs would not take advantage of the progress being continually made. A better plan, believed to have been adopted by the London County Council in the case of circuit-breakers, was for the purchasers to specify a standard type of apparatus in connection with which the manufacturer would from time to time embody improvements without destroying interchangeability. Government inquiries for switchgear called for magnetic blow-out circuit-breakers and knife switches without hinged contacts. Both these requirements had been abandoned by leading manufacturers. The author appeared to have had considerable trouble with switchgear in the early stages. Were the magnetic blow-outs finally deleted in sub-stations? Regarding the bill of quantities, this was very rarely included in present-day specifications. One difficulty experienced was to avoid misunderstanding of the item embodying sundry apparatus, otherwise difficulty arose if quantities had to be increased or decreased.

Mr. H. Kidd supported the desirability of all tenders being brought to a common basis. There was, however, in many cases a preference for an intermediate course between the purchaser specifying in detail and simply asking for results. If carefully drawn up, intermediate type specifications would obviate a tremendous amount of correspondence by giving the contractor details of conditions affecting the scheme. The guarantees should also be clearly stated. Purchasers should specify that curves showing effect of variation of such matters as steam pressure, vacuum, &c., in the case of turbines, temperature and humidity of atmosphere in the case of cooling towers, be submitted with tender, otherwise the guaranteed result could not be checked. The method of test should also be specified. Regarding erection, this was a vexed question, and trouble frequently arose from insufficient information as to accessibility of site, use of tackle, builders' work, &c. Pipe work and supports were matters for which the purchaser should take full responsibility. The general arrangement and principal dimensions of sub-station switchgear should certainly be standardised, otherwise considerable difficulty would be encountered. Other points to be specified by purchasers were limits of current density and temperature rise, performance of transformers and power factors of motors. Attention should be drawn to the B.E.S.C. specifications, which were of extreme value to those drafting many and varied specifications. A more general adherence to these publications would benefit both purchaser and contractor.

Digitized by Google

Mr. J. Frith agreed with Mr. Robertson's criticism of the B.E.M.A. conditions, as they were certainly not to the advantage of the purchaser, and in the long run not to the advantage of the manufacturer. In the present state of the industry it was not always sufficient to state what was wanted and leave it to the manufacturer. The purchaser knew the local conditions which rendered certain methods of manufacture unsuitable, and in that case it was necessary to state both results and methods to be used in getting the results. In the specification for the purchase of coal it was not stated whether the higher or lower calorific value was used. The Institution of Civil Engineers had lately decided that the lower calorific value was to be used in power-plant testing, also the lower value shall be the higher calorific value minus 1,055 times the moisture plus nine times the hydrogen in each pound of coal. It was not stated how the figure 1,055 was arrived at, but it contained the latent heat and an allowance for heating the water to boiling point. A figure more suitable for arithmetical calculation might have been chosen. The meaning of the lower calorific value was not generally understood. It was an admission that the moisture in the flue gases should not be condensed. Taking the higher calorific value in working out thermal efficiencies was assuming that the plant might have condensed the moisture in the flue gases, which engineers were particularly careful not to do; hence the lower calorific value was used. Regarding the clause in the specification making the price of coal go down as the moisture went up, it would seem that the author would be equally pleased to buy 10 buckets of coal and pay for 10 as to buy nine and pay for nine, and then pay his men to throw a bucket of water on the fire. This was not scientific, though it might be sufficiently good for commercial use, and certainly had the merit of simplicity.

Mr. Shepherd, in reply, said it was an extraordinary thing that coal, of which there was an output of something like 300-million tons per annum in this country, was really the only mineral practically all sold without analysis. Regarding moisture, claims could be made against the coal dealer, but for every 6d. allowed the next tenders would cover it. Mr. Watson said the percentage moisture varied according to mode of transit. This was not so in the manner suggested, as coal conveyed by steamer showed a difference of 1 to 1½ per cent. after shipment, whereas the moisture in Yorkshire coal might be as high as 14 per cent. Regarding Mr. Seaton's view that the proper way to buy plant was to state views to the manufacturer and leave it to him to attain the desired result, engineers had their opinions on this point, and, whilst many turbines had been specified and sold in this way, the designer had not in every case acquired the knowledge to build reliable turbines. Mr. Robertson had raised the question of old-time methods of specifying. Those were days when there were many unknown factors, and it was necessary to feel the way. Regarding the choosing of manufacturers of ripe experience, if a certain firm was chosen it was necessary to pay that firm's price. If exact requirements were specified, experience had shown that tenders could be accepted from unknown firms, provided the shops were visited in order to ensure that they had the tools and tackle to handle the contract. Standardisation in switchgear, as in other engineering matters, was certainly desirable. In reply to Mr. Ferguson regarding retention money, it was quite equitable wherever there was maintenance to retain a small proportion, say 10 per cent., until the maintenance period expired. A point was raised about causing contractors trouble in making patterns and drawings. The contracts referred to never included less than two or three dozen articles. It might be the ideal method for the seller to supply standard articles, but if when buying switchgear, say, 20 times one received 20 different types and sizes, the matter had a different aspect. It was surely up to the customer to pay for what was demanded. Regarding Mr. Kidd's valuable remarks on general conditions, British trade in the future was not likely to be built upon large documents or even small documents like the B.E.M.A. conditions. It would have to be built on the system of trust and fair dealing, which had always been a criterion of British industry. Everyone would agree that the purchaser should get out his own pipes, otherwise there would be considerable trouble. The British Standard Specifications were all right up to a point, but they did not go far enough. The author agreed with Mr. Kidd as to the necessity of better standardisation of switchgear, but in the case of transformers this could not be done. Mr. Frith had criticised the coal specification, but it had worked successfully for 10 years. Referring to the table summarising the results of coal from various collieries, it would be observed that the water in the coal varied over wide limits. If the limit was fixed too low the purchaser would have to pay for it.

DISCUSSION AT THE SCOTTISH LOCAL SECTION.

Mr. A. Page said there was great need for engineers specifying thoroughly and exactly what they wanted. In connection with turbo-alternators, if they wished to get a proper air-pump to deal with so many pounds of air per minute or per hour they should state that the pump would deal with the air in such a way as to preserve a definite partial air pressure in the condenser. It was not often thay got steel fittings with a standard turbine on the high-pressure side for superheats. He thought it was a crime to use anything but steel. It was necessary to specify instruments to enable the engineer to get at the efficiency of the plant. If they did not specify the friction from the condenser they might get pumping plant taking twice the power necessary. In connection with starting-gear they should state exactly the kind of fittings they wanted. Similarly with alternator stator construction, the details requiring special attention should be specified in detail. Transformer oils were another case in point. In addition to the main points mentioned in the Paper there should be technical data, the inclusion of which would save time interviewing tenderers to ascertain exactly what was being offered. With regard to coal, this shou'd be purchased from pits of whose coal the purchaser had tests taken over a considerable period, the ultimate price being equated on a heat value basis. He did not agree that standardised switchgear was likely to lead to trouble.

Mr. Seddon thought that it was lamentable contractors and purchasers could not come to agreement with regard to general conditions. On the other hand, he thought that the exact specification of parts tended to impede engineering development. He preferred to specify results expected and leave it to the manufacturer to put forward his best proposition. Much of the loss in the engine room was due to the generator being so far away from the boiler and he thought the ideal would be to have the turbine on the top of the boiler and the generator through the wall out of the heat of the boiler-room, the condenser being immediately below the turbine.

Mr. Morgan said that to tell the contractor in detail what he was to do was to take all the responsibility off him in matters with regard to which he had generally the greater opportunity of finding what was the best method of doing certain things.

Mr. Macleod thought that Papers of this kind were to be commended on account of the breadth of their appeal. Properly drawn specifications protected both contractor and purchaser from infringement of patent rights. He was surprised that many engineers, while specifying carefully for capital items, did not treat consumable stores in a similar way. In the purchase of coal many engineers made the mistake of thinking that economy was effected by purchasing small coal. It often paid to buy large coal and crush it to one's own requirements. For rural areas he commended armoured cables laid direct in the ground in preference to the duct system referred to in the Paper.

Mr. J. M. M. Munro said he did not agree that the lowest tender should invariably be accepted. The ultimate choice should be left to the engineer. It was the man behind the specification that mattered. Unfortunately many local authorities having bought the score of a good musician were content to have the performance by the cheapest orchestra instead of leaving the choice of the performers to the author of the music who would also be the conductor.

Mr. Shepherd, in reply, said there were two axioms in the life of the engineer. One was never to use cast-iron with superheated steam and the other was to use nothing but mica as an insulation for generators. In specifying for large systems it was necessary to specify details in order to ensure satisfactory results. He did not agree with Mr. Seddon's remarks regarding the lay-out of the engine room. With efficient pipe covering the losses to which Mr. Seddon referred were negligible. With wide ranges of variation in percentages of moisture, small coal and calorific value he thought it was uneconomical to purchase coal at a fixed price.

CORRESPONDENCE.

THE BOARD OF TRADE COMMITTEE ON ELECTRICITY SUPPLY.

TO THE EDITORS OF THE ELECTRICIAN.

I think your editorial of March 30th puts the matter of the Board of Trade Committee very concisely. In 1915, in an address to the Institution of Engineers and Shipbuilders in Scotland, I stated that the whole of Scotland should not require more than three power stations, and from data which has been gathered by the Linking-up Committee in Scotland I have had this opinion confirmed. The present maximum demand on the 31 electricity supply concerns in Scotland is of the order of 120,000 kw.

The Committee on Electric Trades held several meetings in 1916, and they gathered a lot of information which should be useful to the Board of Trade Electric Power Committee. I think it will naturally follow that no units of less than 10,000 kw. will in future be installed in any generating station offering a public supply of electrical energy.

I think that joint ownership and bulk supplies will be part of the national policy in connection with electricity supplies to small townships and rural areas in future.

Glasgow, April 12. W. W. Lackie.

TO THE EDITORS OF THE ELECTRICIAN.

In your issue of March 30th you refer to the appointment of a Committee by the Board of Trade to consider and report upon what steps should be taken to secure a cheap supply of electric power in the United Kingdom.

It is very gratifying to learn that this is now being taken up by the Government, as there is no doubt whatever that the prosperity of the country in the coming years will depend very largely upon the development of the electric power supply upon proper lines.

Digitized by Google

The Board of Trade has been criticised for withholding the report of their previous Committee upon the electrical trade after the War, and already the composition of this new Committee is being commented upon.

I think this is a great mistake. The question referred to this new Committee is one that will require lengthy consideration, and it must be obvious that, considering the number of sections of the electrical industry that were under consideration by the previous Board of Trade Committee, this Committee could not have given sufficient consideration to each section to enable them to make a considered recommendation upon each. It is also obviously undesirable to publish what can be nothing more than an interim report. The question is surely large enough and important enough to justify our waiting until it has been thoroughly thrashed out and a considered opinion can be given.

Birmingham, April 13. R. A. Chattock.
City Electrical Engineer.

THE DECIMAL SYSTEM.

TO THE EDITORS OF THE ELECTRICIAN.

I have your letter of the 10th inst. asking my views as to the utilisation of the decimal system throughout.

Referring, first, to the decimal system generally, it seems to me the great argument is that there are no secondary operations to be carried out, as in the case of pounds, shillings and pence, or as in the case of electric machine design calculations, which are invariably made in the C.G.S. system of units and the results then translated into inches. Treating the matter more specifically, I may say that, like most English and American engineers, the fundamentals of my technical education were in terms of the English system of weights and measures. Later on, in electrical work, I found it impracticable to proceed with this system, and went on with the C.G.S. system so far as scientific and designing work was concerned, the results being in the final instance translated into the English system, which, of course, always involves an extra operation, and one more opportunity for error.

In carrying out engineering work on the Continent I have found the decimal system always preferable, and would never think of using the inch-pound system of units in connection with engineering calculations in any country where the metric system was the standard. Until one has worked with the metric system in all its branches the beautiful simplicity is not apparent. After one has become familiar with the decimal system, it is a most irksome task to come back to the inch-pound system, whereas going from the inch-pound system to the metric system I have always found a very simple operation.

Once manufacturers accepted the principle of the metric system, it appears to me a universal change would be more or less automatic without serious complication. Of course, most of the English text-books and hand-books are in terms of inches and pounds, and wholesale revision would become immediately necessary; but, having regard to the fact that the progress of science and engineering is now so rapid that any book is of little value after it is 12 months old, it does not appear that the change over from a literary point of view need be a very troublesome one. So far as the older standard books are concerned, once the metric system were adopted there need be very little complication, since the conversion factors are few and the process of conversion would become automatic more or less from habit and the frequency with which it would be made, since to day conversion from English units to metric units is not very frequently carried out by the majority of engineers.

I have at various times had experience in shops with drawings prepared on the metric system, and I found practically no confusion and practically no difficulty. My experience was that the foremen and men readily grasped the new system of measures, and I think on the whole rather preferred it to the fractional system.

I suppose there must be some good reason why manufacturers have not changed, since in America practically all the engineers make scientific calculations in the C.G.S. system. In a country where such great attention is paid to interchangeability and extreme accuracy of gauges, of course the change-over does involve considerable expense. There is also the fact that in important cases the metric dimensions are not commensurate with the inch system, so that parts made in exact measurements on the metric system would not interchange with parts made on the inch system. I am not in a position to state to what extent this obstacle would weigh in the minds of manufacturers. Speaking broadly, I am of the opinion that it is more a manufacturing question than an engineering one, since there is no particular hardship put on the engineer in converting his results from one system to the other, whereas in the case of the manufacturer there are important commercial considerations with which the engineer *per se* is not concerned.

London, April 16. H. F. Parshall.

TO THE EDITORS OF THE ELECTRICIAN.

Your notice of Mr. Allcock's Paper and the discussion which followed is likely to bring into prominence the subject of a decimal coinage system. It is now some months since I suggested a system which would consist of guineas, shillings, pence and farthings, in which a guinea would equal 1,000 farthings, and a shilling and a penny 100 and 10 farthings respectively, the farthings remaining at their present value, so that one guinea would equal £1. 0s. 10d. of our present money. The system suggested by Mr. Allcock has the disadvantage that it is not easy to convert small sums of old money into his proposed new money. Under the scheme suggested above, all that would be necessary would be to bring the old money to farthings. Suppose we read in the papers that the price of condenser tubes is 1s. 6¾d. This could be easily converted to read 0·075 guinea, 0·75 shilling, 7·5 pence or 75 farthings. It has been objected that this system would require four columns instead of three columns. My answer to that is that there would be less figures in the four columns than in the three. The columns for shillings, pence and farthings could be closer together, because only one figure could appear in either of them, and for the purpose of making them easily recognised might be separated by two faint lines. I give as an illustration of this £147. 10s. 7¾d. in the two systems:—

Present System.	Suggested New System.
£ s. d.	G. s. p. f.
147 10 7¾ ,	141 6 3 1

It seems quite apparent that the suggested new system requires less space, is much neater in appearance and simpler to work with. The letters at the head of the four columns seem to say—Good Systems Prevent Foolishness.

Under this scheme a U.S.A. dollar would equal exactly 0·2 guinea, 2 shillings, 20 pence and 200 farthings, provided the respective Governments could make the necessary arrangements to maintain the rate of exchange. This would surely be a good thing for the Anglo-Saxon race. I would like to see the U.S.A. change the name of their dollar, because it is essentially German in its origin, although, of course, we can hardly suggest it, in view of the statement of the President that they are not at war with the German people. Mr. Allcock's suggestion that we use the term mil in a new coinage system is, in my opinion, the limit in foolishness. Electrical engineers already use the term mil in expressing the thickness of cotton covering on wires for electrical purposes, and the term circular mil is used universally in U.S.A. as a unit of area. It is in my opinion a great mistake to have the same word meaning two entirely different units. That is why I suggest that the word pound should be omitted from our coinage system. With reference to his suggestion that centimetres should be used in place of inches, it is very important that it should be clearly stated what would happen to standard Whitworth bolts and British standard pipe threads.

Gateshead, April 12. W. Rogers.

TO THE EDITORS OF THE ELECTRICIAN.

I have read with very great interest the account you gave in your last issue of the lecture on the decimal system delivered

Digitized by Google

by Mr. Harry Allcock. I beg to add a small item to the discussion, namely, in case England should adopt the decimal system, would it be possible to adopt, at the same time, the comma (instead of the point) to separate the decimal part from the integer in a decimal number ?

I shall be pleased to have an authorised English opinion on that peculiar " point."

Paris, April 10. PIERRE BOSSU.

THE EDUCATION OF APPRENTICES.

TO THE EDITORS OF THE ELECTRICIAN.

Your leading article of April 6 and Mr. F. M. Denton's suggestions in the same issue are of peculiar interest to electrical instrument manufacturers, who are endeavouring to co-operate with the educational authorities to improve the facilities for the trade teaching of lads before commencing, and during, their apprenticeship.

You propose to withhold all technical teaching up to the age of 18 years, that is, during the period when boys' minds are most receptive, and would make it illegal for employers and education committees to teach the rising generation of artisans such subjects as drawing and mechanics. You propose instead that lads should be compelled to devote some 3,000 hours in the first four years of their apprenticeship to a preliminary course in school subjects and the study of the social, and other inexact, sciences.

While many employers realise the necessity for the instruction of their apprentices in the duties of a citizen (politics) and economics, a necessity due to the neglect of their natural instructors in such matters, the complete adoption of your proposals would probably be dangerous and detrimental. Boys entering the works are commonly handicapped by loose habits of thought and a tendency to form strong opinions on insufficient information; as a corrective, they need to be taught the laws of natural science. In a Government factory, where attendance at drawing and other trade classes during works hours was recently made compulsory, one of the lads refused to attend the classes although paid to do so; he stated that he had formed the opinion that he could do any job and therefore needed no instruction, and he maintained that his opinion was as good as that of the Controller. Few boys leave school with any idea that they have been preparing for, and are about to enter, the industrial struggle; many fail to realise that their success depends on habits of self-discipline, co-operation, self-denial, mental effort and strength of character. School life having required from them only about half of the effort made by public schoolboys of the last generation, boys enter a shop where the code of honour consists in getting the maximum pay for the minimum effort, and naturally drift into the habits of the crowd.

Mr. Denton, on the other hand, desires to substitute for works apprenticeship and tuition State education and maintenance for boys—from 14 to 18 years at a secondary school and from 18 to 21 years at a technical school. " The outlay would be great, but the investment good." He deplores the existence, in England, of a number of small firms—stumbling blocks to such a scheme and even to industrial progress. In America, he says, there is no precedent for little independent firms! Let me remind him that such firms are the back-bone of many industries at home and abroad; they are the principal training grounds for men of initiative and resource, and are often the inventors or introducers of new processes or articles of manufacture. One is apt to forget, when regarding a huge modern works, that they probably originated in the efforts of some worker, who, restive under the restrictions imposed by his fellows or his employer, took his courage in both hands and started a small firm. Most great manufacturing concerns originated by this " budding off " process, which is well illustrated in " Lives of English and American Tool Builders," and is active in most healthy industries. Small firms are not opposed to progress, though many might be averse to having all their future employees State-supported at schools until they become grown men, possibly unfitted for industrial life by lack of self-reliance.

The re-awakening of the spirit of industrial enterprise in this country, which your contributor in common with others, desires, must come about through the adoption, in school and factory, of a different attitude to life—by the strengthening of the national mental and moral fibre. Our present troubles are due, not to a multiplicity of small adventurous firms, nor to the lack of State-maintenance of our future workers during youth, but to the superabundance of " soft-jobbers " in all walks of life, the legacy of a long peace. Politicians and pedagogues have petted and pitied large sections of the people. The output per man in this country is now only half or one-third of that in countries like America, where industrial freedom and a sense of emulation among the workers prevail. One wonders what Turner, the artist (at whose death about 20,000 original art studies were found), would think of the " sadness of crowding into each long day, already ' filled ' with manual labour, three hours of mental effort."

Every baby boy born into the world is either a little " soft-jobber " or a little " hard-jobber "; before he is 18 he and his fellows usually know which. The " soft-jobber " seeks the maximum of personal comfort, security, leisure and amusement, for the minimum expenditure of physical and mental effort. The " hard-jobber " finds his greatest enjoyment in a strenuous career, in risking all on an experiment or adventure, in overcoming difficulties and in sacrificing present ease for a distant objective, often in the hope of leaving the rest of the world something to bless him for.

To overcome our present industrial deficiencies, Mr. Denton suggests that we should shake up our little comfortable men, look at the map and begin to realise our empire. I would add that boys should in future be taught by men of high ideals, with a full sense of their duty and of their responsibility for our industrial future and national security. " Soft-jobbers " should be, as occasions arise, eliminated from the teaching profession. Young boys should be given an interest in industrial affairs and production, by the aid of stimulating reading and picture lessons, supplemented by organised visits to industrial establishments and to notable engineering achievements. The distinction between the production of wealth and the art of transferring money from one person's pocket to another's should be explained simply, emphasis being laid on the honourable nature of productive employment; before leaving school the boy should be furnished with a few sound guiding principles for the conduct of life, and the value of initiative and resourcefulness should be inculcated. Industrial leaders would natural emerge from a generation of boys taught on these lines.

I believe it is by such means as these, supplemented by proper supervision, encouragement and tuition of apprentices in the works, that the industrial renaissance of this country can be secured.

London, April 10. ROBT. W. PAUL.

[This letter is commented upon in our Notes Columns.—EDS.]

I.E.E. NOMINATIONS.

TO THE EDITORS OF THE ELECTRICIAN.

With reference to the question of the election of Mr. C. H. Wordingham to the Presidency of the Institution, the nomination seems to be especially impolitic at the present moment. Mr. Wordingham is Engineer-in-Chief to a Government Department. Probably in the near future the Government Departments will be drafting new regulations dealing with one or other of the sections of the electrical industry, and it is quite conceivable that the industry may not always see eye to eye with the Government Departments. In such cases, how could Mr. Wordingham properly represent the industry ?

The institution ought to exist for the protection of the industry, and to elect as President a Government Official at the present time would be about as sensible as if a ratepayers' protection association chose as their chairman one of the clerks in the local rate collector's office. Would it not have been ridiculous for an Admiralty official to have headed the deputation representing the electricity supply industry, which a few days ago waited upon the Reserved Occupations Com-

Digitized by Google

mittee, as the present President did ? This would have meant that an Admiralty official would have taken the lead arguing points against the Admiralty and War Office representatives sitting on the other side of the table. If the new Board of Trade electrical committee have to be approached by the I.E.E., how could the President of the Board of Trade receive the paid official of another Government Department representing a critical and protesting deputation ? Now, more than at any other time, it is imperative that we should have a President unfettered by his official position who can be relied upon to do his utmost in support of our industry. To be placed in such an embarrassing position as Mr. Wordingham would have to occupy would obviously be unfair to Mr. Wordingham himself.

London, April 17. L. L. Robinson.

ELECTRICAL TRADES BENEVOLENT INSTITUTION.

The annual general meeting was held on Monday at the Institution of Civil Engineers, Mr. A. A. Campbell Swinton presiding. The accounts for 1916 showed income £943, including dividends on investments £260, income tax recoverable £67, subscriptions from members £150 and from annual subscribers £120 and donations £338. Grants paid were £64, printing, &c., cost £69, and secretary's salary, commissions and office expenses amounted to £144, leaving a balance of £695. The capital account stands at £9,080, of which £8,710 is invested.

The Chairman, in moving the adoption of the report and accounts, said the grants for the year were less in number and amount than in the previous year because there had been less unemployment, and that Institution had been extremely successful ever since the war commenced in finding employment for applicants.

He said that members' subscriptions increased from £93 to £150 for the year, dividends from investments were £307 (against £301). The Committee were anxious to increase the credit balance from £9,000 to £10,000 and he, believing the best way of getting people to move in that way was to set a personal example, had pleasure in handing the secretary (Mr. F. B. O. Hawes) a cheque for £100. The reduction of the year's income from £3,127 in 1914 to £760 in the past year was chiefly due to the fact that the Festival Dinner was not held. Also the Electrical Engineers' Ball was not held, though the Committee had generously supplied the Institution with some money out of the surplus funds. He regretted that Mr. Justus Eck, who had been Chairman of the Committee for many years and had worked hard in the interests of the Institution, had tendered his resignation.

Mr. W. B. Esson seconded the motion, congratulated the chairman on having become a Life Governor, and said they would doubtless be called upon to do a great deal of work immediately after the war. There were now eight Life Governors, and they would like to increase the number to 20 within a short time.

The Secretary said the finances were in a favourable state, although there was a drop in the receipts. Contributions from members had, however, increased from £93 to £150 and annual subscribers from £87 to £120 and donations (all in comparatively small sums) had gone from £284 to £338. He wished to emphasise the appeal made by the chairman in regard to increasing the invested funds up to £10,000 and he hoped the manufacturers, who were in a happy position at present, would help to do this.

The report and accounts were then adopted.

The Chairman moved the re-election of Mr. W. B. Esson, Mr. E. Garcke, Mr. T. E. Gatehouse, Mr. C. E. Hunter, Mr. W. Ratcliffe Small, Sir Ernest Spencer and Mr. A. A. Campbell Swinton and the election of Mr. George Sutton, if willing to be elected, and failing him Mr. Percy Rosling (of W. T. Henley's Telegraph Works Co.) as members of the Committee. He proposed Mr. Sutton (or Mr. Rosling) in the place of Mr. L. Thurnauer, who did not seek re-election in consequence of the small amount of attention he was able to give to the Institution's business.

The motion was carried, as were also votes of thanks to the hon. auditors (Messrs. Price, Waterhouse & Co.), the hon. solicitors (Messrs. Sugden & Hextall), the hon. secretary (Mr. Hawes), the Institutions of Electrical and Civil Engineers for the use of their halls, and Mr. Campbell Swinton for presiding, and the Chairman expressed the Institution's thanks to the Press for its assistance.

In moving the vote of thanks to Mr. Campbell Swinton, Mr. E. Garcke said he hoped the Chairman's appeal would have the desired effect. He (Mr. Garcke) would do everything in his power to attain that end.

Nottinghamshire Coal Carbonisation Scheme.—It is announced that a site of about 400 acres has been acquired near Nottingham by an influential syndicate, who intend to establish a low temperature coal carbonisation works, engineering and chemical works, and also electric power plant. It is hoped to be able to sell electric current at ½d. per unit.

LEGAL INTELLIGENCE.

Workmen's Compensation.

At York County Court last week Deputy Judge Meynell heard an application, by direction of the Court of Appeal, who had ordered a new trial, in which Messrs. Earle's Shipbuilding & Engineering Co. sought the termination or diminution of an award under the Workmen's Compensation Act to John Walker, a plater's helper, for the loss of an eye. The action was tried at the Hull County Court in September by Judge Fossett Lock, when a decision was given for Walker, against which applicants appealed.

For the company it was said that Walker was injured by a chip of metal on Oct. 13, 1915, and ultimately lost an eye. An agreement was entered into for the payment of 18s. 8d. during total incapacity. In September, 1916, application was heard for review, when Judge Fossett Lock interviewed the man in his (the Judge's) own room, and from what he found he dismissed the application.

For Walker it was said the only ground for the new trial was that the Judge interviewed the man in his private room, and the legal merits were not gone into.

Medical evidence was called for the applicant, and the foreman plater at Earle's Yard said he was prepared to undertake that if the man returned he should not be put into a dangerous place.

Mr. Pearlman (for respondent) said that there was an appreciable risk to the remaining eye by sending the man back to his work, and it was not unreasonable that he should object to take further risk.

His Honour held that no case had been made out for termination of the award, as the man had lost his eye, and the socket was still discharging. But he thought the man was capable of work, though not dangerous work, and he reduced the compensation to 10s. weekly.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 Specifications.

13,886 Heys (Neuland Patents, Ltd.) Dynamo-electric power transmission apparatus.

1916 Specifications.

1,418 Gimingham. Arc incandescent lamp for therapeutic and other purposes. (26/7/16.) 104,350.
Comprises pole pieces of tungsten or other highly refractory material enclosed in bulbs of silica containing nitrogen or other inert gas and being easy to open.

1,436 Pensuti. Device for controlling electric ignition in internal-combustion engines. (3/2/15.) 100,053.

1,550 McColl, A. E. Protective devices for alternating-current electric systems. (2/2/16. Cognate application, 10,227/16.) 104,518.
Controlling means for the protection of the sub-station or distributing end of two or more parallel feeders or circuits oh single-phase or polyphase alternating-current electric systems, wherein one element of each of several reverse-current relays is retained at relatively constant polarity by a pilot wire or wires carrying the sum of the currents from the secondaries of series transformers which are connected in parallel, the primary of each of said transformers being connected in circuit with one of said feeders or circuits at the end adjacent to the source of supply.

1,787 Davies, F. H. Form of junction box or sleeve for wire-armoured electrical cables. (7/2/16.) 104,520.

2,920 Stevens. Means of control of electromechanical transmissions for motor vehicles. (28/2/16.) (Cognate application, 3,331/16.) 104,370.

2,950 Mackenzie & Holland & Wood. Block instruments for railway signalling and like purposes. (28/2/16.) 104,371.

3,036 B.T.-H. Co. & Shuttleworth. Polyphase alternating electric current commutator machines. (29/2/16.) 104,378.
The invention consists in providing a pair of commutating poles spaced apart 180 electrical degrees for each phase, one of said commutating poles being excited, firstly, in accordance with the rotor current, so as to annul the reactance voltage in the short-circuited coil undergoing commutation; and, secondly, by the embracing exciting winding, so that the generated voltage annuls the induced voltage when phase rotation and mechanical rotation are in the same direction, the other of said commutating poles being adapted to be excited in accordance with the stator exciting current so as to annul the voltage generated and induced in the short-circuited coil when the phase rotation and mechanical rotation are in opposite directions.

3,087 Hirst & Brook. Electric motor controllers. (1/3/16.) 104,381.

3,165 Marconi's Wireless Telegraph Co. & Dowsett. Studs or electrodes of electric dischargers. (2/3/16.) 104,385.
Consists in forming the studs of dischargers used in the production of electric oscillations of two different materials, one of which is vaporised at a lower temperature than the other.

3,166 Marconi's Wireless Telegraph Co. & Dowsett. Aeroplanes fitted with wireless telegraph apparatus. (2/3/16.) 104,386.

3,204 Greer, W. M. (Reaks, H. G.) Automatic night tidal semaphores and tide recorders. (3/3/16.) 104,527.

3,230 B.T.-H. Co. (G.E. Co.) Electric motor driving mechanism for machines (3/3/16.) 104,390.

3,254 Wunsch. Electric potentiometers. (4/3/15.) 100,139.

3,255 Gillmor. (Sperry Gyroscope Co.) Voltage regulating systems for electrical circuits. (3/3/16.) 104,391.

3,346 Joel, H. F., & Mawdsley, J. H. St. H. Dynamo-electric machinery. (6/3/16.) 104,535.

3,726 Green. Manufacture of electrically welded link chains and cables. (13/3/16.) 104,397.

3,739 B.T.-H. Co. (G.E. Co.) Coil supports for electric apparatus such as transformers. (13/3/16.) 104,398.

3,795 Salmson, E. J. J. Contact apparatus for the electrical connection of magnetos. (14/3/16.) 104,553.

3,796 Salmson, E. J. J. Interrupting device for magnetos. (14/3/16.) 104,554.

3,976 British Insulated & Helsby Cables & Bayles. Electric cables. (17/3/16.) 104,401.
Consists in winding the conductors spirally on a rubber or like core, and in covering the core and cables with a sheathing of vulcanising rubber, after which the core and the sheathing are vulcanised together so as to embed the cables in position between them.

4,182 B.T.-H. Co. (G.E. Co.) Methods of and apparatus for shaping wire. (21/3/16.) 104,561.

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Motor Omnibuses or Light Railways. At the meeting of the Gloucestershire County Council on Monday the Highways Committee report laid stress upon the heavy damage to the roads by motor omnibus traffic, and the difficulties of maintaining the highways traversed by those vehicles.

The roads were being worn out by traffic which they were not intended to carry. The chairman (Sir Ashton Lister) considered that the roads should be widened and a small light railway should be laid by the side to carry traffic which was now being taken by motor omnibuses, and thus leave the roads free for the purposes for which they were constructed, instead of allowing them to be used as semi-railways. His idea was that the railways should be provided by the county and that they should either run the traffic itself and make a profit, or give a franchise to that class of people who at present were running the motor omnibuses. He pointed out that similar light railways were installed with much success in Belgium before the war.

* * * *

Co-operative Societies and Taxation. At the annual meeting of the National Chamber of Trade various questions relating to income tax, the excess profits duty, &c., were considered.

A motion was carried asking that all trading organisations now registered under industrial and provident societies should be registered under the Companies Acts and pay the same fees and taxes.

The Chamber also affirmed that the excess profits tax should be extended so as to include all earned incomes which had been increased owing to abnormal conditions arising out of the war.

The Parliamentary Committee brought up a resolution on the matter of registration of business names.

* * * *

Registration of Business Names. The Parliamentary Committee of the National Chamber of Trade, in a report on the Registration of Business Names Act, stated that some amendment of the original Act would be necessary.

It was pointed out that one set of the existing provisions was onerous and unnecessary, as it required the names of all partners to be inserted in trade catalogues, circulars and business letters. In one case twelve names had had to be printed and a firm established for a century had been required to comply with the condition.

At the annual meeting of the Chamber an amendment to the resolution of the Parliamentary Committee was carried. The amendment welcomed the Act, and approved of its provisions, "provided it is extended to include all private limited companies."

A further amendment to extend the provisions of sec. 18 of the Act to directors of limited companies, and that firms containing partners of alien origin be required to register, was referred to the Parliamentary Committee.

* * * *

Water Power of India. In the course of his evidence before the Industries Commission, Dr. A. Hay, of the Indian Institute of Science, recently suggested the advisability of making a full investigation of the possibilities of hydro-electric power, and urged the necessity of making a very complete survey of the available water-power of India.

Dr. Hay also recommended the establishment of a hydro-electric department if the Government proposed to start pioneer factories on a large scale. At the Cauvery Falls, Mysore, and at Bombay there are large hydro-electric plants and it is reported that water power is available in many other parts of the Empire, but a survey must be made and data collected before anything can be done.

* * * *

Workmen's Compensation Act Litigation. In connection with schemes for the development of trade and industry after the war, stress is rightly laid upon the necessity of improving the relations between capital and labour, and upon the desirability of friendly co-operation between employers and employés. It is obvious that there has been friction in the past, and any scheme or proposal for minimising or obviating this in future should receive consideration. We believe that one great cause of trouble with labour is the unnecessary and expensive litigation in connection with the administration of the Workmen's Compensation Acts. It is only necessary to look at some typical cases arising out of the 1906 Act to see that workmen's organisations must spend a good deal of time and money in looking after the interests of their members and in seeing that injured workmen get the compensation they are entitled to. If organised workers find it difficult sometimes to secure justice, those who do not belong to a trade union must find it still more so.

In this connection we would call attention to the case of Bower *v.* Meggitt, decided by the Court of Appeal on Dec. 20 last. It appears that a workman fell from a scaffold in a timber yard and injured his knee. In the circumstances there was no question as to his right to compensation under the 1906 Act. He went to a local hospital, where the real nature of his injury was not at first discovered, and where he received certain treatment which was not proper in the light of discoveries made later by the use of the X-rays. He subsequently claimed an award of compensation in the County Court. At the hearing it was contended for the employers that, although there was admittedly an accident entitling the claimant to compensation, his condition at the time was not due to the injury, but to improper treatment at the hospital. It was contended that if he had been properly treated the consequences of the accident would have been quickly removed and the compensation far less than that claimed. The judge decided that the applicant had not discharged the burden of proof that there had been no fresh intervening cause of incapacity, and that his present condition resulted from the accident and not from such intervening cause. On appeal by the claimant the Court of Appeal held that the workman had discharged the burden originally cast upon him of proving incapacity from work as a result of an injury by accident; that the burden lay upon the employers, and not upon the workman, to prove that there had been any fresh intervening cause of the existing incapacity. It was, therefore, for the employers to prove that if a different course had been adopted at the hospital a different state of things would have resulted, and they had not proved that. The workman was in the circumstances entitled to an award, and the appeal was allowed.

We consider the above decision to be both legally and equitably just, but it is probable that the workman and his friends will consider that he is suffering from a grievance, inasmuch as it should not have been necessary to go to the Court of Appeal before obtaining justice. Even if the improper medical treatment had been a fresh cause of the incapacity, it seems to us that it would have been very hard to have penalised the injured workman for something over which he had no control. Frequently, however, it is not the employers, but the insurance company, which is responsible for the litigation, and we know of cases which have been taken to the House of Lords on comparatively unimportant points.

Compensation is only payable when the injury is caused by "an accident arising out of and in the course of the employment," and this provision has resulted in much litigation, while some rather harsh decisions have been given upon it. Of late the Court of Appeal have given what we might term some "strict" judgments on this point. For instance, there was a case where a person who was allowed by her employers to provide herself with a bicycle in order to facilitate her work. She used the machine for some time, and she was injured on a journey while carrying out her employers' instructions. The Court of Appeal held that she did not come within the Act, and her claim for compensation was dismissed.

Another case of this character arose in Scotland (*see* Beattie *v.* Tough & Son, 1917, 1, S.L.T. 27). A girl who had been working at a machine in a factory had been replaced by another. The first mentioned girl subsequently returned to the machine, and endeavoured to help her fellow servant to remedy something out of order in the machine. While so doing her hand was caught and injured. The Court of Session held (on appeal) that she had been injured by accident arising out of the employment. The injured girl was not prohibited by any rule of the factory from doing what she had done, and, as one of the judges put it, "She was doing imprudently, but not disobediently, a thing not different in kind from what she might be required or expected to do," and although not able to plead a case of emergency and necessity, still she was intervening in furtherance of her employers' interest. This decision will be generally approved; but in the course of this case the following illustration from another leading case was given: "If a clerk sent with a message from his employers' office to the foreman, or if a man employed in the engine room had done what appellant did, that would be stepping out of the department in which they were employed, and could not, in my opinion, have brought them within the statute, but appellant was employed in the department in which the machine in question was worked, and had even been employed in working this very machine. It is therefore, I think, too narrow a view to take that she was not at the time of the accident in the course of her employment."

Litigation on other sections of the 1906 Act has brought to light many blemishes in the legislation concerning accidents to workmen, but we think that we have proved enough to show that an amendment of the Act is necessary. It should not be difficult to extend the scope of the law and to introduce a system of insurance against accidents to workers which would remove most of the existing grievances without throwing an undue burden upon industry. It should be to the advantage of capital to have satisfied workers, while the State would derive benefit by the greater security afforded by making accident insurance benefits more certain. Perhaps the Ministry of Labour may find time to consider the question in all its aspects, so that legislative proposals may be laid before Parliament after the war.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Barrow.—At the recent meeting of the Council, the chairman of the Electricity Committee (Ald. Smith) explained that the proposed expenditure on electricity extensions (£13,871) was part of the scheme outlined about a year ago and recently sanctioned.

The Ministry of Munitions did not sanction the whole of the extensions proposed, but they agreed that another water tube boiler and rotary converter were necessary, the cost being £4,221 for the boiler and £1,164 for the converter.

In reply to a question, he explained that the Committee proposed a contribution of £10 towards the cost of determining the question involved in the action Gas Light & Coke Co. *v.* Hackney Borough Council, which was of great importance to all municipal electricity undertakings.

The minutes were approved.

Birmingham.—At a special meeting of the Electric Supply Committee on Tuesday a report was received from Mr. C. P. Sparkes, president of the Institution of Electrical Engineers, on the Nechells permanent generating station.

In his report Mr. Sparkes dealt exhaustively with the advantages of the site in relation to coal supplies, water for condensing, &c. Briefly, Mr. Sparkes advised the Committee that the site was suitable for a permanent generating station, and expressed a favourable opinion on the designs of the engineer (Mr. R. A. Chattock), having regard to the time when it was drawn up and the progress of electrical science.

The Committee accepted the report and decided to proceed with the erection of the permanent station as soon as practicable.

Blackpool.—The Corporation has received from the L.G. Board sanction to borrow £13,871 for extensions of the electricity undertaking.

Chester.—The Corporation have approved the recommendation of the Electricity Committee to apply to the L.G. Board for sanction to borrow £11,500 for laying a cable of increased capacity to supply energy to Messrs. Brook, Hirst & Co. for construction of a sub-station, &c.

Croydon.—The Council recently authorised the extension of the electric supply mains at a cost of over £1,800.

Kilmarnock.—The Electric Supply Committee has recently accepted offers for the supply of additional plant, mains, extensions, &c., at a total cost of £46,000.

Wolverhampton.—The borough electrical engineer (Mr. S. T. Allen) has reported that extensions of the generating plant at the Commercial-road station are urgently required.

It is estimated that the total demand for next winter will be 12,150 kw., against a maximum of 7,250 kw. last winter. When the 5,000 kw. of plant now being erected is completed the plant capacity will be 15,000 kw., not including the battery which is capable of supplying 1,000 kw. for 3 hours at a time. Next winter there would only be 2,850 kw. of spare plant, consisting mainly of old reciprocating sets requiring twice as much coal per unit generated as the more modern plant. Mr. Allen states that during the last month or two there were definite inquiries from firms for supplies amounting altogether to 12,200 kw., and these alone would yield an estimated revenue of £120,000 per annum. An enormous amount of after-war work is being considered and firms are planning the erection of new works. Mr. Allen submits estimates for the purchase of a 5,000-kw. turbo-alternator with the necessary boiler plant, water cooling towers, &c., as follows:—New boiler house wing, including ferro-concrete coal bunkers, £5,000; two water tube boilers with fittings, mechanical stokers, fans and motors, £10,300; one conomiser and chimney, £1,300; boiler feed pump plant, £600; steam feed and blow-off piping, £1,000; ash removal plant, £3,000; engine-room building work (including extensions of new ferro-concrete crane gantry), £3,300; foundations, &c., for turbine set, £1,000; one 5,000 kw. turbo-alternator with condensing and auxiliary plant, steam and water pipes, &c., £23,500; flooring around turbo set, £250; water screening plant, ducts, &c., £750; water cooling towers, £7,000; pumps and piping for cooling towers, £2,000; e.h.t. switchgear and cables, £2,000, plus 10 per cent. for contingencies (£6,100), making a total of £67,100. This amount is £12,000 more than the estimate for the last 5,000 kw. of plant ordered, but provision of £7,000 is made for cooling towers.

The Electricity Committee, reporting upon Mr. Allen's statement, cite the case of Birmingham to show what may be lost through postponing necessary extensions of electricity plant. The Committee realise that the extra costs of material and labour are a small item compared to the revenue which would be lost through not having sufficient plant to deal with the ordinary demands, and the loss, not only to the Electricity Department by revenue, but also to the town generally, on account of the fact that after the war business would be transferred to other towns where supplies could be obtained. The Committee point out that nearly all the new supplies in Wolverhampton have been for works of a permanent nature, and that an enormous amount of general work in Wolverhampton has been suspended until after the war. They have, therefore, sanctioned the scheme of extensions as recommended by Mr. Allen, subject to the necessary Government consents being obtained.

On Monday the Council adopted the recommendations of the Electricity Committee to purchase 2,650 square yards of land adjoining the electricity works, together with canal basins, &c., from the Birmingham Canal Navigations, at 17s. 6d. per square yard, and to lay a h.t. cable to certain works at an estimated expenditure of £2,000.

The salary of Mr. C. Bellhouse, boiler house superintendent at the electricity works, has been increased from £180 to £230 per annum.

GENERAL.

Barnes.—The electrical engineer (Mr. C. S. Davidson) has reported on the question of obtaining a bulk supply of electricity from the London & South Western Railway Co., and he has been directed to make further inquiries.

Mr. Davidson has also reported that he has been looking into the question of installing furnaces suitable for dealing with coke breeze fuel, and he finds that some little economy could be effected by this class of fuel, provided the relative values remained constant. The cost of equipping a pair of small boilers would be £150, and if the guarantees were sustained there is little doubt that the cost of installing would be repaid on the economy effected in a short period. The committee recommended that this work be carried out, subject to a contract, the contract to provide sufficient guarantee as to the consumption of fuel, and also to provide that only one boiler should be equipped at first.

Londonderry.—At the last meeting of the Corporation the electrical engineer (Mr. R. V. M'Crory) reported on the question of the electric supply to the Foyle shipyard, and that no agreement as to the amount payable in respect of the future supply had been arrived at.

On the suggestion of the Mayor, an expert is to be called in to go into the whole question of tariffs, and also to report on the efficiency of the plant at the electric station. A small committee was also appointed for consultative purposes. It was explained that the question involved the installation of a new plant at an expenditure of £26,000. The shipyard would be the only consumers.

At the recent local inquiry into the application of the Corporation to spend £35,500 in extending the electric supply to the garden suburb, which was being erected outside the city boundary, it was stated that it was also proposed to give a supply to the shipyard owing to its rapid development and the installation of large additional machinery.

Richmond-on-Thames.—The Richmond (Surrey) Electric Light & Power Co. has asked the Council to sanction an increase in the charge for electric current, and negotiations are proceeding with regard to the matter.

Sheffield.—On the recommendation of the Electric Supply Committee the Corporation have granted an increase of wages to both the skilled and unskilled employees of the electricity department.

Southend-on-Sea.—In a report of the Electric Light and Tramways Committee it is pointed out that the profits of both undertakings have been considerable during the past five years, and that there is an urgent necessity for additional generating plant.

Walsall.—It was reported at the Council meeting on Monday that £2,000 was included in the general district rate in respect of the prospective loss on the electricity undertaking, but hopes were entertained that substantial compensation might be received from the Government for the commandeering of a new electric generating set.

LIGHTING AND INDUSTRIAL POWER.

Aberdeen.—It has been decided to give a supply of electric current to the Great North of Scotland Railway Co. on the same terms as last year. An application for a supply from the Donside Paper Mills is under consideration by a sub-committee.

Burton-on-Trent.—Last week the Gas and Electricity Committee reported that there was a very good increase in the electric power demand. The increase was about 32 per cent. over that of the corresponding period of 1916.

Carmarthen.—In connection with the dispute between the Carmarthen Electric Supply Co. and the Council as to the allowance to be made for unlighted lamps, a representative of the L.G. Board attended at Carmarthen on Feb. 15 and held an informal inquiry.

The Council claimed what the company considered an unreasonable amount in respect of lamps unlighted, and refused the company's offer. No decision has yet been arrived at.

Digitized by Google

Electric Furnaces in U.S.A.—It is reported that a Heroult electric furnace which has been operating at Duquesne (Pa.) for about six months can easily produce 30 tons of steel per heat, and is operating successfully. Many Heroult furnaces are now operating in the States, and recently there is a marked tendency to put in new ones.

Montrose.—The new agreement with the local electric lighting company for the public lighting of the town has been approved by the Council.

It was explained that the new charge per annum would be £611. 17s. 6d. against £830 under the previous contract, for full time lighting, and £286 against £575 under the restricted lighting.

ELECTRIC TRACTION.

Accrington.—The female workers on the Corporation tramways have been awarded by the Committee on Production a war bonus of 3s. 6d. for those of 18 years and over, and 2s. for those under 18 years of age.

Croydon.—The Tramways Committee recently reported that they had again investigated the question of the introduction of ½d. fares for school children, but they were unable to recommend that the proposal be agreed to. The recommendation was discussed at considerable length and the report was referred back.

Dewsbury.—At the last meeting of the Council correspondence was submitted on the question of the abolition of ½d. workmen's fares on the lines of the Yorkshire (Woollen District) Electric Tramways Co.

In a letter to the Board of Trade the company challenged the power of the Board to determine the question of fares, but it was reported that the result was that the Board had insisted upon restoration of ½d. fares.

Dudley.—At a recent meeting of the Council, Mr. Ballard complained of the increased tramway fares in the borough charged by the local tramway company.

Mr. Round considered that the company were fully entitled to increase their fares. The working classes were not grumbling about them; they were, in fact, getting such good wages that some of them would travel first class if such accommodation were provided.

The Town Clerk pointed out that under the Companies Act the Council could not interfere with the increase of fares unless they exceeded a penny per mile.

The Mayor said the general manager of the company (Mr. W. G. Bond) had sent a communication in reference to the matter pointing out that higher salaries and wages and increased cost of material had rendered a moderate increase in fares absolutely necessary.

It was decided to provide and maintain shelters at the railway termini, and the Streets Committee were instructed to confer with the company on the matter and also to prepare a scheme for submission to the Council.

Dundee.—The Tramways Committee has agreed to increase the wages of tramcar drivers by 3s. a week, making the starting wage 35s. and the maximum 42s.

Glasgow.—The sale of war savings and comforts tickets on the Corporation tramcars last week realised £1,668.

After meeting the cost of prizes, £1,300 will be available in aid of the funds for assisting paralysed soldiers and sailors at Ralston Hospital. In the last drawing of prizes there were seven pictures by well-known artists and 43 awards, each representing five War Savings Certificates for 15s. 6d. During the current week tickets are being sold on behalf of the hospital at Erskine for limbless soldiers.

Judging by the numerous letters that have appeared in the "Glasgow Herald" and other local papers, the natives have been deeply moved by the introduction of the prize scheme, and it is being denounced as an insidious form of gambling. On the other hand, it has very many supporters, and it has proved successful for the purpose for which it was started.

Halifax.—The Corporation has approved an agreement with Messrs. W. H. Smith & Son for the carriage of newspapers on the tramcars, subject to the firm agreeing to pay £50 per annum for such privilege.

L.C.C. Tramways.—The Board of Trade have extended for one year from August, 1917, the times limited for construction of tramways, &c., under the L.C.C. Tramways and Improvements Acts of 1909, 1910, 1913 and 1914.

London Electric Railway.—An application is being made to the Board of Trade for an extension to Aug. 15, 1918, of the time limited by the London Electric Railway Act, 1913, for compulsory purchase of lands, &c. Objections to the Board of Trade by April 21.

Newport (Mon.).—The Council have obtained authority to construct a tramway along the Alexandra-road as far as the dock lock.

The Great Western Railway Co. has been induced to withdraw on reasonable terms their opposition to a tramway over their level crossing. The estimated cost of the scheme is £12,100 and application has been made to the Board of Trade for permission to borrow £13,500.

It is reported by the Tramway Committee that female conductors have not been very successful.

Sheffield Tramway Fares.—At the Corporation meeting last week Councillor Short, in moving that a recommendation of the Tramways Committee as to increased motor omnibus fares be not confirmed, urged that this was not the time for such a step, and that the department was making such profits that it could afford to subsidise the motor section.

In reply, Ald. Cattell urged that all prices had gone up and the traffic could not be carried on at anything like a profit at present rates.

Councillor Holmshaw complained that the tramways department was carried on with too small a surplus, and that too much money had been granted to relief of rates and other objects. Within the next two months they would probably have to increase the tramway fares also.

Ald. Fenton pointed out that having regard to the increase in wages, the cost of petrol and other things, the proposed increases were fully justified. They were losing 2¼d. per 'bus mile, and they could not go on at that rate. The greatest loss occurred on the Wincobank route, where they were losing 4⅓d. per 'bus mile, whilst on the Tinsley route the loss was 2⅔d. per mile and on the Heeley route 2¼d. They had received an application from a trade union asking for an advance of 5s. per week increase in wages per man, and if that were granted it would mean a further expenditure of £24,000 per annum, and the estimated profits next year were only £17,000. It was, therefore, impossible to help the 'buses at the expense of the tramways, and they calculated that if the fares were increased they would nicely clear expenses.

The report was adopted, only four voting for the amendment.

Walsall.—The manager of the tramways has reported on experiments he has made with a trolley reverser, and he has been authorised to fix the apparatus at the termini.

Western Valleys (Mon.) Railless Traction.—The Board of Trade has extended by one year from Feb. 15, 1917, the time limited by the Western Valleys (Mon.) Railless Electric Traction Act, 1913, for the completion of trolley electrical equipment, and by one year from July 8, 1917, the time limited by the Western Valleys (Mon.) Railless Electric Traction (Extension) Order, 1914, for the completion of trolley electrical equipment.

Wolverhampton.—On Monday the Corporation decided to purchase three 3½-ton electric vehicles for the collection of refuse, &c., at £2,930.

Women Tramway Workers' Bonus.—The Committee on Production has awarded a war bonus of 3s. 6d. a week to the women tramway workers employed by Lancashire and Cheshire Corporations and private tramway companies as conductors, trolley girls and cleaners, but those under 18 years of age only get 2s. a week.

The Manchester and Salford conductors had already been granted a war bonus of 2s. and the trolley girls of 1s., and the demand made by the workers' organisation was for a war bonus of 6s. 6d., which would place the women workers on the same rates as men. The Blackburn Corporation is the only Lancashire authority to give a war bonus of 6s. 6d. to men and women tramway workers.

There are between 4,000 and 5,000 workers concerned, and the towns involved in the award are as follows: Manchester, Salford, Rochdale, Oldham, Stalybridge Accrington, Ashton-under-Lyne, Birkenhead, Bolton, Bury, Hyde, Preston, Mossley, Dukinfield, Stockport, Warrington and Wigan. The award operates from the beginning of the first full pay week after Maroh 12.

TELEGRAPHY AND TELEPHONY.

Australian Telephone Metering Apparatus.—The Godfree automatic metering apparatus has been in use, on trial, at the Ballarat (Victoria) telephone exchange for the past 18 months, and Mr. Halion, who is in charge of the exchange, says it has worked "like a charm."

Subscribers no longer (it is said) complain of being overcharged for calls, and the operators are relieved of the duty of recording them. In a recent report to the Postmaster-General, Mr. Halion says the system will be welcomed by the traffic staff wherever it is installed. The inventor, Mr. Godfree, is a young Australian in the employ of the Victorian Railways Department.

Radio-Telegraphy in France.—It is announced that a decree dated Feb. 24 has been made prohibiting the establishment or operation (without the authorisation of the Ministry of Commerce) on or above French territory, or on board French vessels, of machines or apparatus for telegraphing orsignalling. The employment of radio-telegraphic installations on board foreign ships in French territorial waters must also be in accordance with the rules laid down by the authorities. The decree is set out in the "Journal Officiel" of March 6.

Telephone Progress in Canada.—According to recent statistics, there was a capital of $35,572,902 invested in the telephone industry in the Quebec and Ontario provinces at the end of the year 1915.

There are now over 223,666 subscribers in the two provinces to one system alone, compared with 138,370 in 1910 and 82,351 in 1905. The wire mileage in the two provinces increased in the same period in about the same ratio, and the net revenue increased over 1.300 per cent.

Digitized by Google

IMPERIAL NOTES.

Australasia.—The "Australian Mining Standard" says the Town Council of Brighton (Victoria) proposes to establish an electric tramway service to link-up with the Prahran and Malvern Tramways Trust's lines.

Certain ratepayers object not only to the routes selected, but also to the manner in which the scheme has been planned, and as soon as details of the Order in Council have been completed, the objections of the ratepayers will be submitted to the Minister of Public Works.

New bogie type cars have been built at the Newport railway workshops for the Victorian Railway Department's St. Kilda-Brighton electric tramway. These will each seat 52 passengers. A closed-in saloon is provided at each end, and the cars are designed for passengers to enter and leave at the centre. The open section can be closed in, if necessary, and there is a central passage way. The wood used is chiefly Australian.

The Engineer-in-Chief of the Sydney Water and Sewerage Board recommends that a high grade electrical pump be installed at Crown-street reservoir, at a cost of £1,750; also that two travelling job cranes be obtained for lifting screens at pipe head basin, at a cost of £2,000.

The ratepayers of Mittagong (N.S.W.) have decided in favour of the adoption of electric lighting. An offer of current from their power house, Port Kembla, has been received from the Works Department.

Negotiations between the Echuca (Victoria) Council and the Milo Company in regard to a scheme for an electric lighting and pumping installation have been broken off. The contractor for the electric supply works will be required to purchase the local gas works, and the Milo Company's offer of £1,500 was considered too low. Inquiries are to be made as to whether money can be raised for a municipal electric supply scheme.

The experiment of the Prahran & Malvern Tramways Trust in building its own cars instead of having them built in Adelaide has (it is stated) proved successful. The cost is said to be about £150 less than for the Adelaide cars. The body and truck were built at the trust's shops at Malvern.

India.—"Indian Engineering" says people in South India are awakening to the advantages of electricity, and there is a great desire on the part of more than one municipality in South India to emulate the example set by Bangalore.

A scheme is under consideration for the utilisation of waterfalls to supply electric current to Cochin, and there is another for the supply of electric power to the town of Coimbatore, from the Sirmani River.

At a recent meeting of Madura Municipal Council the proposed electric supply for the town again came up for consideration. In a letter from Mr. J. S. Westerdale, executive engineer of the Madura Drainage Works, it was suggested that the Government be requested to reconsider their decision to defer the scheme pending the supply of power from the Periyar River, and also that a consulting electrical engineer be engaged to advise the Council. Mr. Westerdale thought that only sufficient plant should be installed as would supply the immediate wants of the town, and the plant should be designed with a view to the ultimate change over to the Periyar supply when available.

The Council decided to approach the Government on the subject.

It is announced that no fresh applications for the supply of electric current can be received by the Calcutta Electric Supply Corpn., owing to their inability to obtain machinery and materials.

South African Patents, Designs and Trade Marks.—The administration of the Patent Acts and the Trade Mark Acts of all the provinces of the Union of South Africa and the Designs Acts of the provinces of the Cape of Good Hope and Natal have been transferred respectively to the Patent Office, the Designs Office and the Trade Marks Office at Pretoria.

MISCELLANEOUS.

Co-operation and Reseach Work.—The Co-operative Wholesale Society has formed a research department, and Dr. Geoffrey Martin has been appointed to direct its work.

The appointment marks a new departure in connection with the co-operative movement, and it has been rendered necessary by the concessions acquired by the Co-operative Wholesale Society in West Africa, Nigeria and elsewhere, as well as by the development of fresh undertakings at home.

Customs Decisions.—Under a recent Order in Council, the following goods may be imported into Canada free of duty until otherwise provided:—

Rolled iron or steel hoop, band, scroll or strip, No. 14 gauge and thinner, and rolled iron or steel sheet imported by manufacturers for use only in their own factories in the manufacture of galvanised iron or steel hoop, band, scroll, strip or sheet.

The following articles used in Canadian manufactures are subject to the following reduced duties of import duty until otherwise provided: Battery jars of glass and articles of hard rubber imported by manufacturers for use in their own factories in the manufacture of electric storage batteries, 12½ per cent. ad val. under British preferential tariff and 20 per cent. ad val. under the intermediate and general tariffs.

Under a recent Australian Customs By-Law the following material for dry cells are to be admitted as minor articles for use in the Commonwealth, and as such are subject to import duty of 5 per cent. *ad. val.*, under the General Tariff, but duty free if of British manufacture.

Brass caps with nuts, carbons, caps for carbons, zinc cups and terminals (including binding posts) of brass and nuts and washers therefore but not including terminals having metal strips or other metal attachments soldered thereto.

It has been decided that electric blowing engines for organs are subject to 5 per cent. ad val. duty under the Netherlands tariff of import duties.

Enemy Firms in South Africa.—The following firms, amongst others, have been ordered by the Union Government to be wound up:—

Orenstein-Arthur Koppel (Ltd.), Johannesburg (Controllers: J. G. Carter, National Bank-buildings, Johannesburg, and H. P. Webber, Norwich-buildings, Pretoria); Allgemeine Electricitäts Gesellschaft, Johannesburg (Controllers: J. G. Carter and H. P. Webber); Flottmann Engineering Co. (of South Africa) (Ltd.) (Controller: S. Thomson, P.O. Box 228, Johannesburg).

Enemy Firms Wound Up.—The Controller of Bleichert's Aeria Transporters (Ltd.) has applied for a release. Objections to the Board of Trade before April 21.

Foreign Patents.—The Comptroller-General of Patents recently announced that notifications and documents relating to foreign patents, designs and trade marks, which patent agents and others are unable to forward to their destination abroad, may be deposited in the Patent Office (Room 27).

The object of the deposit is to record the intention on the part of the depositor to do any act or to file any document on a certain date at a foreign Patent Office. No guarantee can, however, be given that such procedure will be of any advantage to the persons concerned. Notifications and documents (other than drawings) so deposited must be written on foolscap paper and filed in duplicate. The Chartered Institute of Patent Agents are opening a trust account, into which money in regard to such matters may be paid, subject to such rules as the Institute may make.

Applications for Patents on behalf of Alien Enemies.—The Controller of the Foreign Dept. has granted permission to any person in the United Kingdom to apply on behalf of persons or firms in the Statutory List of alien enemies for patents or for registration of trade marks, or the renewal of same.

Patent Applications by Foreigners.—The Board of Trade announces that the number of applications for patents in the United Kingdom received in 1915 and 1916 were as follows:—

Germany 539 in 1915 (against 234 in 1916), France 471 (501), Italy 136 (141), Belgium 41 (45), Russia 56 (65) and the United States of America 1,847 (2,043).

Applications by enemy subjects are allowed to proceed in the usual way down to acceptance, but no patent has been or will be sealed to an enemy subject during the war.

Shell Holders.—Many firms have found some difficulty in firmly securing shells whilst being screwed. Ordinary grips are apt to cut the surface of the shell, but a Birmingham firm have, we are informed, overcome the difficulty by using Ferodo fabric, which holds the shell quite firmly without damage.

Trading with the Enemy.—The "London Gazette" of April 13 contains additions to and alterations of the statutory list of firms and persons with whom trading by firms and persons in the United Kingdom is prohibited.

Amongst the additions is: *Argentina and Uruguay.*—Accumulatoren Fabrik A.-G. (Calle Tucuman 900, Buenos Ayres).

The entries of the following firms (originally published on the dates mentioned) should read as follows: *Argentina.*—Orenstein & Kappel (Calle San Martin 66, Buenos Ayres) (March 24, 1916); Soc. Anon Argentina Hidraulico Agricola (Calle Moreno 411, Buenos Ayres) (April 14, 1916).

Waste Metal Trade Association.—The iron and metal merchants of S. Wales and the West of England have decided to form a Waste Trade Association in connection with their industries.

Mr. H. E. Rose (Bristol) has been appointed president, and Mr. R. W. Harry (Llanelly) vice-president. A deputation was appointed to wait on the Ministry of Munitions to try to get the trade in waste placed on the essential list.

TENDERS INVITED AND ACCEPTED.

Induced Draught Fans, Mechanical Stokers, Boiler Feed Pump, &c.

Hammersmith (London) Borough Council invite tenders for Induced Draught Fans, Mechanical Stokers, Boiler-feed Pump, Centrifugal Pump for condenser water and strainer for condenser cooling water. Full particulars and forms of tender from the engineer and manager of the electricity department, Mr G. G. Bell, 85, Fulham Palace-road, W.C. Tenders to the Town Clerk, Town Hall, Hammersmith, by 4 p.m. of April 25.

Carbon Brushes and Gear Wheels.

Johannesburg Municipal Council require tenders by April 30 for supply of 10,000 Traction Carbon Brushes, and by noon May 21 for supply of Steel Gear Wheels for tramcars (contract 241). Specifications, &c., from the Town Clerk.

Digitized by Google

Metallic Filament Lamps, &c.

Hoylake and West Kirby Council require tenders by April 28 for one year's supply of Metallic Filament Lamps. Specifications, &c., from the Engineer and Surveyor, Town Hall, Hoylake, Cheshire.

The Victorian Railway Commissioners require tenders by 11 a.m. May 23 for supply of 8,250 Incandescent Electric Lamps during the year ending June 30, 1918. Specification, &c., from the Commissioner's Offices, Spencer-street, Melbourne.

Tramway Material.

Manchester Tramways Committee require tenders by 10 a.m. April 24 for supply of h.d. copper wire. Specification, &c., from the General Manager.

Bolton.—The Corporation has accepted the following tenders:—Edison Swan Electric Co. and General Electric Co., lamps; Le Carbone (Ltd.) and Morgan Crucible Co., carbon brushes for the Tramways Committee; British Electric Transformer Co., Johnson & Phillips and Brush Electrical Engineering Co., transformers; Siemens Bros. & Co., cable necks and cleats; W. T. Henley's Telegraph Works Co., British Insulated & Helsby Cables, Pirelli General Cable Works, C. Macintosh & Co. and W. T. Glover & Co., cables, &c.; Reason Mfg. Co., fuse boxes; C. Macintosh & Co. and Liverpool Electric Cable Co., wire; Ferranti Limited, meters; Venner Time Switch Co., time switches; McClure & Whitfield, motors; Credenda Conduits Co., steel conduits and fittings; Davenport Engineering Co., cooling tower; W. J. Jenkins & Co., coal-conveying plant; Mather & Platt, motors; Jowett Motor Mfg. Co., electric tipping wagon; British Thomson-Houston Co., synchronous condenser and h.t. switchgear and reactances for the Electricity Committee.

Bethnal Green (London).—The Council have placed an order with the British Insulated & Helsby Cables (Ltd.) for one year's supply of electric cable.

Cardiff.—The Corporation has accepted the tender of McWhirter & Son (Cardiff), Ltd., for the repair of a motor-generator at £410.

Bradford.—The Tramways Committee has accepted the tender of the British Hele-Shaw Patent Clutch Co. for 27 gear wheels at £155. 5s.

Glasgow.—The Corporation have accepted the tender of the British Thomson-Houston Co. for the supply of three 1,000 kw. rotary converters, at £3,160.

Perth.—The Council have accepted the tender of the British Westinghouse Electric & Mfg. Co. for one year's supply of house meters. The following firms also tendered: Ferranti (Ltd.), Chamberlain & Hookham, Bat Meter Co., British Insulated & Helsby Cables, General Electric Co., Landis & Gyr, and the Electrical Apparatus Co.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments:—

Postmaster-General's Department, Adelaide.—J. Bartram & Son, 1,000 telephones, 34s. each; 350 ditto, 61s. 3d. each; 51 ditto, £5. 2s. 7d. each; 25 ditto, 28s. 9d. each; 40 protectors, 238s. 7d. each; 30 ditto, 124s. 1d. each; 20 ditto, 63s. 8d. each; 60 ditto, 54s. 1d. each; 100 chambers for microphones, 2s. 3d. each; 12 generators, 40s. each; 200 combined listening and ringing keys, 5s. each; 300 microphone mouthpieces, 7½d. each; 200 ebonite earpieces, 1s. 7d. each; 25 induction coils, 2s. 10d. each; 1,000 heat coils, 27s. 6d. per 100; 250 plugs, 1s. 1½d. each; 1,000 ditto, 1s. 5d. each; 100 ditto, 1s. 6d. each; 20 ditto, 4s. 8d. each; 100 head screws for bell, 4d. each; 200 springs for table telephones, 6½d. each. Western Electric Co., 500 ebonite receiver caps, 2s. 4d. each; 300 opal caps for line lamps, 37s. 6d. per 100; 50 receiver hooks, 2s. 6d. each; 60 relays, 9s. 3d. each; 500 microphone mouthpieces, 3½d. each; 500 carbon diaphragms, 9d. each; 500 ditto, 2d. each; 800 ebonite earpieces, 2d. each; 1,200 ditto, 4d. each; 100 ditto, 5d. each; 1,000 cords, 1s. 11½d. each; 25 foiled paper condensers, 9s. 6d. each; 200 lamps, 6½d. each; 300 fibre sleeves, 4d. each; 6 terminal strips; 24 repeating coils, 56s. each; 200 retardation coils, 17s. each; 100 coils for line relays, 2s. 9d. each; 51 resistance coils, 11d. each; 500 number plates, 25s. per 100. British General Electric Co., 54 repeating coils, 24s. 6d. each; 56 detectors, £3. each; 14 relays, 10s. each; 112 jacks, 10s. 8d. each; 42 ditto, 10s. 2d. each; 76 ditto, 10s. 8d. each; 200 foiled paper condensers, 1s. 1½d. each; 50 ditto, 1s. 7d. each; 100 ditto, 2s. 1d. each; 750 receivers, 5s. 7d. each; 50 ditto, 8s. 3d. each; 200 telephones, 85s. 6d.; 25 telephone sets, 33s. each; 205 micro-telephones, 19s. 9d. each. India Rubber, Gutta Percha & Telegraph Works Co., 8,700 copper tapes and binders, 24s. 6d. per 100. W. T. Henley's Telegraph Works Co., 600 lbs. enamel covered copper wire, 10s. per lb.

Postmaster-General's Department, Melbourne.—J. Bartram & Son, 1,000 gravity indicators, 4s. 2d. each; 500 jacks, 1s. each; 150 nuts, 1½d. each; 500 heat coils, 3½d. each; 250 handles for generators, 1s. 4d. each; 50 microphones, 8s. 7d. each; 50 micro-telephones, 31s. 6d. each. Western Electric Co., 2,000 receiver cases, 2s. 8d. each.

Victorian Railways.—Australian General Electric Co., electric light fittings, at rates. W. T. Henley's Telegraph Works Co., electric light cable, items at £28. 16s., £15. 9s. 6d. and £10. 9s. 9d. per mile. Lawrence & Hanson Electrical Co., Fuller's block accumulators (100 amp.-hour), £1. 14s. 5d. each.

APPOINTMENTS VACANT AND FILLED.

The Governors of the Bennett College, Sheffield, have vacancies in the teaching staff of the electrical and civil engineering departments. Commencing salary £200 per annum. *See advertisement.*

Belfast Tramways and Electricity Committee require a mechanical engineer at their electricity works. Salary £500. Applications by April 23.

Leek Urban Council require a resident engineer for their electricity undertaking. Commencing salary £250. Applications to the Chairman of the Lighting Committee by April 21.

A chief clerk is required for the Burnley electricity department. Commencing wages 50s. per week. Applications to the Town Clerk by April 24.

Birmingham Corporation Electric Supply Dept. require a junior shift engineer for the new temporary station at Nechells. Commencing salary £130, rising to £200 per annum, plus £10 extra per annum during the war. Applications to the city electrical engineer, Mr. R. A. Chattock, 14, Dale End, Birmingham, by April 24.

London County Council invite applications for the position of electrical engineer in the tramways department, at a salary ranging from £1,200 to £1,500 a year. Applications on official form to be obtained from the Clerk of the Council, County Hall, Spring-gardens, S.W., must be returned by 1 p.m. April 23.

London County Council also require an operation superintendent (£500 to £700 per annum) and a development superintendent (£500 to £800) for the traffic branch of their tramways department. Applications by April 23 for the former, and May 7 for the latter appointment.

Ilkley Council have appointed Mr. John Senior as chief engineer of the electricity department, at £250 per annum.

Mr. W. McNab, chief electrician to the Alexandra Docks & Railway Co., has taken up an appointment with the British Mannesmann Tube Co. at Landor.

BUSINESS ITEMS.

Mr. E. Elliott, ivory and wood turner, has removed to Victoria Works, Warstone-lane, Birmingham.

Plant for Sale.—The South African Railways Administration have surplus engines and generating plant for sale.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of June 14. *Further particulars are set out in an advertisement.*

Catalogues, Price Lists, &c.—The Cambridge Scientific Instrument Co. (Ltd.) have recently issued three new catalogues, copies of which may be obtained on request by those interested.

List No. 912 deals with H. & M. recording and index thermometers; list No. 134 gives illustrated particulars of the Cambridge measuring microscope for workshop use; and list No. 191 is devoted to the Cambridge thermo-couple potentiometer.

Messrs. Graham & Latham (Ltd.), 104, Victoria-street, S.W., have ready their catalogue No. 3 of signalling instructional instruments, which gives illustrated particulars of the latest developments in signalling apparatus. Prices are given in a separate sheet, and copies may be obtained on application to the firm.

The Enterprise Mfg. Co. (Messrs. Ashdown & Roberts) have prepared a circular setting out prices and particulars of their a.c. and d.c. fans, regulators, &c. The fans, which are made in sizes from 12 in. to 36 in. and for all voltages, are of British manufacture. Copies of the circular can be obtained from Gun-street Electrical Works, Bishopsgate, E. 1.

From the Spray Engineering Co. (Boston, Mass.) we have received a copy of their bulletin No. 501, dealing with "Spraco Products."

The pamphlet gives brief illustrated particulars of the Spraco system for cooling condensing water, &c., the Spraco air washing and cooling equipment for electrical machinery, apparatus for applying paints and other coatings with compressed air, sprinklers, sprayers, &c. Copies of the bulletin may be obtained from the company.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting to receive an account of the winding up of the Anchor Cable Co. (Ltd.) will be held on May 18 at 5, Lincoln's Inn Fields, London, W.C.

A meeting to receive an account of the winding up of the Miller Anti-Friction Metal Co. (Ltd.) will be held on May 22 at 3, Gore-street, Manchester.

Digitized by Google

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

ALDERLEY & WILMSLOW ELECTRIC SUPPLY (LTD.)—On the past year's working there was a profit of £2,815, compared with £3,064 in 1915. After deducting £1,691 interest and adding £1,242 brought forward, there was a balance of £2,366. The directors recommend that £1,200 should be put to reserve and the balance carried forward. The total receipts for Alderley are £3,116 and for Wilmslow £2,465. The lamp connections have increased from 1,092 kw. to 1,133 kw.

BROMLEY (KENT) ELECTRIC LIGHT & POWER CO. (LTD.)—At the recent meeting Mr. F. E. Gripper said that the lighting restrictions and the Summer Time Act had adversely affected them. Comparing the past year with 1913, the last complete year previous to the war, they found that, although the connections to the mains had increased by nearly 20 per cent., they had sold 190,000 less units for lighting, and, in spite of increased prices charged, had received over £2,700 less on that account; and although they had sold nearly 90,000 units more for power, receiving £560 more under that heading, they were left with a net loss of revenue of over £2,100. Notwithstanding the decrease in the output, the costs of working had increased by £1,974, of which coal was responsible for £1,550, the result being that the profit last year compared with 1913 showed a reduction of over £4,000, equal to 5 per cent. dividend on the share capital. After payment of debenture interest and trustees' fees, the balance was £7,288, or £1,883 less than they had to deal with last year. An interim dividend was paid as usual in October at the rate of 4 per cent. per annum for the half-year, and the directors recommended the payment of a further dividend for the second half-year at the rate of 6 per cent. per annum, making a total dividend of 5 per cent. for the year (against 6 per cent. in 1915), and leaving £2,000 to be carried to general reserve, and £1,538 to be carried forward. The past year had been a difficult one for all electric lighting undertakings. There had been great difficulty in obtaining satisfatory supplies of coal, but they had managed to keep up their stock, and had never been dangerously short. They had been working all the time with a reduced staff, 25 per cent. of their men (including their secretary) having been called up for war service. They could not expect much improvement so long as war continued. When the war came to an end he saw no reason why the company should not fully regain its old position and continue to make still further progress.

CLYDE VALLEY ELECTRICAL POWER CO.—The profit for the half-year ended Dec. 31 last was £59,162, and £15,456 was brought in. After adjusting interest and transferring £25,000 to contingency fund for depreciation, &c. (bringing this fund up to £192,500), there remains £49,258. The directors propose to transfer £6,960 to special reserve fund, to pay a dividend of 1¼ per cent. on the ordinary share capital (tax free), and to carry forward £25,797.

CORNWALL ELECTRIC POWER CO.—At the meeting last week it was reported that the gross profit for 1916 was £14,038. 11s. 9d., compared with £14,273. 5s. 5d. for 1915. After making provisions for bad and doubtful debts, and allowing for interest on debentures and amounts due to the contractors, the balance (including £913 brought forward) was £13,146. The directors recommended that a dividend at the rate of 4 per cent. be paid, which would absorb £7,200, that £4,000 be placed to reserve for renewal of plant, and that the balance (£1,946. 0s. 1d.) be carried forward.

W. T. GLOVER & CO. (LTD.)—The directors recommend a dividend of 6 per cent. on the ordinary shares for the year 1916, as against 5 per cent. for each of the last two years and 7½ per cent. for three years before that. A sum of £6,500 has been allocated to debenture redemption and £15,000 to the reserve, the balance forward being £22,025 (or practically double of last year's figure), subject to the excess profits duty.

MIDLAND ELECTRIC CORPN. FOR POWER DISTRIBUTION (LTD.)—The accounts for 1916 show a trading revenue of £112,856 and a profit of £63,646. The balance to credit of net revenue account, after payment of debenture interest, is £33,183, to which is added £8,932 brought forward, making a disposable balance of £42,115, of which the directors have appropriated £9,773 to depreciation of plant and machinery, £8,616 has been written off of commission and expenses of issues of debentures and shares, &c., and £500 has been transferred to debenture premium redemption account, leaving £23,226. The directors recommend the payment of dividends of 6 per cent. on the preference shares (£3,923 14s.) and of 5 per cent. on the ordinary shares (£7,500), carrying forward (subject to provision for excess profits tax) £11,803. The net capital expenditure for the year in respect of plant, mains, transformers, &c., was £36,916 13s. 2d. To provide for this outlay, debenture stock to a total nominal value of £45,600 was sold. The increasing demand for power referred to in the last report continued to such an extent that it became necessary to again order additional plant. Accordingly a contract was placed for a new generating set of 3,000 kw. capacity, and the erection completed at the end of December last. Since that date still further applications for supply have been received amounting to several thousands of horse-power, which the company is, unfortunately, unable to accept at present as the whole of the plant at the station (including the 3,000 kw. set above referred to) is fully loaded. Negotiations are, however, in progress which, if satisfactorily completed, will enable the company to accept the business offered. The lighting revenue has been adversely affected by the Summer Time Act, the restrictions upon shop lighting, and the earlier closing of licensed houses.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY (LTD.)—The revenue for 1916 amounted to £37,008. 4s. 4d. (compared with £34,823 in 1915), and the expenditure (including £1,504 for debenture interest and £1,500 placed to provision for renewals account) was £25,505 (against £25,062), leaving a net profit of £11,503 (compared with £9,761 for 1915), which, added to £2,282 brought forward, makes an available balance of £13,785. The directors propose to place £5,502. 10s. to reserve fund, to pay the dividend on the 5 per cent. cumulative preference shares (£2,500), and a dividend on the ordinary shares at rate of 6 per cent. for the year (in respect of which an interim dividend at rate of 5 per cent. per annum was paid to June 30, 1916), absorbing £3,000, leaving to be carried forward £2,783. The subscribed share and debenture capital is £135,200, and the total capital expenditure to Dec. 31 amounts to £159,564.

VICKERS (LTD.)—At the meeting on Tuesday Mr. Douglas Vickers, who presided, said that the delay in presenting the accounts for 1915 and 1916 was due to the Munitions and Finance Acts. It was not a difficult matter to settle standard profits in the case of a company that had not been spending money on capital account and had not increased its turnover, but if the company had been progressive, as they had been, allowance had to be made for the increased capital brought in and for the increased turnover. There were no hard-and-fast rules under the Acts to suit all cases, and negotiation was necessary over many points. There arose the question of the amounts to be allowed for depreciation and for writing off special plant. There would not be scope for employment of 5 per cent. of the presses, boring machines and lathes for peace purposes, and the profit out of any work executed on the 5 per cent. would not pay for the upkeep of the rest. The directors held that the only sound financial course was to write off the whole of the capital expenditure on such machines. That principal was so far recognised that most of the recent big plants had been put down, only to be managed by private firms. The company could have closed the matter with the Government some time ago if they had been willing to give way and agree to terms which they thought unreasonable, but they felt it was imperatively necessary to obtain an equitable settlement even if inconvenience and delay were experienced.

WILLANS & ROBINSON (LTD.)—The accounts for the year 1916 show, after payment of debenture interest, provision for depreciation of plant and machinery, re-valuation of stocks and allowances to employees on active service, a net profit of £20,090. Special provision has been made on account of new outlays, and the exceptional wear and tear arising from conditions connected with war output. An interim dividend on the "A" preference stock has already been paid, and warrants will be posted covering the balance dividend on "A" stock, the annual dividend on "B" preference stock and annual interest on those funding certificates outstanding. A dividend of 10 per cent. on the ordinary shares is recommended, leaving £12,140, of which it is proposed to add £10,463 to reserve and to distribute the balance of £1,677 1s. 8d. among the holders of "B" stock and ordinary shares in manner provided by the Articles. The business has largely increased during the period under review and its resources have been fully employed in providing for war requirements.

YORKSHIRE (WOOLLEN DISTRICT) ELECTRIC TRAMWAYS CO. (LTD.)—At the meeting on the 18th inst., the report for 1916 stated that the revenue amounted to £76,140, compared with £71,594 for 1915. After deducting all expenses chargeable to revenue and setting aside £5,100 to renewals fund, the balance is £16,042, which, added to £2,947, makes an available balance of £18,989. The directors recommend a dividend of 5 per cent. per annum on the ordinary shares, carrying forward £3,487.

CITY NOTES.

MEMORANDA.—(April 17).—Consols, 55. Consols Pay Day, May 4. Stocks and Shares Ticket Day, April 26. Pay Day, April 27. Price of Silver, 36 $\frac{3}{16}$ d.

DIRECT UNITED STATES CABLE CO. (LTD.)—The directors have resolved upon the payment of a final dividend of 2s. per share (less tax), making a total distribution of 4 per cent. for year ended March 31 last.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The directors recommend a final dividend for the year to Dec. 31 of £1. 2s. 6d. per share (making with the interim dividend already paid, 7 per cent. for the year), tax free. They also recommend a distribution of £1. 10s. per share (tax free) out of interest received. The dividend and distribution will be payable on the 1st inst.

MONTE VIDEO TELEPHONE CO. (LTD.)—An interim dividend for the half-year ended Jan. 31 last at the rate of 6 per cent. per annum has been declared on the ordinary shares.

Digitized by Google

THE ROUND TABLE.

By "KVA."

An excellent story has come to me second-hand from a friend of mine on H.M.S. ——, now busy in the —— Sea. He was himself witness of the following incident. Two electricians were told off to fix up some apparatus which, for certain reasons, could not be made dead. During the operation of tinkering with the connections one of them got a sharp shock which made him jump and swear at the same time. "What's up," said his mate, "is it 'ot?" "'Ot! no; only stung with a —— amp.!" An officer within earshot vouches for the truth of this incident.

* * * *

As I am now an "allotmenteer," and have "juice" available, I am anxious to make the "spuds" grow when I do get a chance to put them in the ground. Mr. Kerr (Hereford) has kindly sent me a useful pamphlet on Electro-Culture, which I can recommend "to those about to harry" the clods and clumps of mother earth. I find there is one rather apt misprint in the pamphlet. It refers to insulators as "insultators!" This is not Mr. Kerr's experience, I believe, for his potatoes, under electric influence, appear to have been very far from insulted; they have swollen to quite abnormal dimensions out of sheer love for the treatment!

* * * *

A writer in the "Yorkshire Post" is concerned that electrical men are not doing their bit towards "strafing" the submarines. He says, amongst other things:—

It was recently reported that the Italians had invented a magnet of sufficient power to be of service in the matter of salvage. Could not this be improved upon or extended in dealing with submarines? Would it be possible to magnetise or electrify the water to such an extent as in a given radius round a ship to be of sufficient power to hold up, block, divert or retard the course of a propelled torpedo before reaching its quarry? I should imagine the generator would be similar in principle to a wireless installation on board ship. It would operate in the event of the trail of the torpedo being sighted. I give this suggestion for what it is worth. I am no electrician; but the possibilities of electricity are practically unlimited. Oil on the troubled waters has been knowr to save a ship. Are there no other agents which might be employed for a like purpose?

The answer to the last question might be "magnetic ripples on the surface of the ocean."

* * * *

The prospect of the mechanical milkmaid gives the London "Star" man an opportunity of which he is not slow to take advantage. He says:—

We are faced with the possibility of an automatic kitty, a mechanical milker that on the pressing of a button will do the work of the absent maid. There are many obvious advantages about these clicking automata. In some cases their nimble pistons and suction pumps are operated by a gas engine, and gas engines never ask for a rise. Nor do they want evenings off to go to the pictures. They seldom strike, never answer back, and, beyond a small paraffin ration and some oil, consume but little food. Again, one of the disadvantages of the late Kitty was her propensity for marriage. No soone. had her cows got to know her touch than some lubberly swain came and saw and floundered before her apple-cheeked smile. And the farmer had to put another small ad. in the local paper. The gas engines and motors neither marry nor are given in marriage.

Now, while gas engines "never ask for a rise," they have been known to leave without notice by way of the window or roof!

After the above little effusion the "Star" man tries to set his mechanical Kitty to verse. He confesses that "neither Mr. Sidney Cooper nor Mr. Robert Bridges could get the divine afflatus to work on an internal combustion "horizontal." However, he has a try himself, with the following result:—

Daughter of Ceres, handmaid of the Gods,
To you my song! Thy differential gear,
Like Phaeton's car adown the Via Lactea,
Throbs like a Ford. Thy clucking piston rods
Cry out for oil, while the tired chauffeur nods
And dreams of peace, and gross, material beer.
Hail, ½ H.P.!

After that I must turn the subject over to Edmund Hill. He is now settling down in one of London's suburbs, and can probably see a little electric milking done, to get the inspiration!

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, April 17, 1880.]

ELECTRO-METALLURGY.—This process has been applied to the making of statues, the method having been successfully inaugurated by the reproduction of a large clay model in bronze by the electro-typing process, instead of the usual one of casting. This statement is warranted by the announcement that the Electro-Metallurgical Co., of Brussels, has just completed a colossal statue in bronze of Jan Van Eyck, the great painter, by the system of galvanic deposition.

THE TELEPHONE.—The Edison telephone is in full operation in Paris, the exchange there numbering over 350 subscribers. The carbon transmitter and Phelps receiver are employed. The lines are under the management of the State, and a closed circuit is employed in order to avoid induction currents. Experiments up to distances of 140 miles have been made with success. Trial of the telephone is also being made at the Carberry Mine, near Inveresk, in Scotland.

ELECTRIC LIGHTING.—The Victoria Docks and Holyhead Harbour are to be lighted by electricity. The Royal Navy is adopting Brush's light. Siemens light has been introduced into the Siam Dispensary, Bangkok, as a rival to Jablochkoff's. South Kensington Museum is also, we hear, to be lighted by the Brush system. The arrival of spring has brought with it a discontinuance of Siemens light in the reading room of the British Museum until next autumn. The authorities regard it as a good success.

Spanish Port Improvements.—Various new works are to be undertaken for the improvement of the port of Alicante, including:—

Construction of a slip with two lines of rail going to a depth of 4 metres. One of these lines is for hauling up vessels up to 400 tons; the other is for small craft, such as lighters, boats, &c. Ships will be hauled up by electric power. Sheds will be placed on the new piers, as well as storehouses for goods, and electric cranes and railway lines for the transport of goods will be laid down. The actual cost of the works is placed at about £80,000.

Telephony in Argentina.—Government sanction was given recently to the Compañía Union Telefonica to open an office in Lan s, and to open a branch in the Saladillo district of the city of Rosario.

Señor Enrique Jamieson has been authorised to construct a telephone line between Messrs. Manuel Ferrari & Co.'s premises in Puerto Coyle, and their estancia, Moy Aike, in the National Territory of Santa Cruz.

Authority has also been given to the Sociedad Ganadera Bella Vista to construct a telephone line between the company's establishment on the south bank of the Rio Santa Cruz (Territory of Santa Cruz) up to the Chilean frontier and to connect it there with the line which the Chilean Government has authorised the company to construct.

Bolivian Patent Law.—The patent law which came into force on Jan. 1 provides for the granting of patents for 15 years.

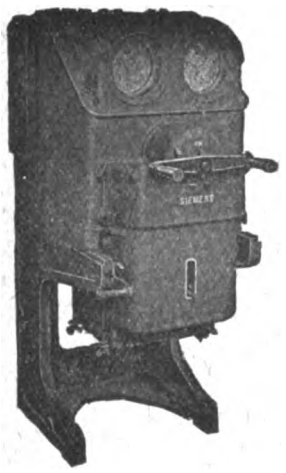
There is a progressive tax of 20 bolivianos (£1. 12s.) for the first year, 30 bolivianos for the second, 40 bolivianos for the third, and so on in successive years, provided that where a patent exists abroad, the Bolivian patent and that abroad lapse at the same time. Provisional patents may be obtained for one year. A foreign inventor may patent his invention in Bolivia within a year of obtaining the foreign patent, and the patentee must work his invention in the country within two years of the grant of the patent. The expenses incurred in obtaining a patent, with the first annual payment, amount to about £12.

TUNGSTEN FOR ELECTRICAL CONTACTS
MORE EFFICIENT AND MUCH CHEAPER THAN PLATINUM.
Recommended for use for X-Ray Targets, and as Contacts on Induction Coils and Tapping Keys, Magnetos and similar devices where there is frequent making and breaking of Electric Current. Also suitable for Gas Engines, Circuit Controllers, and like purposes.
Write for Particulars:—
THE L.P.S. ELECTRICAL COMPANY, 14, Hewick Place, Westminster, S.W.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 100, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

Digitized by Google

SIEMENS



IRONCLAD
SWITCHGEAR
FOR ALL
PURPOSES

Control Pillars
Distribution Boards
Main Switchboards

Write for particulars to —

SIEMENS BROTHERS DYNAMO WORKS LIMITED
Head Office: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: Western 6349. Telegrams: "Siemsbalos, Kens, London."
Lamp and Supplies Dept. 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: City 5350. Telegrams: "Siemotor, Cent., London."
HOME BRANCH ADDRESSES:
Birmingham—Central Ho., New St. | Manchester—196, Deansgate.
Bristol—30, Bridge Street. | Newcastle—64-68, Collingwood
Cardiff—89, St. Mary Street. | Sheffield—22, High St. [Bldgs.
Glasgow—66, Waterloo Street. | Southampton—46, High Street.
Branches in Principal Towns Abroad.

Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
PHOSPHOR TIN.
PHOSPHOR COPPER.

CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.

GENUINE
M & M VULCANISED FIBRE.
MOSSES & MITCHELL, 122 & 124 GOLDEN LANE, LONDON, E.C.

INSULATION BEADS

ELECTRIFICATION OF COLLIERIES.

In a Paper recently read before the North Staffordshire Branch of the National Association of Colliery Managers and the Association of Mining Electrical Engineers (Lancashire, Cheshire and North Staffordshire Branch), Mr. Harold Green, A.M.I.E.E., electrical engineer to the Earl of Ellesmere's Collieries (Worsley, Lancs), described the gradual change over from steam and compressed air to electrical driving of the existing plant at a group of eight collieries. The change over commenced about six years ago, and electricity has gradually superseded other drives as these required replacing, either on account of being worn out or being unsuitable under changing conditions. The collieries are linked up by a private railway, and this was taken advantage of for running the overhead extra high-tension wires alongside it.

Two sources of power are available. At No. 2 there is a battery of 50 coke ovens, and gas engines have been installed to work on the waste gas. No. 8 is the largest group of pits, and as a large amount of exhaust steam is available mixed-pressure turbo-alternators have been installed. Provision has been made for a mixed-pressure turbine plant being installed at No. 5 Colliery in the future. It was decided to transmit power at 10,000 volts, because a supply was already being taken from the local Power Company at Nos. 4, 5, 6 and 7. At these places the supply came in at the above pressure to sub-stations and transformers stepped down to 400 volts. Two outstanding features have been aimed at, viz., duplication and standardisation. Special attention has been paid to avoid, as far as possible, the paralleling of alternators or transformers, and the complete system is worked entirely on what might be termed a change-over system. The possibility of a bad power-factor has been guarded against by installing synchronous motor-generators wherever possible. The whole group of collieries is linked up by two sets of extra high-tension lines, one of which is connected to the source of supply at No. 2 and the other at No. 8. At each colliery there is a sub-station provided with change-over switchgear, so that the supply can be taken from either generating station as desired. The overhead high-tension wires are of stranded copper, each 0·1 sq. in. sectional area. They are carried on the usual A and H poles, 40 ft. long, with channel-iron arms. In certain cases where the railway bridges are over public roads there is a special arrangement, so that the wires will hang directly over the bridge. Where footpaths have to be crossed a terminal pole is erected on each side of the road, so that there is only a short and separate span of wires across the road; the wires are not in tension, and consequently there is very little risk of breakage. At colliery No. 3, the centre of the system, a tower form of sub-station has been erected. The high-tension wires are taken directly into the top-floor chamber, through leading-in boxes, and connecting to isolated links, so that any section can be easily disconnected for testing purposes. Two B.T.H. electrolytic lightning arresters are installed here to deal with surges or discharges on any part of the system. The ground-floor of the sub-station is divided into two parts, one of which contains all the high-tension switchgear, transforners, &c., and the other part all the low-tension switchgear, &c. The high-tension switches are operated from the low-tension chamber. Four step-down transformers are installed, each of 250 kw. capacity. Two of these are in duplicate and step-down from 10,000 to 400 volts for use on the surface load, and the other two, also in duplicate, step down from 10,000 to 2,200 volts for the underground load. At No. 2 group is a gas-engine station, power being derived from a battery of 50 coke ovens. The ovens were laid down about 15 years ago and the electrical plant was worked on 220 volts, direct-current, from two 115-kw. Belliss & Morcom high-speed sets. These sets are still running, and it is remarkable how few repairs have been required. When the plant was first laid down the electrical manufacturers hardly appreciated the severe conditions under which such plant had to work, the greatest trouble being due to sulphur in the atmosphere. The special precautions necessary in constructing machines to work under these conditions were only appreciated when gas-engine driving of generators came to the fore. It is now a well-known fact that the atmosphere in a gas-engine house calls for special precautions in the design of electrical apparatus. Even on switch contacts, &c., the atmosphere has a very bad effect. Open-type switchgear installed under these conditions should be at least of twice the usual capacity. When the gas-engine plant came to be installed it was decided to generate at 400 volts, three-phase, because this was the standard pressure to be used on the various colliery motors. To enable the gas-engine plant to be of service for the old coke-works plant, two 150-kw. synchronous motor-generators were installed, to convert from 400 volts alternating-current to 220 volts direct-current. They are started up from the direct-current bus-bars, and then synchronised.

The first two gas engines installed were each of 250 kw. and are of the "Duplex" type, made by Messrs. Mather & Platt; they are of simple construction and take up little room for the power developed. The gas-engine plant is now being extended. Two small Westinghouse sets of 55 kw. each are being installed for use at week-ends, and another set of 600 kw. by Messrs. Browett, Lindley & Co., which is designed on unusual lines, will shortly be delivered. Owing to an increase in the demand for current it was decided to develop about 600 kw., and after consideration it was desired to install two engines of 400 H.P. each, and there will be one alternator of 600 kw. capacity, arranged on its own bedplate, with two bearings. The alternator is to be between the two engines and connected to them by flexible couplings and friction clutches. The air to all the engines is filtered by a "Heenan" air filter, to deal

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

PRESCOT OVERHEAD EQUIPMENT.

The real secret of long life in trolley wire and fittings is smooth running, on a flexible line.

Excessive tensile strength of the trolley wire is at best a very doubtful *palliative;* well designed fittings and carefully erected non-fouling or Channel wires are a *preventive* of overhead troubles.

We are not only Copper Wire Drawers, but also Experts in the Design and Erection of the Overhead Equipment of Electric Railways and Tramways.

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

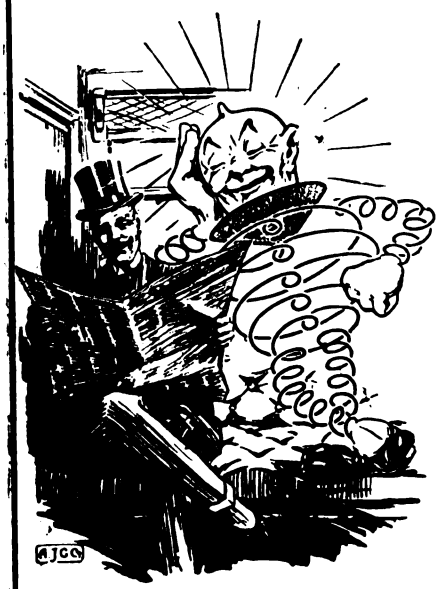
QUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026 Grams: Viamaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.
ELECTRICAL MACHINERY
Engineers, Edinburgh.
See our Illustrated Advt. last week.

Digitized by Google

For Train Lighting
POPE
ELASTA
(*British Made*)
WIRE LAMPS
Brilliant & Economical.

Pope "ELASTA" Lamps are made with a specially strong filament which withstands severe vibration; impervious to the jolts and jars of Railway Trains.



"What would you do without me on your journey home?"

Advt. of Pope's Electric Lamp Co., Ltd., Hythe Road, Willesden, N.W.10.

FOR
High and Low Tension
SWITCHGEAR
THE
NEW SWITCHGEAR CONSTRUCTION CO., Ltd.
SUTTON, SURREY, ENGLAND.
ABC Code 5th Edition. Telephone: Sutton 773.

Electrical Engineers and Manufacturers
The House for Electric Heating.
Special Offer of "Quead" and "Ensign" Fires from Stock.
Be Patriotic and Save Coal.
Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.
Telephone: Gerrard 7601 (2 lines)

Petrol Engine Sets.
Manufactured in sizes from 2 kw. to 20 kw.
Quotation for larger sizes on application.
F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON

with 1,200 cubic ft. per minute. The gas has an average calorific value of 450 B.T.U. and it is filtered through purifying beds and stored in a gas-holder of 250,000 cubic ft. capacity. The gas-engine plant has a capacity of 1,210 kw., and an additional unit of 600 kw. with 230 kw. from the high-speed steam engines makes a total for this station in the near future of 2,040 kw. The current from the station is stepped-up to 10,000 volts in an adjacent sub-station. In the same sub-station there are also step-down transformers, so that current can be taken from the other generating station if desired. At No. 8 colliery there is the mixed-pressure turbine plant consisting at present of two units each of 1,000 kw. capacity, by the Westinghouse Co. Provision is made for a further 2,000-kw. set in the near future. The voltage is 400, but is transformed to 10,000 volts for transmission to other collieries. For use underground at this colliery the current is stepped-up to 2,200 volts. The main switchboard consists of 11 panels; the transformers, h.t. switchgear, &c., are placed in the basement and entirely isolated. The switchgear is in cubicle form and is operated from the main switchboard above. The capacity of this station will be 4,000 kw., or a total of 6,040 kw. for the two stations. The Paper also gave a description of the plant at the various collieries, and stated that the various motors have been standardised. The particular machines to which this applies are as follows:—Screen type motors, 5 B.H.P., 15 B.H.P., 25 B.H.P. and 40 B.H.P.; ordinary open type, 5 B.H.P., 10 B.H.P., 15 B.H.P., 25 B.H.P. and 50 B.H.P.; haulage motors, 40 B.H.P., 70 B.H.P. and 100 B.H.P., all being of the wound-rotor type.

The supply at each colliery is controlled from a sub-station, equipped with step-down transformers. The neutral point, in each case, is earthed. Until recently the underground lighting was installed on the simplex, solid drawn, conduit system, with the usual fittings. Extensions, or replacements, are now being carried out on a new system, employing twin armoured cables, V.I.R., and bitumen sheathed, which can either be run along arching, suspended or buried. A special universal joint box is provided, one of which is fixed at each lighting point. If the cable is buried the junction box is threaded to take a 2 in. galvanised pipe, which terminates in the usual fitting, and so forms a strong standard. If, however, the cable is run along arching, or suspended, the boxes will take an ordinary ¾-in. conduit, to which is attached the gas-tight fitting.

The author demonstrated by means of model installation his method of underground signalling and also a system of visual signals, which displayed considerable ingenuity. In regard to the signalling system, every 400 yards or so along the haulage road a specially designed magneto is fixed, similar to the ordinary telephone ringing magneto, but more robust. The armature is driven through a train of gears as usual. On the slow-speed shaft a free wheel is fixed, similar to the bicycle free wheel. The line wire, which is also the pull wire, is taken over this free wheel and terminates with a weight. The other end of the line wire is made fast. This is repeated, say, every 400 yards, and all the magnetos connected in series, as also any bells required. The two extreme ends of the line are earthed. If the line is pulled at any point along the road, the nearest magneto armature will be rotated, generating alternating current, which is transmitted along the line and through all the bells or buzzers. Experiments on this system have exceeded expectations.

With regard to the visual signal installation, the indicator is of the luminous type. The signals given appear as a luminous stencil on an opaque ground, showing the number of rings given, the nature of the signal and the level the signal has been sent from.

COAL CUTTING BY MACHINERY.

Part II. of the General Report on Mines and Quarries for the year 1915 contains statistics as to the use of coal-cutting machines, output of coal, &c., in the United Kingdom. In 1915 coal-cutting machines were employed at 638 collieries, compared with 652 in 1914, and the total number of coal-cutters was 3,089 (against 3,093), of which 1,449 were operated electrically and 1,640 were compressed air machines.

In Scotland out of 908 machines 754 are electric cutters; in the Northern district, of 605 machines the electric numbered only 134; in York and North Midland the figures were 753 and 380; in Lancashire, North Wales and Ireland, 447 and 36; South Wales, 139 and 44; and in the Midland and Southern district, 237 and 101 respectively. Of the 1,449 electric coal cutters 770 are disc machines, 397 bar, 270 chain, 6 percussive and 6 rotary heading machines. The following table gives the quantity of mineral cut by machinery in the various mining divisions during 1915:—

Division.	Statute tons cut by Electricity.	Compr. air.	Total.
Scotland	7,690,752	1,207,098	8,897,850
Northern	1,266,107	2,365,053	3,631,160
York and North Midland	3,766,960	3,561,194	7,328,154
Lancashire, N. Wales and Ireland	306,204	1,850,177	2,156,381
South Wales	211,686	325,053	563,739
Midland and Southern	1,136,563	796,277	1,932,840
Total in 1915	14,378,272	10,131,852	24,510,124
Total in 1914	14,208,562	10,065,955	24,274,517

Digitized by Google

The New Prices of WIRUM Lamps.

The Brimsdown Lamp Works, Ltd., regret that present high costs of materials make it necessary for them to notify increased prices of WIRUM Lamps as below.

These New Prices apply to all orders received on and after April 16th, 1917.

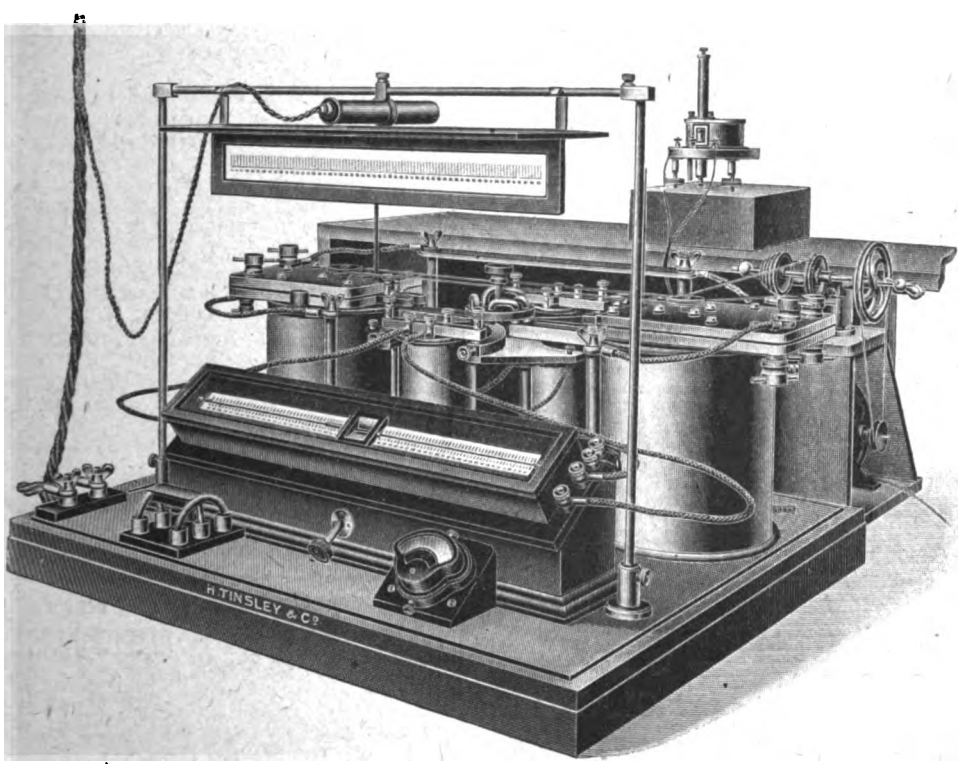
NEW LIST PRICES.

100/130 v. up to	50 c.p. (pear shape)	**2/6**	each.
200/260 v.	16 c.p.	**3/3**	,,
Do.	25, 32, 50 c.p.	**3/-**	,,
All voltages	100 c.p.	**5/-**	,,

The Brimsdown Lamp Works, Limited,

3, Brimsdown, Enfield Highway - - - Ponders End.

Accurate Resistance Measurement will be required in the future.



Standardising Bridge as set up in our Laboratory comparing two Resistances of ·0005 Ohm to one part in a Million.

All Laboratories should possess one of

Dr. C. V. DRYSDALE'S

Standardizing Bridges

(Kelvin, Carey-Foster principle)

For comparing resistances of ·00001 ohm and upwards.

H. Tinsley & Co.,

SOUTH NORWOOD, LONDON, S.E.

Digitized by Google

QUEENSLAND ELECTRIC SUPPLY AND TRAMWAY UNDERTAKINGS.

Up to the end of 1916 the following Orders in Council had been issued by the Public Works Department under the Electric Light and Power Act, 1896, authorising the supply of electricity within the areas mentioned :—

City Electric Light Co., for Brisbane ; Charters Towers Electric Supply Co. (since transferred to Charters Towers Gas, Coke, Coal & Light Co.), Charters Towers ; Rockhampton Gas & Coke Co., Rockhampton ; Bulloo Divisional Board, portions of Thargomindah and Wiralla parishes ; Commissioner for Railways, Eagle Junction to Indooroopilly railway station ; Thomas Tonks (since transferred to Toowoomba Electric Light & Power Co.), streets within the city of Toowoomba ; Rockhampton Harbour Board, Rockhampton ; Electric Energy Supply Co. (Ltd.), the whole town of Warwick ; Toowoomba Electric Light & Power Co., streets within municipality of Newtown ; David Edwards, sanitary area of town of Ayr ; D. S. M. Finemore (since transferred to Electric Supply Co. of Bundaberg, Ltd.), sanitary area of city of Bundaberg ; Ed. J. Redmond (since transferred to Electric Supply Co. of Childers, Ltd.), radius of about 2 miles from Childers post office ; Council of town of Dalby, the whole of town of Dalby ; Edwd. James Redmond, sanitary area of town of Gayndah ; Barcaldine Shire Council, whole of town of Barcaldine ; Council of town of Coolangatta, whole of the town of Coolangatta ; Jacob Binding, sanitary area of town of Kingaroy ; Bundaberg Gas & Coke Co. (Ltd.), whole of shire of Woongarra ; Electric Supply Co. of Bundaberg (Ltd.), Gooburrum and Barolin ; Frede. C. T. Dent, whole area within city of Gympie ; Roma Electric Light & Power Co., town of Roma ; Irvin S. Crow, whole of town of Gladstone ; City Electric Light Co., whole of town of South Brisbane.

Electric Tramways.—The Department of Public Works announce that up to date 33 Orders in Council have been issued by the Commissioner for Railways (under the Railways Acts, 1882-1890 and the Brisbane Tramways Act, of 1913) for the construction of electric tramways and extensions on the overhead trolly system, &c. In regard to the Brisbane tramways there was one Order authorising the use of electric traction in place of horses, and there were 25 Orders for extensions, with six Orders under the Brisbane Tramways Act of 1913. There was also an Order in Council authorising the construction of the Townsville tramways, *i.e.*, the main line to Show grounds and branch to Hermit Park.

ELECTRIC TRUCKS IN A BLIZZARD.

On Feb. 5 last New York City experienced a severe blizzard. A 50-mile gale accompanied the heavy snowfall, and traffic was badly affected. The American Express Co., which operates 245 electric and 259 petrol trucks in the city, reports that during the day they had 46 trouble calls from their motor trucks, six being from "electrics" and 40 from disabled petrol trucks.

It was found necessary to tow in two of the electric and 14 of the petrol trucks. This is another proof of the almost absolute reliability of the electric truck in all kinds of service and weather conditions for businesses requiring dependable transportation facilities. The electric commercial vehicle has made rapid strides during the last few years, and is fast becoming ar important factor in city transportation in the United States.

UTILISATION OF BLAST-FURNACE GAS IN SWEDEN.

Our contemporary "Engineering" announces that the Royal Waterfalls Board has made an agreement with the Oxelösund Iron Works Co. whereby all the blast-furnace gas from the works will be employed in the generation of electrical energy.

The aim is to produce a considerable quantity of electric current, of which the Waterfalls Board has secured the greater share ; this will relieve the Västeras steam central reserve of the Alfkarleby power station, and thereby reduce the expenditure for coal. The large Hemsjö Power Co. has entered upon an agreement for supplying large portions of the Kronoberg district with electric current from its large power stations at Mörrunström, by means of a line via Ryd and Grimslöf to Huseby. At the latter place it is proposed to erect electric furnaces for the exploitation of iron ore found in the district. Negotiations are also proceeding between the Hemsjö Power Co. and the State railways with reference to supplying power to the latter's peat factory, now in course of erection at Vislanda. In connection with the regulation of Lake Salen, with a view to obtain additional power, there is a scheme for laying dry some 1,000 hectares (2,470 acres) of land by means of electric pumping, the first attempt of this nature in Sweden. It is also proposed to extend the electric distribution scheme to Gransholm, Gemla and Växjö.

CLEANING BLAST FURNACE GAS BY ELECTRICITY.

The "Iron and Coal Trades Review" reports that at Bethlehem (Pa.) almost perfect cleaning of the raw gas leaving the dust catcher is accomplished in an electrical experimental treater. In the event of the ultimate installation of large electric precipitators in connection with new blast furnaces, in plants where gas fuel is at a premium, the logical plan would be to insulate all mains, &c., leading from the furnace to boilers and stoves, and from the latter back to the furnace ; this would include downcomers, dust catcher, precipitators, connecting mains, boilers, stoves and hot-blast system.

THE GREAT CENTRAL RAILWAY passes from the Metropolis Northwards through the centre of industrial England, throwing out its branches Eastward and Westward to the Coast.

¶ Its Lines run over the Great Midland Coalfield (of over 4,000 square miles area) which extends into the Counties of York, Nottingham, Derby and Lincoln. This Coalfield is the largest in the British Isles, and is estimated to contain not less than forty-nine thousand million (49,000,000,000) tons of coal.

¶ The important Coalfields of Lancashire and North Wales are also traversed by the Company's lines.

¶ There is thus afforded an easily accessible source of fuel supply.

¶ The New Eastern Port of Immingham should particularly attract traders, as its modern equipment and accessibility at any time of the day or night, irrespective of tides, are important time and labour saving factors.

¶ Adjoining the Great Central Railroad at various parts of the system are situated Valuable Sites for Works, where, by the introduction of siding accommodation, goods can pass right into and directly out of the works, which greatly assists the Manufacturer to attain his desired position in the World's Markets.

¶ For information please communicate with the G.C.R. Publicity Office, 216, Marylebone Road, London, N.W.

¶ Owners and Agents of LAND and BUILDINGS for SALE or TO BE LET near the Great Central Railway are requested to send particulars to the G.C. Estate Office, 12, Paton Street, Piccadilly, Manchester.

SAM FAY, General Manager.

ADMIRABLE SITES FOR NEW WORKS, FACTORIES, &c.

BASTIAN METERS FOR DIRECT CURRENT ONLY.

Made in ENGLAND with

BRITISH CAPITAL and BRITISH LABOUR.

THE BASTIAN METER COMPANY, LTD., BARTHOLOMEW WORKS, KENTISH TOWN, N.W.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,032. [Vol. No. 4 LXXIX.] FRIDAY, APRIL 27, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 137
Arrangements for the Week 139
Electric Vehicles. By C. G. Conradi. Illustrated 140
Wayleaves.—*Discussion* 142
The London and North-Western and Bakerloo Electrification. Illustrated.—*Continued* 144
Range of Wireless Stations. By Capt. R. Chenevix Trench, R.E. Illustrated.—*Continued*.. 147
First London Engineers Volunteers 149
THE RATING OF AUTO-STARTERS 150
REVIEW 150
Some Points for the Board of Trade Committee on Electric Power. By a Power Supply Engineer 153
High-Tension Overhead Transmission Lines. By G. V. Twiss. Illustrated 154
Training of Disabled Sailors and Soldiers for Electrical Sub-Station Work 155
LEGAL INTELLIGENCE 156
Patent Record 156
Volunteer Notices 156
COMMERCIAL AND INDUSTRIAL SECTION 159
Electricity Supply 160
Tenders Invited and Accepted 163
Financial Matters 164

NOTES.

Co-ordination of Electricity Supply.

UNDER the title of "Some Points for the Board of Trade Committee on Electric Power," we publish in another column the views of a power supply engineer on some of the problems of electricity supply industry in this country. Past history has much to do with the present situation. If only we could make a fresh start, things would be so much easier, but, unfortunately, things must be taken as they are. Undoubtedly greater foresight might have been shown in the past, so that a less tangled state of affairs would have been the result, but in any case it is impossible to map out completely the development of a growing industry, the importance of which was by no means realised in the early days. The position at the moment is that some £75,000,000 has been the expenditure in this country, and of this sum approximately one-half is on account of generating plant. If a clean sweep is to be made, this means an enormous capital expenditure and a heavy financial burden for many years until the unproductive capital is wiped off. It is this burden which always makes the engineer and the financier hesitate in taking a plunge for a clean sweep, and leads to a more gentle handling of the problem. The position would undoubtedly be much simplified if the State were to advance capital on easy terms. This is not an unreasonable proposition, for the country as a whole stands to gain greatly with a cheaper supply of electrical energy.

The Desirability of State Control.

ON the other hand, if the State advances capital, does this necessitate State control? We must confess that State control to any large extent does not appeal to us; it is liable to introduce inefficiency, more particularly in an industry which is not fully developed, and which should, therefore, not be dealt with on any hard and fast lines. On the other hand, some measure of State control has its advantages, and we think such control must be expected if capital is advanced by the State. It appears to us that the precedent set by the American Public Utilities Commission is one that might well be followed in this country. Such a method would safeguard the public interest, and at the same time would permit the distributors to form an operating organisation, this organisation dealing mainly with the question of generation on a large scale for bulk supply. There are many important problems connected with any scheme of this kind, one of the most important being that of the proper utilisation of our coal. There is a tendency at the present day to look more favourably on the question of preliminary treatment of coal so as to recover ammonia and other products before it is used as fuel. At present these valuable by-products are chiefly wasted. Unfortunately, they cannot be recovered without a certain expenditure of fuel in the process, and this no doubt is one of the reasons that has operated against the adoption of such processes hitherto. The proper utilisation of our coal is, however, so important a problem that it should be investigated with every care, and for this reason there is much to be said for the idea that all raw coal should be taxed to a small extent. Since a tax of only 1d. per ton would bring in a revenue of about £1,000,000 per annum it follows that the tax need not be at all considerable. Indeed, a sufficiently large sum could easily be obtained to investigate the whole problem in the national interest.

Practical Acoustics.

WHILE the study of the practical applications of light have made considerable progress during recent years it is somewhat surprising that there has been no corresponding advance in the scientific study of applied acoustics, which enter into many practical problems. Apart from its obvious relation to the design of musical instruments, it is an important factor in public buildings and in fog-sirens and similar sound-devices used at sea. The greatest handicap under which the study of such problems has suffered has been the difficulty of securing a precise standard of intensity. Measurement is an essential preliminary to scientific advance in any direction. Improved methods of measuring light and illumination have been a most important element in illuminating engineering. But the difficulties of making numerical determinations of the intensity of light, though considerable, are small compared with those attending corresponding measurements in the case of sound. The question has been recently taken up in the United States, and we notice in the "Journal" of the Franklin Institute a description of some interesting experiments by Mr. L. V. KING on the acoustic efficiency of fog-signal machinery.

The Inefficiency of Sound Devices.

IN the year 1873 trials on sound signals were undertaken by Trinity House, with the co-operation of Prof. TYNDALL. At that time it was found no sound signal could be relied upon for hearing at a distance of more than two or three miles. It was also found that the passage of sound through the atmosphere was unaffected by fog, falling snow, rain or hail, but that contrary winds caused interference and that sound-shadows might be formed by the intervention of points of land, and

Digitized by Google

due to other effects. Experiments followed in the United States, but as late as 1903 Lord Rayleigh remarked that the sound produced by a powerful steam siren, capable of being heard at a distance of eight miles, required energy to be expended at the rate of 100 H.P. This result indicated the need for an inquiry into the conditions affecting the acoustic efficiency of fog-sirens, and better results appear to have been obtained with the "diaphone," a specially designed compressed air siren due to Mr. J. P. Northey, of Toronto. A curious circumstance is that, according to Mr. King, the popular impression that sound-energy follows the inverse square law is rarely correct. In his original experiments Major Liversmore, in a report to the Lighthouse Board of the United States in 1894, made use of a jew's harp in a specially designed box as a comparison standard. Mr. King has made use of the more complete Webster phonometer, with which he obtained some interesting results. He finds that the acoustic efficiency, even of the latest and improved fog-sirens, is of the order of only 6 to 8 per cent., and even this is much greater than that of the majority of musical instruments. We gather that Mr. King's experiments have been inevitably restricted by the war. It is to be hoped, however, that the more general study of the use of sound-devices at sea is only postponed and will be resumed after the termination of hostilities.

National Education.

Those interested in education will note with pleasure many of the suggestions made by Mr. Herbert Fisher, the new Minister of Education, in introducing the education estimates in the House of Commons last week. We are glad to see that an effort is to be made to pay the teachers a living wage. Mr. Fisher very rightly stated that in education almost everything depends upon the personal element, and that if the teacher is bad the most costly buildings and equipment will not make up for his defects. Certainly the salaries at present paid for elementary teachers are no inducement to proper talent. It appears that before the war 42,200 certificated teachers were drawing salaries of less than £100 per annum. Mr. Fisher is rightly of opinion that the first condition of educational advance is that we should pay our teachers better, and that the State should pay them direct, so as to ensure that the increased salaries go into the rightful pockets. Another point to which Mr. Fisher also referred was the care of our children immediately above the age at which they leave school. It is then that they are most impressionable, but the country fails to get the best value from the education that has been given, because so much of the training and instruction is quickly lost. The view that we should economise in the human capital of the country, which has been too long allowed to run to waste, is one that is eminently sound.

British Science Guild.—At the Annual General Meeting of the Guild, which will be held at the Mansion House, London, on Monday next at 4 p.m., an Address will be delivered by Lord Sydenham, and among the other speakers will be Sir William Mather, Mr. H. A. L. Fisher (Minister of Education) and Mr. H. G. Wells.

Combined Research Institute for the Entente Nations.—Mr. Audiffred has proposed to the French Senate the creation of a special Institute for Scientific Research on the part of the Entente nations and neutral countries. Such an institution would serve to collaborate researches of common interest and is complimentary to a similar proposition suggested in Parliament in 1901 but intended to apply to France only. In these days of specialisation there is certainly a need for some centre where the mutual relations of researches in different fields can be established.

Board of Trade Committee on Electric Power.—Sir Albert Stanley has nominated Mr. J. F. Crowley, D.Sc., B.A., M.I.E.E., to be an additional member of this Committee in order to watch the interests of Ireland during the inquiry.

The Héroult Electric Furnace.—According to "Engineering," licences have recently been granted by the United States Steel Corporation for five 6-ton Héroult electric furnaces for making special steels, and one 2-ton furnace for making special alloys. The installation of these six furnaces will bring the total of this type operating, or contracted for, in the United States and Canada to 114. Of these 30 have been licensed since January 1st of the present year.

Efficiency Cost of Steam and Electric Winding Plant.—In a recent Paper before the South African Institute of Electrical Engineers, Mr. H. W. Clayden compares three forms of winders employed in the Rand mines, and gives the average monthly cost during April, May and June, 1916, of the Ward-Leonard, three-phase and steam types, as follows :—

	Ward-Leonard.	Three-phase.	Steam.
Average shaft H.P. hours	25,436	26,124	20,425
Attendance, oil and E.R. stores	0·158d.	0·161d.	0·176d.
Repairs, wages and stores	0·97d.	0·292d.	0·035d.
Power, electric and air or steam	0·893d.	1·038d.	1·746d.
	1·148d.	1·491d.	1·957d.

He finds that the Ward-Leonard is not only the most efficient and cheapest both in power and maintenance, but is by far the easiest winder to operate.

Electricity Supply From the Gas Point of View.—At the annual meeting of the Scottish Gas Managers held at Glasgow the other day, Mr. Charles Fairweather, gas engineer of Kilmarnock, delivered a presidential address, in the course of which he said that the development of electricity supply had brought the gas industry from being a monopoly down to the level of a competitor, but the change had been for the good of the industry. To-day in all large cities the two industries progressed side by side. Each had its sphere and its limitations. In thickly populated districts central stations for electricity supply would be paid down and current distributed to the surrounding areas at the lowest possible cost. This was the latest form of competition they had to face, and they were handicapped by the large number of small gas undertakings already in existence, whereas in electricity supply there was no such impediment to progress. By high pressure distribution of gas they must render available long lines of mains and so absorb the smaller undertakings.

The Industry's Pledge.—The following letter appears in the "Electrical World" from Mr. E. W. Rice, jun., President of the General Electric Co. :—

The President's message expresses in simple but powerful words the solemn and final judgment of a great peace-loving people on the issues of this great war.

While every thoughtful citizen must realise the gravity of the steps which we are now taking, there will be no holding back, and no matter what trials the future may have for us, the knowledge that we are fighting in defence of all that makes life worth living will enable us to persevere until victory for ourselves and our natural allies has been obtained.

Men of the electrical industry, representing every phase of scientific and engineering activity, will be able to render invaluable service, as a modern war, as is well known, cannot be won by courage and strength alone, but demands skill in control of complicated machinery, and the use of scientific methods all the time and everywhere.

This is not a war between peoples, but a mighty conflict of irreconcilable ideals of Government and of life, and there can be no question, therefore, that every citizen of this country who treasures our ideals will welcome the solemn privilege which has been forced upon him of fighting for them. We all devoutly hope and believe that the entrance of our nation on the side of liberty and humanity will bring to a speedy end this terrible scourge of the world.

The Metric System in the United States.—In view of the recent discussion on the metric system at the Institution of Civil Engineers on the 22nd ult., it is of interest to note that a conference on the subject was held at the last meeting of the American Association for the Advancement of Science. The outcome was the formation of a permanent organisation, to be known as the American Metric Association, to further the adoption of the international metric, gramme and litre, which, it may

Digitized by Google

be noted, were legalised in the United States as early as 1866. Discussions on the subject in this country have proved somewhat inconclusive, the obvious advantages of a change being countered by conjectured difficulties in altering existing methods. It would certainly be a pity if the opportunity of making progress presented by our present close relations with the industries of allied countries using the metric system did not lead to some practical step forward being taken.

Institution of Electrical Engineers.—*Election of Council.* At a recent meeting of the Association of Municipal Electrical Engineers of Lancashire and Cheshire the following resolution was passed :—

That the members of the Association of Municipal Electrical Engineers of Lancashire and Cheshire congratulate Mr. Wordingham on being nominated as President of the Institution of Electrical Engineers, and desire to place on record their high appreciation of the services rendered by him to the profession over a long period of years.

The Association regrets to note that opposition to the nomination of Mr. Wordingham has arisen in certain directions, apparently because he has at times offered candid criticism on various matters which have been the subject of debate at engineering meetings. The Association feels that instead of criticism being the ground for objection to Mr. Wordingham's nomination for this office it should rather be considered a qualification, as honest criticism must at all times act beneficially in regard to any subject of a debatable nature.

The Association enters its strong protest against the unfair attacks which have been made against Mr. Wordingham's nomination, as by reason of his official position he is obviously unable to reply thereto.

The following members were present and signed the resolution :—

S. L. Pearce.	P. P. Wheelwright.	A. W. Clegg.
J. A. Robertson.	H. Wilkinson.	C. J. Wood.
R. Blackmore.	C. L. Stewart.	W. Chamberlain.
H. Dickinson.	A. T. Smith	J. E. Starkie.
S. J. Watson.	W. J. H. Wood.	D. H. Davies.

Mr. G. W. Partridge has been nominated as an additional candidate for the position of Vice-President at the forthcoming election of the Council by the following members :—

Frank Bailey, C. A. Baker, R. W. Blackwell, F. A. Bond, W. W. Blunt, H. R. J. Burstall, H. J. Cash, J. K. Catterson-Smith, C. B. Clay, H. W. Couzens, Philip Dawson, A. C. Eborall, A. L. C. Fell, H. W. Firth, Haydn Harrison, W. T. Hodgson, R. H. Houghton, A. E. Jackson, C. Jones, H. A. Madge, E. Manville, P. V. McMahon, E. W. Monkhouse, N. W. Prangnell, J. H. Rider, H. W. Ridley, F. F. Robinson, L. L. Robinson, C. Newton Russell, W. Rutherford, J. Sayers, H. Scholey, W. C. P. Tapper, G. H. Verity, F. J. Walker, A. H. Walton.

Institution of Civil Engineers.—At the Annual General Meeting of the Institution of Civil Engineers held on Tuesday evening, April 17, the result of the ballot for the election of officers was declared as follows :—

President : Mr. William Barton Worthington (Derby) ; *Vice-Presidents* : Mr. John A. F. Aspinall (Liverpool), Mr. Harry E. Jones (London), Sir John Purser Griffith (Dublin), Mr. John A. Brodie (Liverpool). *Other Members of Council* : Dr. Charles C. Carpenter (London), Dr. Dugald Clerk, F.R.S. (London), Col. R. E. B. Crompton, C.B. (London), Mr. Maurice Deacon (Matlock), Sir Archibald Denny, Bart. (Dumbarton), Mr. William H. Ellis (Sheffield), Sir Robert R. Gales (India), Mr. A. J. Goldsmith (Queensland), Sir Robert A. Hadfield, D.Sc., M.Met., F.R.S. (London), Brigadier-General B. H. Henderson (London), Mr. Robert W. Holmes (New Zealand), Prof. Bertram Hopkinson, C.M.G., F.R.S. (Cambridge), Mr. G. W. Humphreys (London), Mr. Summers Hunter (Tynemouth), Dr. W. H. Maw (London), Mr. Charles L. Morgan (London), Mr. Basil Mott (London), Sir Henry J. Oram, K.C.B., F.R.S., Engr. Vice-Admiral (London), Mr. Frederick Palmer, C.I.E. (London), Capt. H. P. R.-Sankey, C.B., R.E. (ret.) (London), Sir John F. C. Snell (London), Mr. E. F. C. Trench (London), Mr. William F. Tye (Canada), Sir Philip Watts, K.C.B., LL.D., F.R.S. (London), Mr. Edward J. Way (South Africa), Sir Alfred F. Yarrow, Bart. (London). This Council will take office on the first Tuesday in November, 1917.

The Council of the Institution of Civil Engineers have made the following awards for Papers read and discussed during the Session 1916-1917 : Telford Gold Medals to Messrs. G. W. Humphreys and J. B. Ball (London) ; George Stephenson Gold Medals to Messrs. P. V. O'Brien and John Parr (Perth, W.A.) ; Telford Premiums to Messrs. P. V. O'Brien (Perth, W.A.), J. L. Hodgson (Luton), W. Brown (Glasgow), and P. M. Crosthwaite (London) : and a Crampton Prize to Mr. F. J. Waring, C.I.E. (London). The awards for Papers published in the "Proceedings" without discussion will be announced later.

It is announced that candidates for the Associate-Membership examination will in future be required to show a suitable knowledge of one of the following languages : French, German, Hindustani, Italian, Russian or Spanish.

OBITUARY.

Deaths on Active Service.—The following deaths on active service are reported :—

We regret to record the death of Mr. H. A. S. White, A.M.I.A.E., senior motor engineer of a salvage vessel of the Royal Fleet Auxiliary, who was drowned, in consequence of the vessel being driven ashore in a heavy gale on the 11th inst. Mr. White, who was 29 years of age, and was the only son of one of the oldest employees of The Electrician Co., started business on his own account as a motor engineer in 1910, and since March, 1916, he held an Admiralty appointment. He had been a lecturer and instructor in motor-car engineering at the Farnham, Guildford and Wimbledon Technical Institutes, and at the last-mentioned institute he was engineering assistant master in the junior technical school and evening classes. In 1912 he passed the City and Guilds final honours examination in motor car engineering, and was placed on the City and Guilds list of registered qualified teachers. In 1913 he was elected an Associate Member of the Institution of Automobile Engineers. He was in charge of the electric lighting on the vessel on which he was engaged, and only returned to duty after a short leave on the 8th inst. Mr. White held an experimental licence for wireless telegraphy until the outbreak of war.

Lieut. J. C. Wright, R.G.A., 25 years of age, who was killed on April 10, held the B.Eng. degree of Liverpool University.

Second-Lieut. A. A. Johnston, R.F.A., formerly in the G.O. dept. of the India Rubber, Gutta Percha & Telegraph Works Co., died of wounds on the 16th inst.

Capt. E. M. Green, Hampshire Regt., 27 years of age, missing and unofficially reported killed, received scientific training at the City and Guilds Technical College, Finsbury, and afterwards became a chartered patent agent.

Sergt. J. Place, E. Lancs. Regt., killed in action, was formerly a conductor on the Burnley tramways.

PERSONAL.

Mr. A. H. Seabrook, the general manager of the Marylebone Electric Supply Dept., has been asked by Sir Arthur Duckham, chairman of the Advisory Committee of the Ministry of Munitions, to advise him in connection with a scheme for securing the economical use of coal.

Mr. A. H. Desforges, who has been in the service of Messrs. Siemens Bros. & Co. (Ltd.) nearly 20 years, has been gazetted Second-Lieut. (temp.), and appointed Equipment Officer, R.F.C.

Mr. R. C. Sticht, who has been appointed by the company owning the Mount Read-Rosebery (Tasmania) mines to make investigations and conduct experiments in connection with the electrolytic treatment of Hercules and Rosebery ores, recently left Tasmania for America. He anticipates being away for six months.

The Director-General of National Service has appointed Mr. R. E. Graves to be Director of Substitution.

War Honour.—We learn that Bomb. A. R. Biggs (R.G.A.), formerly in the India Rubber Co.'s rubber department at Silvertown, has been awarded the Military Medal.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, April 27th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, Exhibition-road, S. Kensington, S.W. Papers on "A Note on the General Equation for Wave Motion in an Elastic Medium," by Prof. J. A. Fleming, F.R.S. ; "The Effect of Stretching on the Thermal Conductivity of Wires," by Mr. A. Johnstone, B.Sc. ; and "Cohesion," by Prof. H. Chatley, D.Sc.

MONDAY, April 30th.

British Science Guild.

4 p.m. At the Mansion House, E.C. Annual General Meeting. Address on "National Reconstruction," by the Rt. Hon. Lord Sydenham, F.R.S.

Royal Society.

4.30 p.m. At the Royal Society, John-street, Adelphi, W.C. Howard Lecture on "Works Organisation and Efficiency," by Prof. W. Ripper, D.Eng., D.Sc. (Lecture II.)

TUESDAY, May 1st.

Faraday Society.

8 p.m. At the Rooms of the Chemical Society, Burlington House, W. General Discussion on Osmotic Pressure. Papers on "The Colloidal Membrane : Its Properties and its Functions in the Osmotic System," by Dr. F. Tinker ; "Osmotic Pressure in Relation to the Constitution of Water and the Hydrates of the Solute," by Mr. W. R. Bousfield, F.R.S.

THURSDAY, May 3rd.

Institute of Metals.

8.30 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, S.W. The "May Lecture"—"Researches made Possible by the Autographic Load-Extension Optical Indicator," by Prof. W. E. Dalby, F.R.S.

Digitized by Google

ELECTRIC VEHICLES.*

BY C. G. CONRADI.

Electric vehicles, although rapidly increasing in number in this country, are not a very familiar sight in our streets. In the United States it is otherwise. There are already over 35,000 electric vehicles in the States, and the fact that 70 per cent. of recent orders were repeats speaks for itself. In Greater New York there are over 2,500 commercial electrics, which is some 43 per cent. of the total number of vehicles used for commercial purposes.

High-speed, high-powered touring cars have no doubt led business men to call for the same features in vehicles required for commercial and town use, in ignorance of the fact that running costs go up within limits roughly as the square of the speed.

In comparison with horse traction, it is found, when all expenses have been duly charged, that in practically all spheres of operation horse traction is more expensive and less efficient than motor traction, its best relative performance being in very short haul traffic, with numerous stops, a service suitable to its low speed and radius of action. This can be readily understood, as the capital costs in the case of a horse and its comparatively inexpensive vehicle are low, whilst the repairs item is almost non-existent.

A deterrent to the more general use of the electric passenger vehicle is no doubt the high first cost. Under normal conditions and with continually increasing output, prices will fall; but it is questionable whether the £100 electric of Dr. Steinmetz will ever be realised, although it has recently been announced that a New York firm are putting a vehicle on the market at £200, whilst the already large numbers of taxis in American towns are to be swelled by an additional 500 in New York, and a similar number in Chicago. In spite of high cost, and probably assisted to some extent by the abnormal conditions under which the petrol vehicle finds itself, the number of electrics has increased in about two years from 75 to over 1,000, with ever increasing acceleration.

The "Fram," which is a French machine, is a good instance of the possibilities of designing the chassis readily for a special purpose. This has some unusual features. The power unit is completely installed on a detachable fore carriage, which can be used with a number of bodies designed if required for different duties. Special loading devices can be employed, and winches, capstans, tipping gear, &c., run off the car battery. It is most important that full advantage should be taken of such auxiliary apparatus in order to distribute the capital charges and wages over a greater mileage, the main idea being to keep the high priced vehicle moving and at work, not standing for long periods idle whilst being loaded or unloaded.

Features which have been pointed to as serious drawbacks to the electric vehicle are its comparatively low speed and the weight of the battery. First as regards speed, what is required for urban work is the maintenance of as high an average speed as is economically possible. I would draw attention to the following figures, which give the results of a series of tests published in "Central Station" between an electric and a petrol lorry geared respectively for 12 and 18 miles per hour. The course was triangular and the roads good. Duration of stops in the case of (*a*) two minutes, (*b*) one minute; number of stops 24; distance between stops 0·42 mile.

	Average speeds		
	Electric.		Petrol.
(*a*) Leg 1 level	10·76	.....	9·41
,, 2 up	7·08	.....	8·85
,, 3 down	11·12	.....	7·2
Average	9·65	.....	8·48
(*b*) Leg 1 level	11·4	.....	10·08
,, 2 up	6·9	.....	7·83
,, 3 down	11·8	.....	10·56
Average	10·03	.....	9·48
General average	9·84	.....	8·98

This shows the average speed of the electric to be approximately 10 per cent. higher, although geared and powered for a 30 per cent. lower speed. The battery considered alone is certainly a heavy piece of apparatus, but when the total weight of the different types of vehicle are considered it will be found that the electric is only a few hundredweights the heavier, and this at the low maximum speeds in use is no great disadvantage.

For commercial vehicles the most common design embodies a plain rectangular channel or pressed steel frame, semi-elliptical springs with countershaft, and roller chain drive to the rear wheels, the motor being connected to the countershaft, which carries the differential gear by silent chain, spur or bevel gear. Other less usual but more flexible designs employ motors built into the wheels themselves, two or all four wheels being driven as desired. The most notable example of this design is the Cedes, in which a distributed field is used, and many of which are in use in London on ambulance and fire brigade work, giving a mileage of up to 100,000 without appreciable depreciation taking place.

The Walker Vehicle Co., of Chicago, build the complete power unit in the back axle, which consists of a torpedo-shaped casting containing a single motor and the differential gear. The motor spindle is hollow, and encircles the drive shaft, which passes through the centre of the axle. Each end of the drive shaft carries a pinion which engages with two idler wheels, one on each side of the centre line, these in turn driving the internal toothed ring, which is practically the full diameter of the wheel.

The Commercial Truck Co. until recently employed worm gear on their smaller chassis. This, however, has now been brought into line with their other sizes, where a motor with concentric double reduction epicyclic gear is used on each wheel. In the heavier machines all four wheels are driven, with usually only the front wheels steering. Some makers have developed four wheel steering, but it is seldom that this is necessary, besides which it greatly increases first cost and leads to difficulties in steering.

The Couple Gear Co. use a high-speed motor mounted in a fixed horizontal position in the wheel, its shaft carrying a bevel pinion at each end, gearing with two parallel bevel rings on which the road wheels are mounted. The motor is set at a slight angle to the plane of the wheel, so that the pinions engage with their respective halves of the racks whilst being free of the other half. A reduction of 25—1 is used, and an efficiency of 97½ per cent. is vouched for by the American Bureau of Standards.

In the wheel drive of the Mossay vehicle, which is now being built in this country, internal helical gear is used with a reduction of about 15 : 1. A special feature of this design is that the vertical axes of the steering pins are in the centre plane of the wheel, which reduces steering forces to a minimum and prevents road shocks being transmitted back to the steering wheel.

A vehicle which has been largely used by the municipal authorities in Paris, Nancy and other towns in France, is the Fram, in which all of the driving mechanism is carried on a detachable fore-carriage. Steering is assisted by accelerating the outside motor above the speed of the other by means of an automatic attachment to the steering wheel. This throws 27 cells out of the complete 44 on to the outside motor and 17 cells on the other.

A fact that strikes one in studying the design of the various vehicles now on the market is that no two are exactly alike, but no doubt each designer has had in view the obtaining of as high a mechanical efficiency as possible. This is very essential in electrics, as low efficiency seriously affects the battery, and through it the speed and effective radius of the vehicle. Ball or roller bearings are usually considered essential as affecting the efficiency, especially on heavy loads and in frequent stop service; but it is very questionable to my mind whether they justify themselves commercially, as they add both to the weight and first cost of the vehicle. The former give good results on the motors and countershaft, but for the wheels roller bearings are desirable, especially the Timken type, which allow of adjustment for wear.

The Battery.—The types of battery available at the present time number practically only two—viz., the lead sulphuric acid combination and the iron-nickel alkali cell. The former may be further divided into the flat plate and the ironclad exide, in which the active material of the positives is enclosed in hard rubber tubes. To secure lightness, the ordinary flat plate in the past has been reduced until it is usually only about ⅛ in. thick. Plates of this thickness are not such as will stand up to excessive vibration or buckling stresses, and, although well supported by separators, require to be taken out at fairly frequent intervals—say after 4,000 to 5,000 miles running—and the sediment washed out of the containing boxes. The spacing of the plates is arranged to be the minimum that the volume of electrolyte will permit, whilst the specific gravity is kept high, frequently as high as 1,300. The separators are usually of wood ribbed on one side and plain on the other, the plain side being placed next to the negative plate and the ribbed the positive, with a thin perforated sheet of ebonite between. Celluloid should not be used for separators, as the strong acid eventually attacks this.

The boxes are made of hard rubber with sealed-in but removable lids, which prevent splashing, rubber vent plugs being fitted to allow of the addition of distilled water, the taking of gravities, &c.

The ironclad battery costs nearly double what the thin flat plate

*Abstract of a Paper read before the Derby Society of Engineers.

Digitized by Google

battery does, but as it has many advantages besides that of having at least double the life it no doubt is the better paying proposition. It can run a much longer time without cleaning out, and it can be boosted at very high rates. This capacity for taking high rate boosting charges which the ironclad enjoys, together with the Edison battery, has entirely altered the radius of action of electric battery vehicles. For instance, the vans used by a cartage company in London, which have a normal radius of about 40 miles, are doing 70 miles per day regularly by reason of their having a mid-day boost of 1½ hours.

The only factors in charging at high rates which may act injuriously are gassing and heating, and these appear when more current is being passed through the battery than the plates can utilise. When the battery has been fully discharged, 50 per cent of the charge can be put back in an hour without damaging it in any way.

The method requiring least attention is that where a constant potential of 2·3 volts per cell is applied, and by which some 90 per cent. of the charge can be got in. It is necessary, however, that the charging apparatus should be fit to stand this, as the current at commencement of charge with a fully discharged battery will be five times the normal—*i.e.*, the instantaneous current on a 2-ton vehicle battery will be 200 amperes, which will, however, fall to about 40 amperes in two hours.

Great care appears to have been bestowed on all the details of the Edison cell, and it is mechanically fit to stand up to all the abuse which is likely to be met with in vehicle working. As is to be expected from a consideration of the construction of the Edison battery, its cost is high, and for the same duty is roughly twice the price of an Ironclad Exide, although, on the other hand, it is guaranteed to give at least double the life and require very little attention. The voltage is low, only 1·2 per cell, but the individual cell is light, and the larger number required does not mean an increase in total weight. The internal resistance is high, which is a disadvantage for some classes of service.

The cell known as the "Alklum" is similar in type and construction to the Edison, and is based on a prior patent to the Edison, granted to E. W. Jungner in 1899.

The location and design of the battery compartment are important, and must be such as to involve the minimum amount of labour in giving the battery attention. It is most commonly slung from the underside of the frame, and in this case should be preferably arranged for drawing out on rollers in such a manner as to expose every cell fully to view. A particularly neat arrangement of this kind is that employed on the Mossay chassis, where the battery is contained in two boxes carried by rollers on cross channel irons on the underside of the frame. The rollers are attached to the boxes by levers, and are normally out of action until the levers are raised, when the weight is transferred to them and the boxes easily drawn out sideways. Another method is to make the whole compartment easily removeable, but this entails the use of a small truck and some form of lifting and lowering gear. This method is very suitable where a system of battery hire is in force, as it enables a discharged battery to be quickly replaced by a charged one, with only a few minutes' delay to the vehicle.

In the G.M. design the battery is placed above the frame and partly under the driver's seat, where it is always accessible at a moment's notice, the only objection being that it lengthens the whole chassis a matter of perhaps a couple of feet. A usual position for the battery on pleasure cars is under a hood in front, giving it a very similar appearance to a petrol car.

The batteries which we have examined will be seen to have different characteristics, and therefore they are not equally suitable for all services. Thus the flat plate lead battery is most likely to be used for light work, where often low first cost is a desideratum, and where heavy discharges are not likely to be often called for, although in the case of private owners the attention required by a lead battery, which must be to a certain extent skilled attention, may make the more expensive alkaline battery a more attractive proposition.

For work on heavy and hilly routes the Ironclad Exide has the advantage of being able to give heavy discharges without dropping its voltage appreciably, and with the advantage over the flat plate battery that heavy charging and discharging can be done without much risk of loss of active material.

The alkaline battery, and more particularly the Edison, is probably most useful where charging time is limited and full advantage can be taken of its capacity for rapid charging and where rough usage is likely to be the rule. Unless other conditions favour its use, it should not be used where current is expensive, on account of its lower efficiency, and for the same reason it is at a disadvantage on hilly routes. As far as can be ascertained, the Edison battery is foolproof, provided nothing but distilled water is added to it and its temperature is not allowed to rise above 140°F.

On account of battery capacity, it is desirable that motors for road vehicle work should be as light and efficient as possible without sacrificing anything in the way of reliability. They should be specified to give 300 per cent. overload without sparking, and this they are frequently called upon to do in practice.

It is not usual to fix either fuses or automatic cut-out switches in the power circuit, and no great apparent need for these has arisen

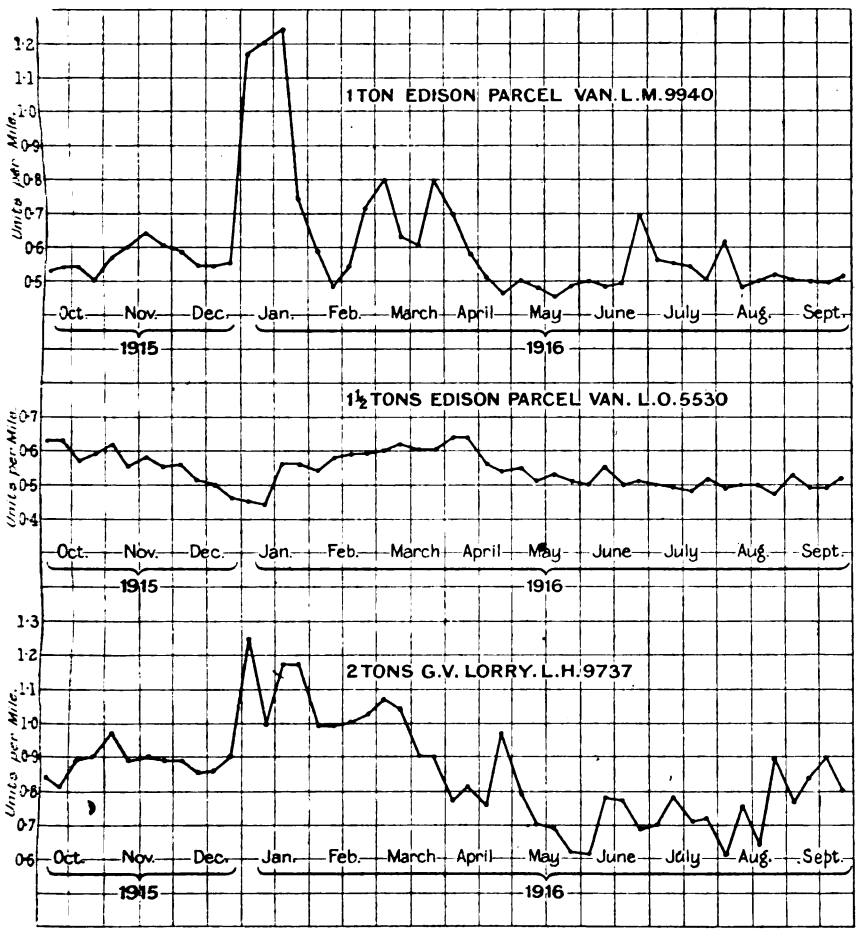


Fig. 1.—Records of Energy Consumption.

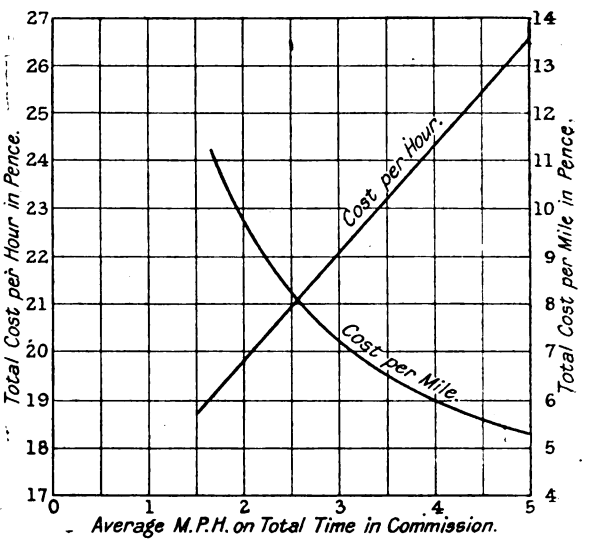


Fig. 2.—Curves showing Variation of Cost with Time in Commission.

Digitized by Google

in operation: the light and horn circuits of electrics are, however, protected by fuses, and an automatic cut-off switch operated by a contact on the meter is generally fitted in the charging circuit in the case of vehicles using lead batteries to prevent overcharging. A reversible electricity meter with large dial should be fitted on battery vehicles to show at all times the state of the battery. A very useful type of meter is that manufactured by the Sangamo Electric Co., in which a form of differential shunt is used to compensate for battery inefficiency and give preferably a correct reading on charge and run fast on discharge to an adjustable extent. The amount of such adjustment will vary according to whether the battery is lead or alkaline type, and also with the nature of the work which is being done.

Conditions of service vary so widely that it is impossible to set down figures for running costs without making a study of each individual case. Fig. 1 shows the weekly consumption of current of three vehicles throughout a year's working. The curves indicate two maximum periods, usually occurring in autumn and spring, with a low point at Christmas and low all through the summer. The maximum periods of consumption coincide with the wet periods of the year, the roads being generally hard and dry round about Christmas. In the case of the 1-ton Edison vehicle, the peak in January was found to be due to the vehicle having to be run with a broken spring (front) and the body blocked up with wood, when no doubt the wheel was somewhat out of line.

Fig. 2 emphasises the fact that high priced vehicles should be kept running as much as possible of their time, so as to spread the capital charges and keep down the cost per mile. A good return is obtained on money spent on loading devices, and therefore no pains should be spared to scheme out the best methods.

The electric vehicle should be backed up as strongly as possible by central station engineers, as from their point of view it provides a very profitable load, being mostly off the peak, and it may also be quite an extensive one, an average sized vehicle consuming 12,000 units per annum, representing at 1d. per unit a revenue of £50, with little if any additional capital expenditure.

WAYLEAVES.

The following is an account of a discussion which took place before the Institution of Electrical Engineers on Mr. C. Vernier's Paper on the above subject. An abstract of the Paper appeared in The Electrician of April 20th :

Mr. C. H. Wordingham said it was essential to the success of large power undertakings that there should be overhead mains, and also that such underground mains as there were should be taken by the most direct routes. It was also important that existing rights—local authorities or private—should not be unduly interfered with. In many instances, however, these rights had been employed in an iniquitous manner to obtain advantages to which the authorities or persons had no possible claim, and which could not have been contemplated by Parliament when their rights were granted. As Mr. Vernier said, there should be an appeal to some competent tribunal, composed of persons having judicial functions and accustomed to weighing evidence and aided by expert and impartial advisers on the technical points.

Col. A. M. Ogilvie said the evil dealt with by the Paper required more than ever to be dealt with in view of the large possibilities for electricity which were expected to follow the war, when he thought Parliament and the public would be in a more reasonable spirit in regard to the matter than they had been before the war. The Post Office Bill giving rights of wayleave over private property was passed last year without serious opposition. Mr. Vernier referred to the satisfactory statutory powers obtainable by power enterprises under the Electric Lighting Acts. He did not regard them as satisfactory. An enterprise without statutory powers was in an equally good position to obtain wayleaves over private property. Both depended upon negotiation. The undertaking without statutory powers was not restricted in its power of placing wires over a roadway, whereas the authority with statutory powers had to get the consent of the local authority, which might attach unreasonable conditions. The Post Office had suffered enormous inconvenience and loss from the difficulty they had in dealing with public authorities. There were such an enormous number of road authorities guided by advisers with extraordinarily varying knowledge of the law. There was a strong case for legislation in that respect as well as with regard to powers over private property, with regard to which the resonableness of Mr. Vernier's scheme could not be doubted. There should be a judicial body to determine the conditions on which statutory rights over private property could be obtained. This should not be put in the hands of individual arbitrators advised by surveyors unfamiliar with the conditions applying to electrical work. The Post Office found County Court Judges and Stipendiary Magistrates varied extremely in their views and gave unreasonable judgments. The Post Office had the right of appeal to the Railway Commission, and they would prefer always to deal with a regularly constituted body with experience of the circumstances to be considered.

Mr. W. B. Woodhouse said the existing legislation did not give them the freedom they should have. One or two additional reasons why compulsory wayleaves for overhead wires should be obtainable were as follows : In many districts underground mains were dangerous because the districts were undermined. There was often a case on those grounds for running overhead lines on higher pressures than Mr. Vernier had mentioned, and the power companies also had to transmit very large amounts of power for some distance. The wayleave of to-day involved two lines at the worst, but that of the future might involve a dozen, and rights over wide stretches of country would be required to get the current away from their big power stations. It was an urgent necessity if they were to develop on those lines, and it was practically the only way the demand could be dealt with to-day. Still further wayleaves would be required when railway electrification was done on a general scale. The national need for electric power was as great as for telegraphs and telephones, and the valuable precedent of last year's Bill must not be lost sight of. The recommendation of Lord Cross's 1900 Committee with regard to wayleaves for wires, cables, pipes and other things mentioned by Mr. Vernier, had not been acted upon. There was no need to distinguish between a county borough and an urban district council. Their constitution had nothing to do with the nature of the way over which one wanted to take the overhead lines. The suitability of overhead lines should be determined by some tribunal sitting locally. A wayleave could not be granted under the Settled Lands Act for more than 21 years. That point might be dealt with in new legislation. In dealing with lands in the hands of trusts or executors it was sometimes necessary to pay a great deal for legal expenses. In one case he had to get a wayleave for about two miles of mains, and the legal expenses were nearly £100. A business had grown up of seeing how much could be got out of public supply authorities in that way. He got a wayleave for six poles, terminable by six months' notice, and the legal expenses were £9. It was scandalous that a supply authority should be robbed in that way. There should be no veto by a small local authority. An urban district council offered to give his company permission for a 10,000-volt line on condition that it was covered with insulation throughout. He trusted the whole question of wayleaves would have the attention of the Board of Trade Committee that was now sitting. The Institution should support with one voice Mr. Vernier's recommendations.

Mr. D. A. Starr said he trusted the recommendations in the Paper would awaken our legislators to the unsatisfactory conditions under which the electric supply industry was operating. In Scotland, however, there were not so many obstacles. Harmonious relations existed between the undertakers and the local authorities, who were really the County Councils and who mostly acted as reasonable business men. His company had many miles of overhead lines, mostly on private ground. A special department under the guidance of a skilled valuator dealt with wayleaves. They had little trouble now with the local authorities, the Board of Trade dealt with the matter in a public spirited manner, and the regulations imposed were not onerous. The company had demonstrated to the satisfaction of the road surveyors that overhead crossings were not dangerous, if constructed in accordance with the Board of Trade Regulations, and they generally advised the County Councils accordingly. The author did not refer to private roads open to the general public and public roads over and under railways. These were almost as important as the matters dealt with. The imposition of easement rents in the case of roadways open to the general public was unjust, and merited prompt redress. The granting of authority might be vested in local authorities, as in the case of highways, and without payment. His company had a satisfactory arrangement with the railway companies. The latter fixed for cables over or under the railway an annual nominal rental, or charged a rate per mile and a rate per 1,000 units per mile per annum. The annual rental asked by some landowners was extortionate. Model rates stated to landowners when giving them plans, particulars of pole positions, &c., were 1s. per pole standard per annum, and 1d. per lineal yard per annum for cables laid solid, and the company undertook to remove the cables on receipt of six months' notice, and to settle all reasonable claims for surface damages sustained by tenants in consequence of the laying, maintenance or removal of cables. Negotiations were opened with the agricultural tenants, and their support enlisted if possible. Some progressive farmers welcomed the proposals, as they required power supply, and they were sometimes provided with transformers as a set-off against damages claims. On the same basis as the poles the price for underground cables should not exceed 0·15d. per lineal yard. His company paid at once for the damage done in the construction of the lines, and the annual payment was made in accordance with the damage done in the maintenance of the lines. The Paper showed that remedial measures should be taken at once in regard to obtaining consents. An appeal to the Board of Trade should be allowed in all cases, and questions concerning amenities of land owners or tenants should be left to an independent arbitrator. In Ontario, where public utility companies could expropriate land, negotiations were facilitated, and arbitration was unnecessary in many cases. If the Supply of Electricity Bill became law a great many of the present difficulties would disappear.

Mr. A. J. Stubbs said the difficulties in regard to wayleave-getting were much greater with regard to small people than with big people, and compulsory legislation for expropriation would be supremely beneficial.

Digitized by Google

The Post Office engineer would find it his duty to secure that the Postmaster-General's rights should be conserved in connection with any legislation on behalf of the power authorities, but the Post Office engineers and the power engineers were brothers-in-arms, and should be in a position to help each other. It might be desirable to draft a short bill conferring upon power engineers the same privileges and concessions as were conceded to the Post Office. It might be argued that the privileges of the Post Office had not proved oppressive to private owners, that they had proved advantageous to the community, and that it would be a convenience for all electricity undertakings to be controlled by the same conditions and procedure. The Post Office had the right of appeal to the Railway Commissioners, whereas in the Paper the assumption was that the appeal of the power engineer should be to the Board of Trade. He did not know how Mr. Trotter would view a suggestion that the Board of Trade in regard to power undertakings should be somewhat in the same relation to them as the Post Office was to telegraphs and telephones, *i.e.*, rather that it should control the general arrangements of the system than that it should be in a position to act as adjudicator, and, if the procedure for power undertakers were assimilated to that of the Post Office, the Board of Trade would then be in a position rather to support the power undertaker before the local tribunal than to merely act as an adjudicator between the parties. The undertaker would then have the collaboration of an authority that had a wide experience of the whole business in hand. In those conditions any concessions or advantages secured by either the Post Office or the power undertakings would automatically be extended to the other.

Mr. J. C. Wigham asked why anybody should have the right to forbid electricity undertakers putting their lines overhead. There was no argument in favour of the retention of legislation giving such a right. The points as to whether it was proper to run a certain line and as to the compensation to be paid should be kept quite distinct. The power engineers would be pleased to have the same rights as the Post Office, who ran wires where they liked, disputes being settled by a magistrate or County Court judge, or in Scotland by a sheriff. The Lands Inquiries' Committee's report, quoted by the author, recommended that a Government department should say whether a scheme should be carried out, and that judicial Land Commissioners should assess any damage. The author proposed to put both these powers in the hands of the Board of Trade, and the alternative suggestion that the question of compensation should be referred to two surveyors would not appeal much to anyone who had had to deal with surveyors. The draft bill prepared during the past 12 months between the Association of Electric Power Companies and the Municipal Engineers went carefully into the withholding of consent and the granting of wayleaves. According to that Bill the power of deciding whether a line should be run was to be given to the Board of Trade, who were also to appoint the arbitrator, and all questions of compensation were to be handed over to the same arbitrator. That was because only one man who was continually dealing with questions of wayleaves could be expected to form a fair judgment as to the compensation to be paid; otherwise decisions of £1 a pole would be given in one district and 1s. a pole in another. In the draft Bill put before Sir Charles Parsons' Electric Committee the question of establishing a judicial electricity committee somewhat on the lines of the Railway Commissioners—somewhat of the judicial nature proposed in the Paper—was put forward with strong evidence in its support. Possibly that body was wanted for deciding the judicial points. The Board of Trade or the new electricity committee, if established, might decide the technical points as to whether a line should be run, but the question of compensation should go into the hands of a judicial body, and not into the hands of an arbitrator appointed by a Government department.

Mr. E. T. Williams said the advance which electricity supply would make if the proposed reforms were carried out would benefit manufacturers and put them in a better position to meet foreign competition. In the interests of the country they had reason not only to expect but to demand that electricity supply should receive the consideration which was due to it. To show the unreasonableness of local authorities he quoted charges per annum per acre demanded by such authorities, and varying from £117 to £4,292. In many cases of supplying munition works powers had to be taken under the Defence of the Realm Act to force wayleaves to be granted. The author thought there should be a right of appeal to the Board of Trade in all cases. He suggested that they might add "or an electricity board," possibly acting with the Board of Trade. A small extension of the Telegraph Construction Act, 1916, providing that "the Board of Trade or Electricity Board is empowered to authorise the laying down or erecting of power lines on private lands" would give them their remedy at once. It was important that electricity supply should be represented in a concrete form by a recognised public or semi-public body. The Land Inquiry Committee recommended that the Government department (he would add "or Electricity Board") authorised to give such sanction should have the power to make an order for the compulsory acquisition of easements or wayleaves. This report could be referred to in making applications. He thought the majority of cases could be settled by the Electricity Board which he suggested should be established, and that it would only be necessary to appeal to a higher authority in exceptional cases. Much had been achieved by the industry, but he thought the time had come when if they got the proposed power behind them they would be carried on to achievements which they did not realise at present. There would be a vast amount of electrification after the war, and Parliament would probably be choked with work, so that progress ought to be made now with the matter under discussion. Electricity supply was more important than the water supply and the docks, and they should not hesitate to demand that a public body should be appointed to deal with it.

Mr. H. M. Sayers said the Spanish law regarding wayleaves substantially followed the Italian law. Compulsory wayleaves were granted subject to proper compensation. Compensation was decided by the application of the general law for easements. The regulations had some points of difference from the Italian and French law. He would send in a translation of the regulations and an abstract of the general law with regard to compensation.

Mr. J. E. Kingsbury said Mr. Vernier's proposals were sound and necessary. The question was how soon they could be carried out. The powers obtained by the Post Office last year were recommended by a Parliamentary Committee in 1885. If a Parliamentary Committee's proposal took 30 years to be carried into effect how long would a proposal by that Institution take? They were suffering from a lack of public appreciation of what the proposals meant. He had to remain some years without a telephone because the Dulwich College Commissioners refused to have any overhead wires on their land. When public bodies had opinions like that it was not surprising that private individuals resented any interference with their property. People should be educated to regard the matter from the point of view of public utility and not to stick to their rights to the injury of their fellows.

The President said the Paper under discussion was written at the request of a committee appointed by the Council to report to them on certain lines. The future of electric supply was closely wrapped up with the erection of super-power stations, the question of the outlet from those stations was wrapped up with necessary modifications in legislation, and it was thought advisable to call upon a member competent to deal with the matter to lay its whole history before them. The Council had decided to grant the Paris premium to Mr. Vernier for his Paper. The non-statutory authority was immensely stronger than the statutory one. A local authority could not refuse permission to a non-statutory undertaker to cross a highway, but if a line was to run along the highway it would be a matter of negotiation. A statutory authority was in a different position. The Post Office were very flexible when dealing with non-statutory authorities, and gave them reasonable facilities. Italy secured compulsory wayleave powers in 1894, Switzerland in 1902, and the United States in 1912. He thought we should obtain them in the next two years.

Mr. Vernier said, in reply to the discussion, he was sorry two years had elapsed since he was first approached with the suggestion that he should contribute the present Paper. The present extraordinary circumstances were to blame for the delay. He agreed that the present was a propitious time to bring up such a Paper. Since the Paper was written the Board of Trade had appointed a committee to inquire into the question of providing a sufficient supply to consumers. This was a secondary question, but no doubt the committee would also consider the main question. Mr. Stubbs said the powers granted to the Post Office had not been oppressive to landowners, but so far as he could find they had not been exercised to any great extent. It was too early to form an opinion as to what reception the Act of last year would receive from the public. As Mr. Starr said, the County Councils were the authorities from whom consent had to be obtained in Scotland. It was a point worth remembering that they were not in England, Ireland and Wales, as they sometimes tried to exercise powers that had not been conferred upon them. The company with which he was connected had a similar organisation to that mentioned by Mr. Starr to deal with wayleaves. A good many difficulties were experienced in the smaller undertakings particularly, because there was no proper organisation to deal with the subject, it being left to local or district engineers, with no co-ordination between the individuals. There were certain powers to break up private roads in the Electric Lighting Acts, and roads were scheduled in the particular Electric Lighting Orders. For roads not scheduled a further order could be obtained for particular roads, and the question of compensation was referred to an arbitrator. His company had a similar arrangement to that mentioned by Mr. Starr for a standard payment to coal companies and a charge per unit, and they had a similar arrangement with a railway company. Railway companies claimed that they were entitled to a wayleave if a cable was supported by their bridges, although the roads over the bridges might be public roads which the electricity undertaker was authorised to break up. As a compromise in such cases his company fixed a standard charge. He was surprised that Mr. Starr agreed to a charge per unit. It was an iniquitous arrangement, and was one of the onerous conditions landowners had tried to impose, but it was no business of theirs what was done with the current. Mr. Starr mentioned 1s. per pole for overhead and 1d. per yard for cable. That worked out at ½d. per yard for overhead and eight times that for cable. It ought to be the other way round. He (Mr. Vernier) did not know why the Postmaster-General should be in such a privileged position as he only provided telegraphs and telephones. Other people, providing other utilities, wanted to live as well. With Mr. Wigham, he wanted to know why anyone should have the right to prohibit overhead mains. It was only because Parliament had not yet recognised the importance of electricity supply and the economies obtained by using overhead mains. Mr. Wigham said the decisions as to whether it was reasonable that a line should be run and as to compensation were both in the hands of the Board of Trade. That was only indirectly so. The question of compensation was a subsidiary matter. He had hoped some speakers would have made some remarks as to what was a fair assessment. Mr. Williams suggested, as he had previously suggested in his own Paper, that these powers should be delegated to an Electricity Board. He (Mr. Vernier) thought it would be a very good thing. It might rank with the Government Department which it was suggested should settle whether a particular main should be put down under compulsory powers. He hoped the powers required would be obtained in less than two years.

Digitized by Google

THE LONDON AND NORTH-WESTERN AND BAKERLOO ELECTRIFICATION.

(*Continued from p.* 107.)

ROLLING STOCK.

The joint stock trains consist of five cars, *i.e.*, two motor cars and three trailers. The trailers are standard London Electric Railway stock, while the motor cars were designed for the Ealing C.L.R. extension from Wood-lane over the new Great Western line to Ealing Broadway, the opening of which has had to be postponed for the time being.

From the illustrations it will be seen that the motor cars are provided with a covered vestibule at the trailing end and that middle doors have been fitted. This is the first tube stock to be run in passenger service on a main line, and provision has had to be made to enable passengers to get on or off at the stations on the L. & N.W. line which have platforms of the standard main line height. This has been done on the trailer cars by superimposing a raised platform on the existing gangways of these cars, as seen in Fig. 5, which shows the relation of the two platforms. It has been possible to do this without encroaching on available headroom owing to the open character of these gangways. The closed vestibule has prevented any similar provision being made on the motor cars.

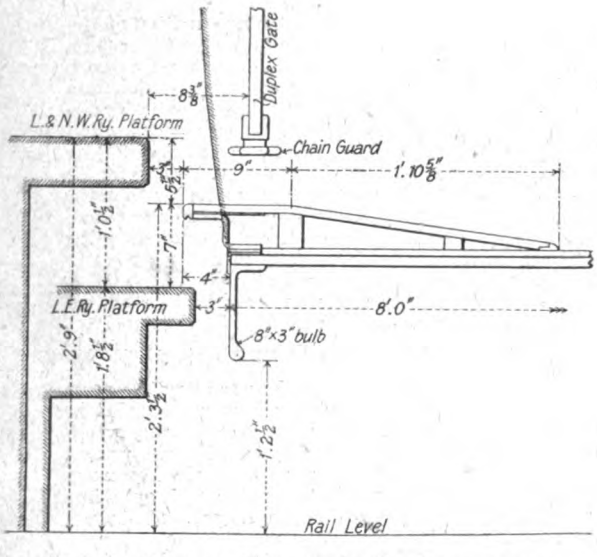


FIG. 5.—RELATIVE POSITION OF CAR PLATFORM TO STATION PLATFORM.

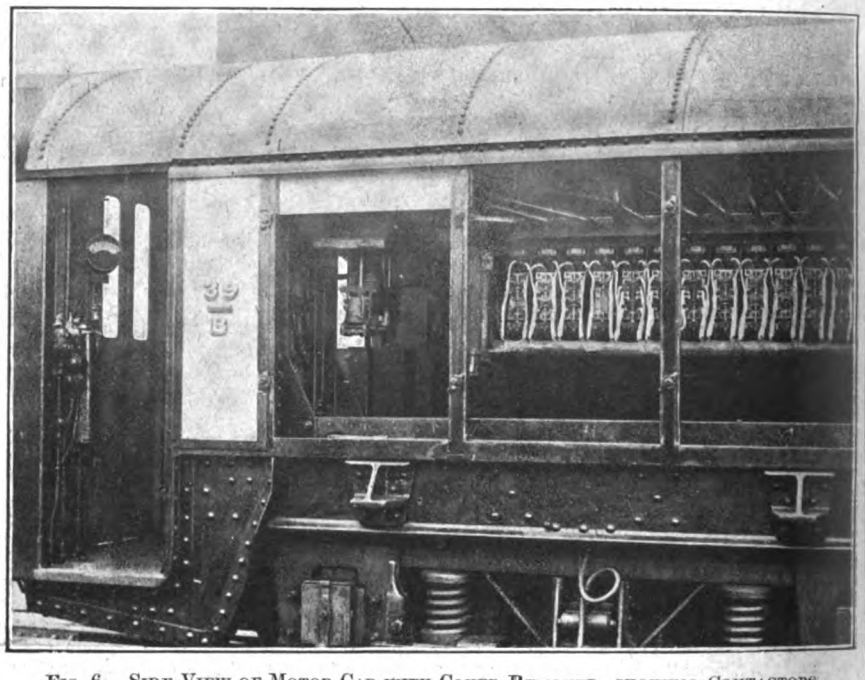


FIG. 6.—SIDE VIEW OF MOTOR CAR WITH COVER REMOVED, SHOWING CONTACTORS.

The number of seats in the motor cars is 32 and in the trailer cars 52. The seats of the motor cars are upholstered in red Pegamoid.

The cars are constructed of steel, with some wood interior finish. With regard to ventilation, in addition to the ordinary drop lights, an air duct with perforations runs the whole length of the car, and is open to the air at the ends.

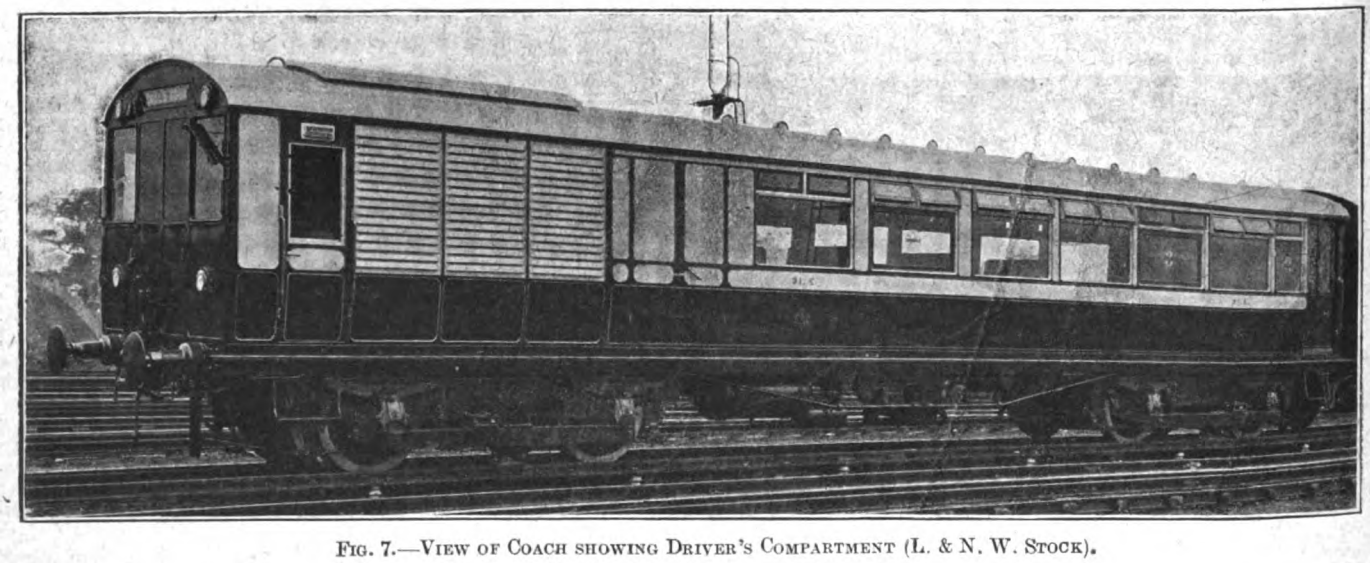


FIG. 7.—VIEW OF COACH SHOWING DRIVER'S COMPARTMENT (L. & N. W. STOCK).

The motor trucks are of the equaliser bar type, with helical springs. The framing is built up of mild steel rolled sections. The trailer trucks, which are built up of pressed steel sections, are fitted with laminated side bearing springs. The motor

Digitized by Google

cars were constructed by the Brush Company, at Loughborough, and the leading dimensions and weights are as follows:—

Length overall	47 ft. 9 in.
Width over body	8 ft. 9 in.
Total height from rail	9 ft. 3½ in.
Centres of bogies	29 ft. 6 in.
Diameter of motor wheels	36 in.
Wheel base of motor bogie	6 ft. 8 in.
Diameter of trailing wheels	29 in.
Wheel base of trailer bogie	5 ft.

Weight of car completely equipped :—

Motor end	21¼ tons.
Trailer end	9¾ ,,
Total	30¼ tons.

Total weight of five-car train (unloaded), 110 tons.

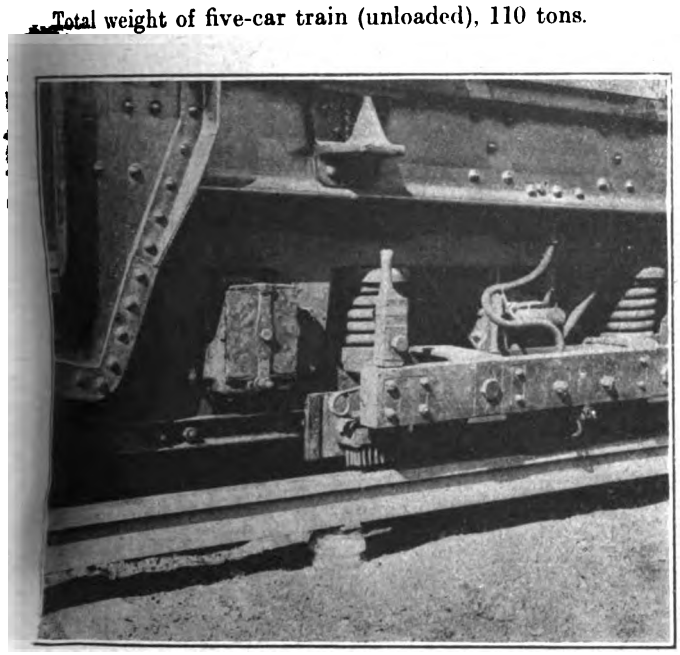


Fig. 8.—View showing Sleet Brush Fitted in "Off" Position.

side. On the trailer truck of the motor car, there was insufficient clearance below the sole bar of the body to fit positive shoes, so that these have had to be arranged on the truck of the adjacent L.E.R. trailer car, and connection made to the motor car by means of jumpers.

Other points in the conversion from earth to insulated return were the provision of negative switches and fuses to the

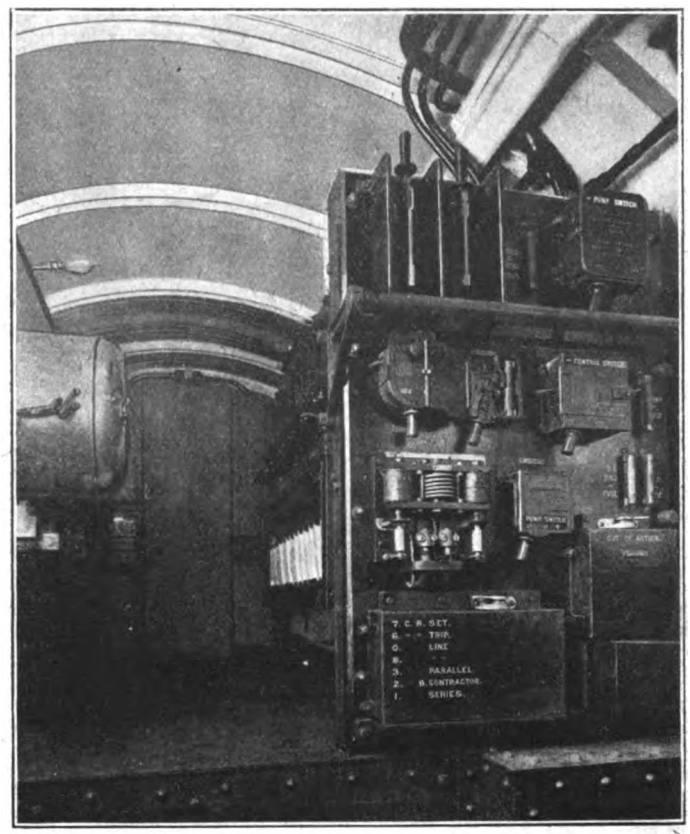


Fig. 9.—Interior of Motor-cab showing Main Switchboard and Front of Contacts.

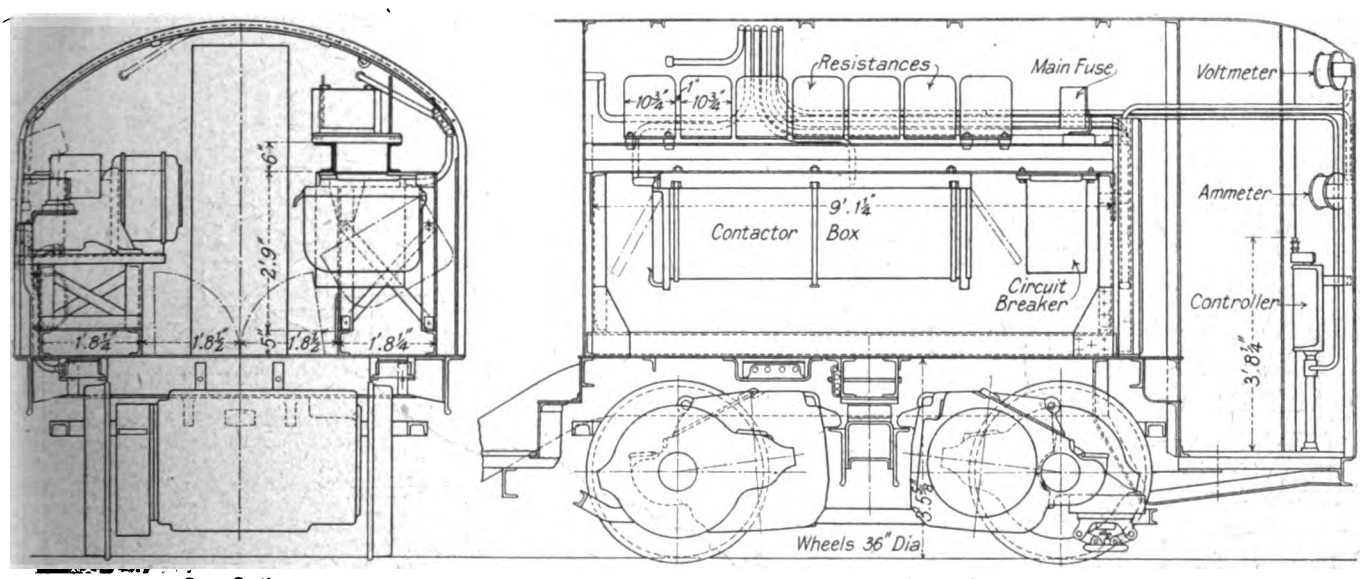


Fig. 10.—Arrangement of Electrical Equipment in Motor Car.

Power and Control.

Electric current at 600 volts direct is supplied north of Queen's Park to Bakerloo trains from the L. & N.W.R. power house at Willesden.

As the Central London Railways system employs an earth return, while the L.E.R. system employs an insulated return, it has been necessary to modify the equipment of the motor cars accordingly. For this purpose, two additional sets of shoe gear have been fitted on the motor trucks, one on either main circuit and each of the auxiliary circuits. In doing this care was taken to reproduce the standard arrangement of London Electric Railway wiring, so that electrically the difference between the two types of stock should be confined to the control equipment.

Fig. 7 is a view of a motor coach, while Fig. 6 shows the contactor gear. The general arrangement is shown in some detail in Fig. 10.

The control equipment supplied by the B.T.-H. Co. is of the relay automatic type. The normal method of operation with

Digitized by Google

this system is to place the controller at once to the full-on position when starting a train. The contactors are then picked up in their correct sequence by the current limit relay, which operates as soon as the motor current has dropped to a pre-determined value.

The relay consists of two shunt and one main coil. The latter carries current equal to that of one motor only. The actuating coils of the contactors are energised through one or other of the two shunt coils in such a manner that, if one is energised through one shunt coil, the next one to close will be energised in series with the other shunt coil. The two relay shunt coils act on two plungers controlled by gravity. Each plunger, when in its lower position, closes a disc switch in series with the other shunt coil; but when raised (due to its coil being energised) it opens this switch. Thus, when one of the plungers is raised the shunt coil, acting on the other, cannot be energised because of the break in the circuit produced by the above mentioned switch, but although it is the control current that raises the plunger, so as to produce this break, it is the current passing through the main coil which maintains the break, and the plunger is not released until this current has dropped to the pre-determined value. Then the plunger falls and closes the switch which completes the circuit for the next contactor coil to be energised.

The principle underlying the method of control adopted in connection with the current limit relay is that, after a contactor has been picked up, as described above, its coil is immediately transferred (by means of interlocks) to another wire. There are thus essentially two operating wires, the picking up wire and the retaining wire (although other wires are introduced for forward and reverse, circuit-breaker setting, &c., &c.).

As there are no main 'bus lines down the train a potential relay is fitted on each motor car, which drops all contactors on that car when the shoes lose current. This is necessary, because when no current passes through the main coil of the current limit relay it ceases to exercise its control over the rate of picking up of contactors.

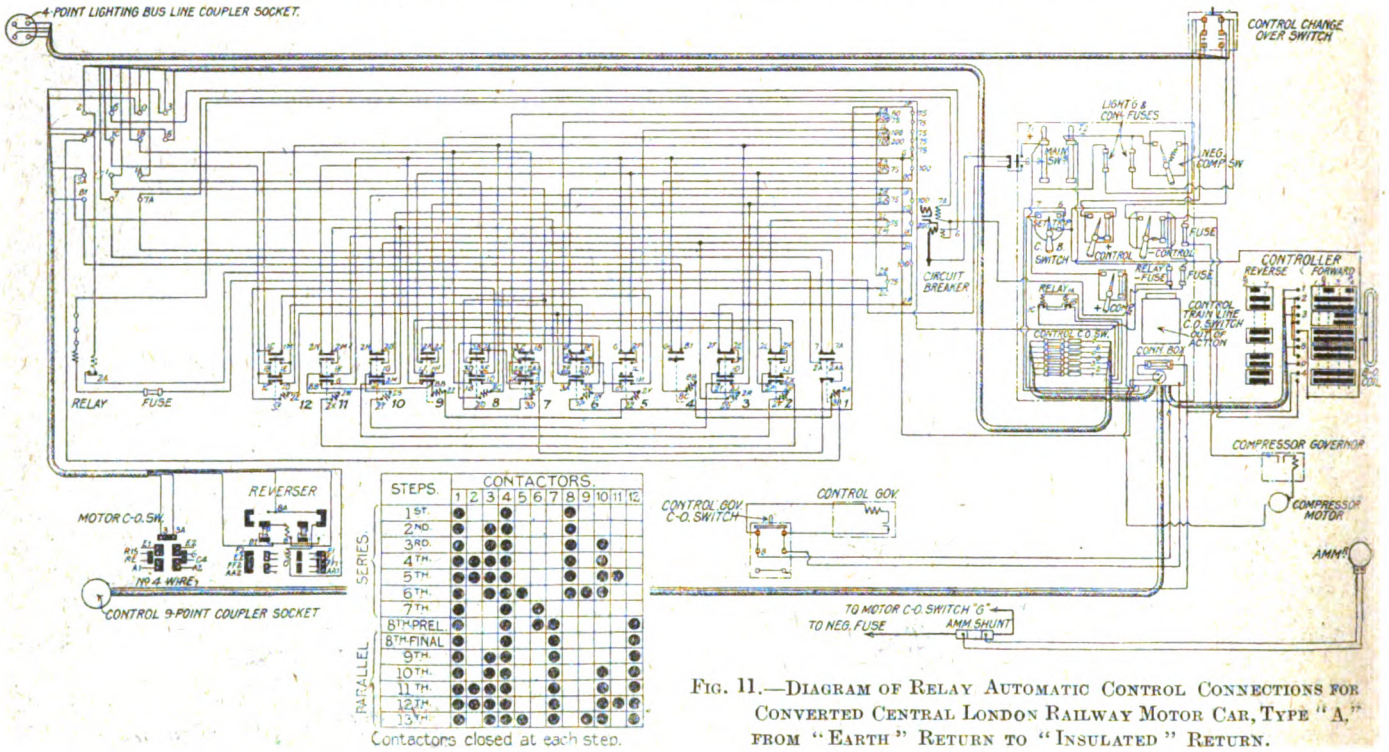


Fig. 11.—Diagram of Relay Automatic Control Connections for Converted Central London Railway Motor Car, Type "A," from "Earth" Return to "Insulated" Return.

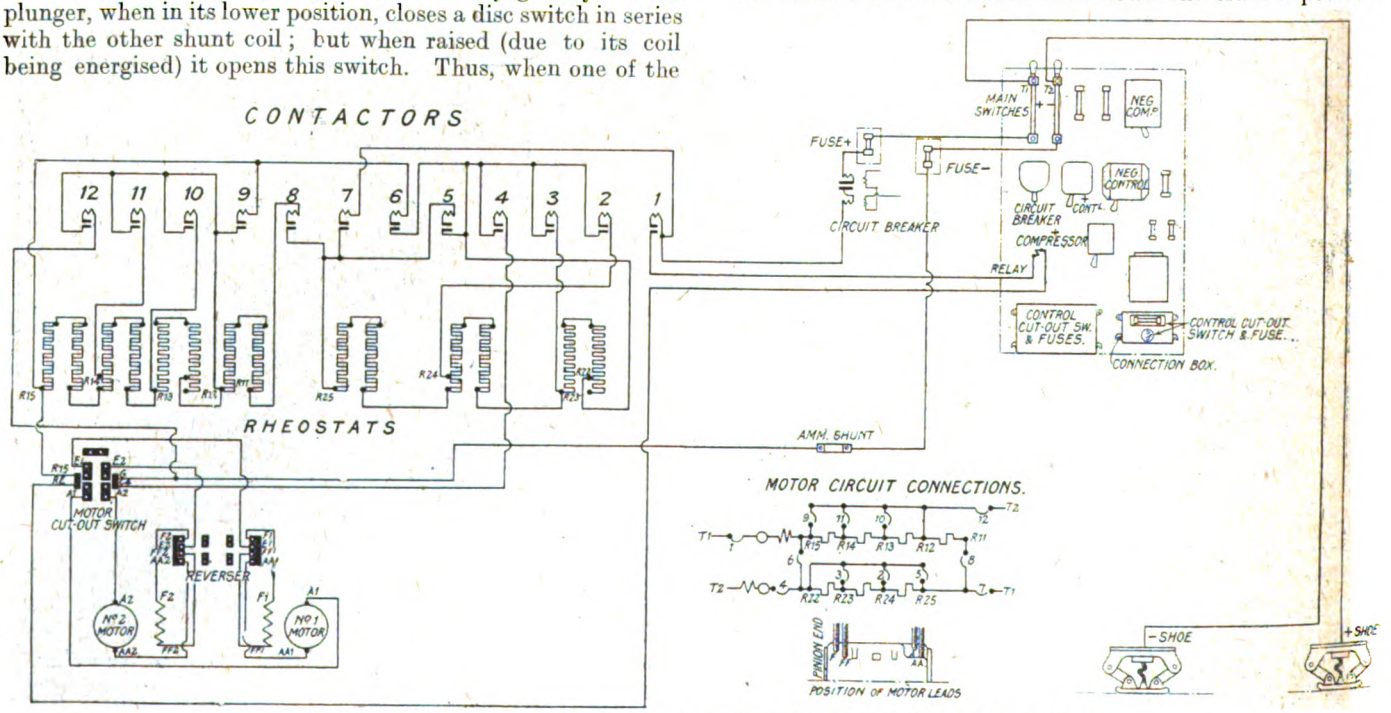


Fig. 12.—Diagram of Power Circuit Connections, Relay Automatic Control.

(To be concluded.)

Digitized by Google

RANGE OF WIRELESS STATIONS.

BY CAPT. R. CHENEVIX TRENCH, R.E.

(*Continued from page* 105.)

Summary.—The author introduces modifications into the Austin-Cohen empirical formula for the range of wireless stations so as to take into further account the effect of actual working conditions. The results obtained are illustrated by means of a number of curves, and the use of these curves is finally illustrated by the working out of certain empirical examples.

IV. Having discussed above the relations between height, power and range for an assumed normal set of conditions, we will now consider the effect of variations from those conditions.

(1) *Nature of Intervening Surface.*—It is probable that with long range stations using very long waves, the intervening surface does not much affect matters unless much of it is mountainous or either station is screened by a near mountain range.

For short range work over land, however, with small wave-lengths, the value of $h_1h_2\sqrt{P}$ obtained from the curves is too low. In the first place the wave-length obtained from equation (17) is too small for transmission over land, and a longer wave must be used giving a higher value to $h_1h_2\sqrt{P}$. In the second place this higher value applies only to transmission over sea for that wave length, and must be further increased for transmission over land.

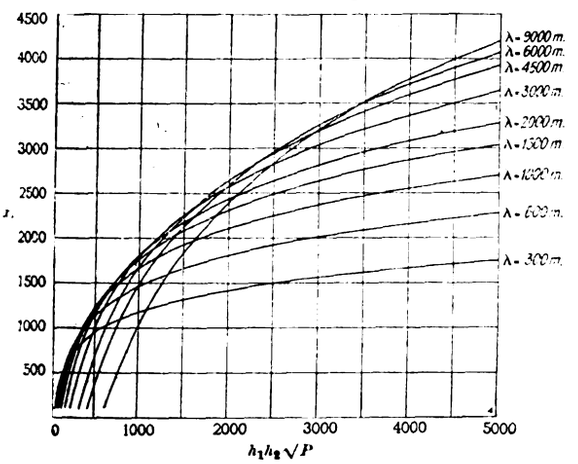


FIG. 4.—OVER FLAT LAND.
h_1h_2 in metres. P in watts. x in kilometres.

Dr Eccles* gives the following formula for the screening effect of mountains, based on the diffraction theory:—

$$P_2 \propto \frac{P_1}{\lambda^2 x^2} \varepsilon^{-2\sqrt{(2x\chi_1\chi_2/\lambda)}} \quad . \quad . \quad . \quad . \quad . \quad (28)$$

Where (if S and R are a sending and receiving station and T the intervening crest)

χ_1=Angle TSR in radians (1 radian=$180°/\pi$),

χ_2=Angle TRS ,, ,,

x and λ being in any like units.

This may be written

$$\sqrt{P} \propto \sqrt{P_2}\lambda x \varepsilon^{(2x\chi_1\chi_2/\lambda)^{\frac{1}{2}}}.$$

Combining this with equation (16) we get

$$h_1h_2\sqrt{P}=65\lambda x\varepsilon^{(0\cdot0015x+\sqrt{2x\chi_1\chi_2/\lambda})}, \quad . \quad . \quad (29)$$

or the value of $h_1h_2\sqrt{P}$ obtained from the curves must be modified by the factor

$$\varepsilon^{(2x\chi_1\chi_2/\lambda)^{\frac{1}{2}}}.$$

This factor will allow for screening by the height of opaque land intervening and it may assume a considerable value.

We have also to allow for loss due to the actual accidents of surface, whether hilly, mountainous, bearing magnetic ores on the surface, &c. This is exceedingly high for short waves, much less for long. One way of making a rough allowance is to consider the overland range equivalent to an increased range over sea, the increase depending on the kind of land and the wave length. There are, however, no sufficiently inclusive data on which to base such a direct estimate of equivalent ranges. Another method here put forward is to multiply the oversea value of $h_1h_2\sqrt{P}$ by ε^A, where A is some function of x and λ; there is not enough information available to deal with the matter fully, but the form $\varepsilon^{Kx^{\frac{1}{2}}/\lambda}$ is suggested as satisfying practical conditions, where K is a co-efficient depending on the nature of intervening land.

The following values are proposed for K:—

For flat land	0·02
For hilly land	0·1
For mountainous land	0·24

No authority is claimed for the above suggestion and it is based on no special series of tests. It is put forward, however, as giving consistent results in accordance with practice.

Equation (16) then becomes

$$h_1h_2\sqrt{P}=65\lambda x\varepsilon^{\frac{0\cdot0015x}{\sqrt{\lambda}}+\frac{Kx^{\frac{1}{2}}}{\lambda}} \quad . \quad . \quad . \quad . \quad . \quad (30)$$

This in turn suggests a most economical value of λ for every range, at which $h_1h_2\sqrt{P}$ is a minimum. The solution of the differential equation for the minimum gives the following result:—

$$\sqrt{\lambda}=\sqrt{Kx^{\frac{1}{2}}+\left(\frac{0\cdot0015x}{4}\right)^2}+\frac{0\cdot0015x}{4} \quad . \quad . \quad . \quad (31)$$

It will be seen that when K is zero, this gives the same result as equation (17). The curves given for flat, hilly and mountainous land are worked out from equation (30).

(2) *Type of Aerial.*—The aerial to which the curves apply has an effective height of about 0·9 times its actual height, while the capacity of the receiving ship's aerial is given as 0·0018 mfd.

In using various types of aerial we should make the following allowances:—

(i.) *Sending. Effective Height.*—The value of $h_1h_2\sqrt{P}$ obtained from the curves must be multiplied by $1{\cdot}8h_1/l$, where $\frac{1}{2}l$ is the effective height of the aerial, obtained by the method given in equations (4) to (6), and h_1 is the actual height.

(ii.) *Receiving.*—The conditions here are much more complex than in sending, owing largely to the partial re-radiation of the received energy. Authorities differ on the various effects, and it is not proposed to go into all the considerations here. One important point, however, pointed out by Dr. Eccles*, must be explained. This is broadly as follows:—

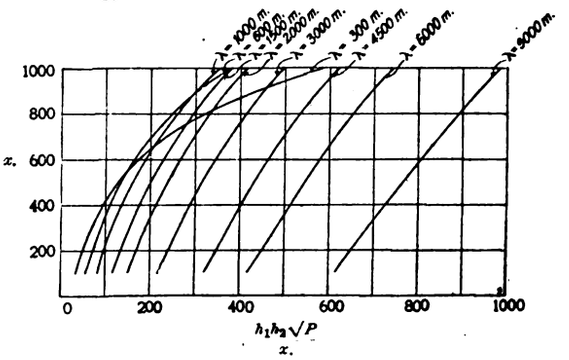


FIG. 5.—OVER FLAT LAND.
h_1h_2 in metres. P in watts. x in kilometres.

The coupled detector circuit introduces an effective resistanc into the aerial, which may be increased or decreased by closing or loosening the coupling. On the old principle that most work is done when the external (working) resistance is equal

* "Wireless Telegraphy and Telephony," by W. H. Eccles.

* "Wireless Telegraphy and Telephony," by W. H. Eccles.

Digitized by Google

to the internal (wasting) resistance, the coupling should be such that the effective resistance introduced is equal to the total aerial resistance from re-radiation, earth and all other sources. When this is achieved 50 per cent. of the aerial's energy will be delivered to the coupled circuit and more than this cannot be delivered.

Thus, whatever the resistance of the receiving aerial, about 50 per cent. of its received energy may under best conditions be delivered to the coupled circuit.

Considering then the effects of the qualities of an aerial on receiving we may say :—

Effective Height.—The same allowance for effective height must be made as in sending.

Capacity.—In receiving, the greater the capacity of the aerial and the larger the wave-field affected by it in consequence, the more power is collected from the passing waves, and if no disturbing factor were introduced the ratio $P_2 \propto C_2$ would be correct, where C_2 is the capacity of the receiving aerial. This ratio may be applied with sufficient accuracy for our purposes to small or medium sized aerials with good earths. For long distance directive aerials, however, where the great sending power requires a very large aerial capacity, it has been found advisable to use a smaller capacity for receiving to avoid excessive earth losses.

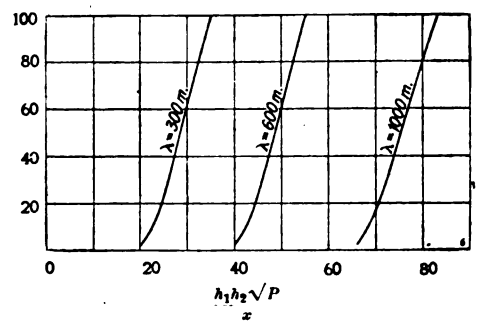


Fig. 6.—Over Flat Land.
h_1h_2 in metres. P in watts. x in kilometres.

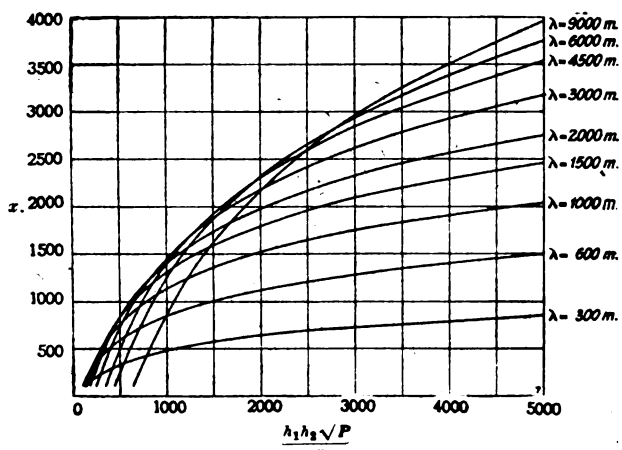


Fig. 7.—Over Hilly Land.
h_1h_2 in metres. P in watts. x in kilometres.

We will say then as an approximate estimate for general application that the value of $h_1h_2\sqrt{P}$ obtained from the curves should be multiplied by $0{\cdot}0018/C_2$, while the allowance to be made for earth losses will be discussed later.

The capacity of a single wire aerial per unit length depends mainly on the ratio of the diameter to the height of its various elements, but for practical purposes of an approximate estimate we may say that the capacity per metre length is about $6{\cdot}5\times10^{-6}$ mfds. For a multiple wire aerial it is well known that the capacity does not increase in proportion to the number of wires, but much less rapidly, and the closer the wires the less rapid is the increase in capacity. It is useful in estimating to make a rough approximation beforehand for the capacity of such an aerial, and this is given by the following formula :—

$$C=6{\cdot}5\times10^{-6}\times m\{1+K(n+\tfrac{1}{2}+\tfrac{1}{3}+\ldots.+1/n-1)\} \quad . \quad (32)$$

Where—

C = Capacity in microfarads,

m = Combined length of horizontal and vertical portions in metres,

d = Ratio $\dfrac{\text{distance apart of parallel wires}}{\text{length of parallel wires}}$,

n = Number of wires in parallel, so that there are $(n-1)$ terms in the bracket,

K is a constant which depends largely on the value of d. A value for K which is applicable to most practical conditions is $1{\cdot}4\sqrt{d}$.

This will give the capacity of an ordinary aerial within 10 per cent. If the horizontal and vertical portions differ much in number or spacing of wires, each should be worked out separately and the sum taken.

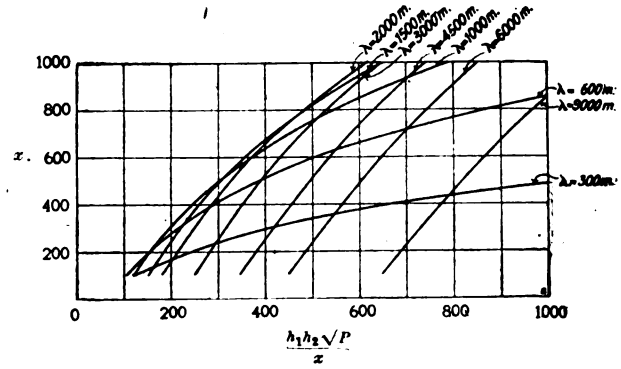


Fig. 8.—Over Hilly Land.
h_1h_2 in metres. P in watts. x in kilometres.

A common value for d is about 1/40, and in this case the capacity per metre length of the aerial is about as follows, for different numbers of wires :—

No. of wires.	Capacity per m. length in micro-microfarads.
1	6·5
2	9·4
3	11·6
4	13·5
5	15·3
6	16·9
7	18·5
8	20·1
9	21·7
10	23·4
11	25·0
12	26·5

Where d is about 1/50, the capacity varies nearly as the square root of the number of wires.

(iii.) *Directive Aerials.*—A special case is that of the directive inverted L aerial. If both sending and receiving aerials are of this kind, the sending power required to deliver a certain power to the receiving aerial is a fraction of that required with non-directive aerials of the same total radiation. When the length is about 10 times the height a study of the polar diagrams suggests a value of about 0·4 for this fraction, and accordingly we may modify the value of $h_1h_2\sqrt{P}$ by $\sqrt{\cdot4}$, or 0·63, if both aerials are directive, or by 0·8 if one aerial only is directive.

(3.) *Earth Connections.*—The results given by the curves will not be reached even approximately if a bad earth connection is used. As already explained, the radiation efficiency is $R_r/(R_r+R_e)$, and the greater part of R_e is due to earth connections. With the best possible earth in good soil on the most efficient wave-length (about $1{\cdot}5\ \lambda_n$) R_e will hardly be less than R_r. With a bad earth it may be many times as great, and the importance of keeping it as low as possible is evident. This is especially the case with an aerial of low radiation resistance.

A bad earth also increases the damping and impairs resonance ; this is especially harmful in sending with the quenched spark, where the oscillations in the aerial decay with its own decrement, and receive no reinforcement from a loosely-coupled closed circuit.

Digitized by Google

For the purposes of this discussion we will call a good earth one in which R_e is nearly equal to R_r at about 1·5 times the natural wave-length, a moderate earth one in which R_e is about twice R_r, and a bad earth one in which R_e is four or five times R_r. In cases where a bad earth only can be obtained at the sending station the best radiation efficiency becomes R_r/R_r+5R_r); that is, it is reduced from about half to about one-sixth, and the necessary power must be multiplied by 3, or $h_1h_2\sqrt{P}$ by about 1·7. For a moderate earth P should be multiplied by 1·5 or $h_1h_2\sqrt{P}$ by about 1·2.

The effects of a bad earth connection are much less felt in receiving, because there the coupled circuit can take about half the power collected by the aerial whatever the resistance

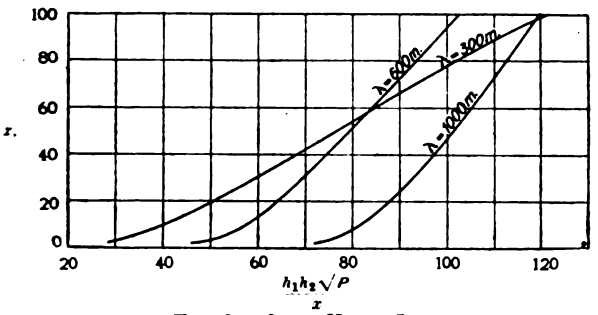


Fig. 9.—Over Hilly Land.
h_1h_2 in metres. P in watts. x in kilometres.

of the latter. But, as Dr. Eccles * points out, for reasons which will not be gone into here, a bad earth connection impairs the absorbing qualities of an aerial and less power is collected.

If an insulated counterpoise is used in sending the value of R_e will generally, but by no means invariably, be less than with the conductive connection, and the radiation efficiency greater.† The use of a counterpoise also imparts to its aerial a smaller capacity and greater inductance than an earth, and so reduces the decrement at any wave length, since $\delta=R/2fL$. In spite of this, due perhaps to the absence of some "ground wave" phenomenon, its effect at a distance is not so great as that of a good earth, though a good counterpoise will send better than a bad earth. For the sake of an approximate estimate

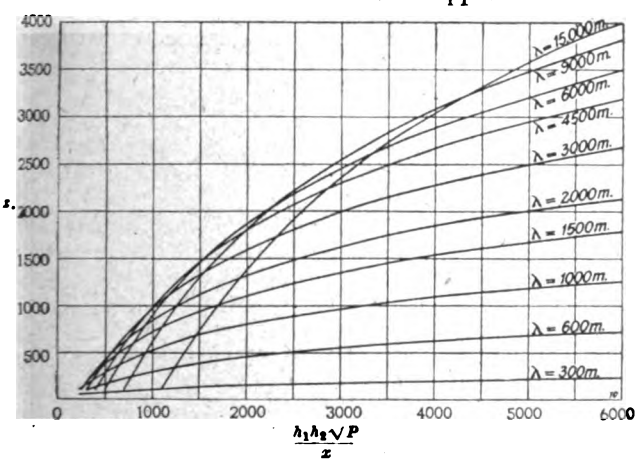


Fig. 10.—Over Mountainous Land.
h_1h_2 in metres. P in watts. x in kilometres.

we may class a counterpoise at the sending station with a moderate earth, entailing a modifying factor to be applied to $h_1h_2\sqrt{P}$ of about 1·2.

On account of its small decrement, however, a properly built counterpoise of large area may be used with advantage in quenched spark systems, instead of a direct earth connection. In these systems it is important to keep the aerial decrement from all sources as low as possible, in order to get good resonance effect.

The capacity of an earthed aerial is greater than that of the same sized aerial with a counterpoise. In receiving, due partly to this greater capacity and partly, perhaps, to some "ground wave" effect, there is no doubt that an earthed aerial picks up a considerable amount of energy that is missed by a counterpoise aerial. Also, as already stated, a receiving aerial is much less affected by a bad earth than a sending aerial, and it appears in practice that even a bad earth may receive more strongly than a good counterpoise. At certain stations fitted with earth and counterpoise for alternative use, but unfortunately without means of measuring the received power, it appeared that the aerial with a good earth received about 100 per cent. stronger signals than with a counterpoise, and this excess was rather less with a bad earth. We will say then, for the sake of an approximate estimate, that the value of $h_1h_2\sqrt{P}$ must be multiplied by about $\sqrt{2}$ or 1·4 for receiving with a counterpoise, and by a less amount, say, 1·2, for receiving with a bad earth connection. The effect of a moderate instead of a good earth in receiving is not great enough to necessitate modifying our figures.

(To be concluded.)

* "Wireless Telegraphy and Telephony," by W. H. Eccles.

† The use of the counterpoise eliminates the resistance of the direct earth contact, but it introduces a large resistance due to induction of earth currents below the counterpoise. The latter will generally be less than the resistance of direct contact unless the conductive earth is a very good one.

FIRST LONDON ENGINEERS VOLUNTEERS.

EASTER TRAINING, 1917.

It is seldom that a volunteer corps is fortunate enough to obtain so valuable and enjoyable a training as that of the 1st London Engineers Volunteers during Easter. The only unpleasant part of it was the severity of the weather, but the work done was of so vigorous and interesting a nature that the men put the meteorological conditions aside and laughed rather than grumbled at its inclemency.

A programme of training, admirably adapted alike to the requirements of the corps and the brevity of the time, was most kindly arranged by Col. Chesney, R.E., the Commandant of the Royal Engineers at Esher, and carried out by Capt. Courtman, R.E., the Commandant of the School of Military Engineering, and Capt. Higgins, R.E. It was felt that in dealing with a corps of this nature whatwas required was rather a thorough grounding in technical essentials than any attempt at more ambitious work. The course was, therefore, confined to knots and lashings, the use of spars, trestle bridging, floating bridges and bridging expedients. So successful, however, was the course that it is not improbable that a more advanced course may be carried out in the future.

It was originally intended that the working party should go into billets at Esher during the four days, but the impossibility of obtaining any accommodation precluded such an arrangement, and necessitated daily travelling to and from Waterloo. In some ways this proved to be an advantage, as certain members were thus able to attend who could not have been absent from town for the whole period. The wretched state of the weather, too, counterbalanced any regret for the absence of camp conditions.

Owing to the uncertainty as to whether Easter would be kept as a holiday, the number attending was not as large as had been hoped. It averaged roughly 10 officers and 40 N.C.O.'s and sappers daily. The party left Waterloo each morning about 9 a.m. and returned each evening about 6 p.m.

On reaching Esher on Good Friday the party marched at once to Sandown House, the headquarters of the School of Military Engineering, and proceeded without delay to the lecture room. Here officers and sappers were cordially greeted by Col. Chesney, and a lecture on the use of spars was given by Capt. Courtman. This over, a three-mile march brought the party to Heywood, where the remainder of the morning was spent in going rapidly through the various knots and lashings. The 1st London Engineers has received a thorough grounding in these elementary matters, and the work was, therefore, rather a recapitulation than a lesson. After 20 minutes for lunch, three sections were formed for practical instruction in the use of spars.

For the remaining three days, the party was divided into two sections, A and B, whereby the subjects to be dealt with could be taught to and practised by each in turn without overcrowding. The lectures were delivered by Capts. Courtman and Higgins, and dealt with trestle bridging, floating bridges, and bridging expedients.

One interesting part of the programme was the construction of barrel piers and rafts, work which came to many of our sappers as a novelty. But the real cream of the training, as far as amusement went, was the making of bridging expedients.

The corps owes a very great debt of gratitude not only to Col. Chesney, who arranged for the training, but to Capts. Courtman and Higgins for the way in which it was carried out. To Sergeant-Major Gordon and his body of instructors (all of whom cheerfully gave up their Easter leave for the purpose) also great thanks are due; they will not be forgotten by the 1st London Engineer Volunteers.

Mention must also be made of the kindness of the Quartermaster of the School of Military Engineering, who arranged tea for the party when work was done.

In conclusion, it must be recorded that the training was honoured by several visits by Col. Chesney; on Good Friday, by General Dickie and Major Edwards; on Saturday, by General Sir Desmond O'Callaghan and Col. Ormond, and again on Sunday by Major Edwards.

Digitized by Google

The Electrician.

FRIDAY, APRIL 27th, 1917.

Editorial and Publishing Offices:—

1, 2 & 3, SALISBURY COURT, FLEET STREET, LONDON, E.C. 4.

Telephone: City 4698-9. *Telegrams:* "Electrician Newspaper London."

THE RATING OF AUTO-STARTERS.

It is a remarkable fact that practically no two manufacturers of auto-starters have a common method of rating. As examples of the various methods of rating may be mentioned the following :—

(*a*) Starting motors of their rated horse-power against full-load torque during a maximum period of 1 or 1½ minutes in the starting position, to be followed by a running period or rest period of not less than 10 times the starting period. If the starting period is, say, only ½ minute, then two starts may be made with one minute rating, or three with 1½-minute rating.

(*b*) Starting with twice full-load current from the line, with the motor connected to the 50 per cent. tap, at intervals of 30 minutes for a starting period of 1½ minutes, with a temperature rise not exceeding 70°F.

(*c*) Auto-transformers are rated to take from the mains a current not exceeding 2½ times the full-load current of the motor, with the motor connected to any tapping, for a period not exceeding 1 minute or 1½ minutes, followed by a cooling period of at least 10 times the starting period, for an indefinite number of times, with a maximum temperature rise not exceeding 100°F. (measured by the increase of resistance of the winding).

(*d*) With full-line voltage applied to line terminals and current taken from taps giving between 40 per cent. and 60 per cent. of the normal line voltage, 300 per cent. of full-load current appli d for the first 15 seconds of each four-minute period for not more than one hour must show no resultant flaming or molten droppings. The oil, if any, in which the transformer windings are immersed shall not overflow the containing case.

(*e*) With full line voltage applied to line terminals and current taken from taps giving between 40 per cent. and 60 per cent. of the normal line voltage, 250 per cent. of full-load current applied for three minutes, followed by a cooling period of one hour with a maximum temperature rise not exceeding 100°F. measured by thermometer.

Of these methods, the fourth is the least to be desired from an engineering point of view, and it is difficult to understand how such a rule came to be accepted, as recently as 1915, by the National Board of Fire Underwriters.

From the user's standpoint the third method, which allows of an indefinite number of starts with a one minute "on" and 10 minutes "off" cycle with a maximum temperature rise (measured by the increase of resistance) not exceeding 100°F., ensures absolute safety under normal conditions of starting as well as under conditions which never arise in industrial motor starters. This method of rating is similar to the one used for intermittent motors, and if it be correct for the auto-starter it is equally correct for the resistance starter used with continuous-current motors. But since it is inconceivable that either form of starter would be subjected in ordinary industrial service to "crane" conditions of service it is unreasonable for any manufacturer of control gear to expect the user to pay the extra price demanded, and it is equally unreasonable for the user to expect the manufacturer to standardise such gear for ordinary industrial purposes.

The fifth method, in effect, allows of three heavy one-minute starts being made in quick succession, these three starts being followed by a rest period of one hour, with a maximum temperature rise (measured by thermometer) not greater than 100°F. It is inconceivable that a heavier duty than this is likely to be imposed on an ordinary industrial starter, and, furthermore, in practice the test is an easy one to make.

Both the manufacturer and user of simple and relatively inexpensive apparatus would do well to insist upon tests which can be made without difficulty and without using the paraphernalia of the test room. If this be decided upon at the outset, the intermittent test will be ruled out, as also will the temperature rise test by the increase of resistance method. Apart from the difficulty of making the latter test it is doubtful whether the test would give information as reliable as that given by a properly placed thermometer.

The difference in the cost of an apparatus which allows of an indefinite number of starts being made without the temperature rise exceeding, say, 80° F., and of an apparatus which allows of a certain number of starts in an hour without showing "resultant flaming or molten droppings," is considerable. In view of this it is desirable that the user should know the specification to which the starter has been made. Since there is no reason why there should be more than one set of specifications for such starters it is to be hoped that the section of the Engineering Standards Committee dealing with the subject will, by bringing the maker and user together, succeed in drawing up a specification acceptable to both. It is only by minimising the number of specifications that manufacturers can hope to manufacture economically and that users can hope to buy economically. In the past the manufacturer has paid far too much attention to the whims of the consulting engineer, and we look forward to the time when electrical manufacturers are sufficiently strong, both as regards policy and product, to resist the unreasonable demands of their clients.

REVIEW.

The Engineer's Year-Book of Formulæ, Rules, Tables, Data, &c., for 1917. By H. R. Kempe. (London: Crosby Lockwood & Son.) Pp. 2151. 20s. net.

Casting our minds back to 1894, from which year the present publication dates, we seem to have memories of a compact volume which might reasonably be called a pocket book. From such humble origins has the present stately volume descended, which seems to contain all that can usefully be known about that vague and elusive form of human knowledge comprised under the heading of "engineering." It is plainly a book to be treated as reverently as the "Encyclopædia Britannica" itself, and almost as compressed. However, there is hardly any necessity to descend to detail, a task which is quite beyond us in respect of time and space. It must suffice to draw attention to the new features introduced into the publication. There are new sections, dealing with water power development and navigable waterways; the portion referring to gas and gas-works has been entirely rewritten, and a short section has been added with reference to the metric system. An Italian section has been added to the commercial glossary, which is, however, designed on such a principle that it is not easy to find the foreign equivalent for a given English word. This year-book, as our readers already probably know, is divided into a large number of sections, each of which constitutes a brief treatise on some aspect of engineering work. It includes references to almost every phase of such knowledge, including civil, mechanical, electrical, sanitary, marine, steam engineering, &c., and would form a considerable addition to any book-shelf, which is in need of further useful literature of the kind.

Digitized by Google

SOME POINTS FOR THE BOARD OF TRADE COMMITTEE ON ELECTRIC POWER.

BY A POWER SUPPLY ENGINEER.

It is an interesting speculation to consider what one would do with the "sorry scheme of things" could they but "remould it nearer to the heart's desire," and there would, no doubt, be a concensus of opinion as to the steps proper to be taken to provide this country with an adequate and economical supply of electric power if no organisations to this end already existed.

The new Board of Trade Committee in their deliberations on this question have no such simple problem before them, for to a greater or less degree regard must be paid to the existing undertakings and the necessity to utilise existing capital expenditure to the best advantage. The problem, however, does seem to fall in clear issues.

It is obvious that a large measure of co-ordination is necessary for economy, that future developments of demand will call for large units of generating plant, and that as a consequence facilities must be given for a wide scheme of transmission mains to the various distributing centres. Furthermore, the whole problem of cheap power is inextricably bound up with the economical treatment of coal and the recovery of such products as ammonia and tar.

The rapid provision of large stations with their inter-connecting mains will call for a large and immediate expenditure of capital which must of necessity take some years to yield a fair return, and the financial arrangements necessary to tide over the years of construction, and early working must to some extent affect the problem.

The electric supply industry in this country has expended some £75,000,000, of which approximately one-half is on generating plant. If present stations are to be superseded this must be written off rapidly, and the double financial burden will not be a light one. It is with some degree of confidence, however, that one can look forward to a very rapid growth of load so that the financial stress, though severe, should not be for a long time.

For the provision of the capital the State will presumably be looked to, but what form the assistance should take is an open question. Is it to be State management, as the Post Office, State-controlled enterprise of existing bodies, as are controlled establishments under the Munitions Act, or the absorption of the existing undertakings into one, or, perhaps, a few large undertakings, as the London traffic problem has to some extent been dealt with? This is the first broad issue, and a clear decision as to the wisdom or otherwise of State management of a trading concern of this kind will, it is hoped, not be avoided.

Whatever advantages may be claimed generally for State management they would seem stronger in the case of a business which has, so to speak, become crystallised—that is, in which progress is likely to be along definitely accepted lines. This cannot be said to be the case with electricity supply, which can look forward to a development at least 10 times as great as at present, which has yet to deal in a satisfactory manner with the basic problem of the proper treatment of raw coal, and which in its nature is so closely allied with the coal, iron, steel and certain chemical industries that the measure of co-operation necessary is difficult to foretell, and can only be proved by experience.

It seems possible, therefore, that the committee will decide against State management in favour of some measure of State control, meaning by this not only regulation but assistance of private enterprise. The past control exercised by the Board of Trade has not been merely repressive, but frequently destructive of development, and this must be changed.

On the assumption of State control by the Board of Trade or some specially constituted body, an operating organisation will be necessary, and there is a wide field of choice. Are the existing distributors to join together to utilise their wide local experience and to endeavour to agree as to the future duties and extensions of each undertaking? There is much to be said on both sides as to this, more particularly due to the complication that arises from the existence of local authority and company undertakings, and of the limited tenure of the majority of the latter. It would seem that the path of least resistance would be to preserve the present distributing authorities dealing, at the same time, with the unsatisfactory position of companies working under Lighting Orders and dealing with generation and main transmission by a new organisation which would for the sake of accelerating development receive some sort of State assistance. The form this organisation could take seems broadly to be either a joint concern in which distributing authorities invested in proportion to their demands and from which they shared the benefits proportionately, or an operating company relying on public subscription for share capital and on the State and existing distributing authorities for loan capital.

The control of the profits and prices of such an organisation would not be difficult, and the management would doubtless be more single-minded and efficient than if subject to the control of a large committee.

The distributing problem in course of time would work out its own salvation. Many small undertakings would be merged into the larger ones, and eventually one might look forward to a comparatively small number of distributing undertakings whose independent existence would encourage a healthy spirit of competition for good results.

If a super-operating organisation is created the necessity for a controlling body may be felt, and we have in such case the precedent of the American Public Utility Commissions, or, in a minor degree, our own Railway Commissioners, but the fuel question must take the principal part in the committee's decision.

200,000,000 tons of coal are consumed annually in this country, and it seems possible by economic treatment to produce three times the useful effect from the same amount of coal. Much of the fuel would be used for steel production, chemical and furnace processes, much for domestic purposes and an increasing amount for power. Even ultimately it is unlikely that electricity supply will deal with more than one-half of the coal consumed in the country, and, therefore, the problem of fuel economy is not one solely for electrical supply to decide, and there must be a large measure of co-operation between the electricity supply, colliery and gas undertakings, steel and iron works, and all the large coal using industries of the country. Therefore, any new supply organisation should be of the most flexible kind, so that where necessary intimate co-operation may take place with other industries and individual enterprise will not be hindered from developing on new lines side by side with the main organisation.

Control by repression and penalties is almost inseparable from State departments, whereas in the commercial world a bonus is considered to be the equitable offset for a penalty. If the progress of invention is to be stimulated the creation of a commercial undertaking, subject to such control as that of the Railway Commissioners, would seem most hopeful.

If it is decided that the State should assist financially in the early years there seems sufficient justification for taxing all users of raw fuel and using the revenue so obtained to develop economical processes; for example, if a tax of 1d. per ton were imposed on all raw coal, with a rebate to those users who extracted the tars and ammonia, a revenue of, say, £1,000,000 per annum would be produced. If this tax were increased annually by 1d. per ton until it reached 1s., we should in 12 years have obtained, say, £30,000,000 for development, and we should also have imposed a strong inducement to economy.

The municipal interest in electricity supply has been detrimental to development ever since 1882, and it will not be overlooked by the committee that the whole problem would be enormously simplified if municipal undertakings were handed over to operating companies, subject to satisfactory control in the public interests. Cheap power is much more important to a district than an occasional contribution to the rates at the expense of the user, and it will be a good thing when this fact is more widely appreciated.

Digitized by Google

HIGH-TENSION OVERHEAD TRANSMISSION LINES.

BY G. V. TWISS.

Summary.—The author discusses the subject comprehensively. Dealing first with the general design of transmission lines, a comparison is drawn between the factors of safety required in this country and those in Canada and the U.S.A. Curves are given for facilitating calculations of cost. In dealing with line materials, a comparison is drawn between the pin-type of insulator and the suspension type. The Hewlett and metal hooded insulators are discussed at some length. Finally, the mechanical design and the testing of insulators are considered.

1. General Design of Transmission Lines.

Spacing of Conductors.

Arrangement.—Conductors may be arranged in any of the ways shown in Fig. 1. The diagrams show arrangements for double circuits, but for single circuits half of each diagram may be read.

The considerations which influence the choice of arrangement of conductors are as follows: —

(*a*) Electrical considerations.

(*b*) Mechanical considerations, such as: Possibility of wires swinging together. Leverage on the cross-arms and poles. Snow, either unevenly weighing down the conductors, or falling off and causing the conductors to foul one another or to come too close together.

From the electrical point of view, the A and B arrangements in Fig. 1 are equally satisfactory. In any case, however, the maintenance of an equilateral triangle is not of the greatest importance, and on some of the largest modern transmission lines no attempt is made to obtain a triangular arrangement. From the point of view of swinging together, C1 is the best, and B1, B2 and B3 come next,

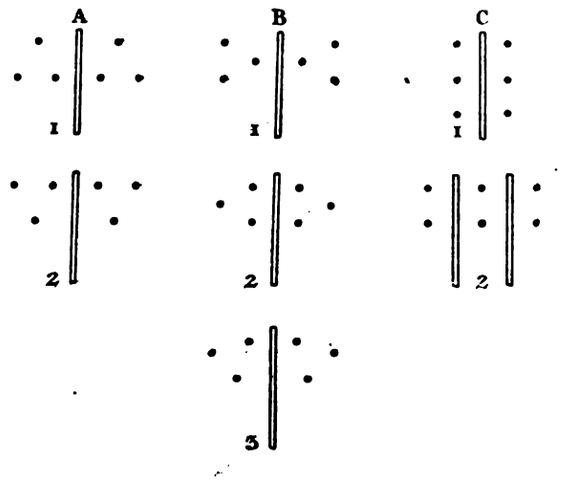


Fig. 1.—Arrangement of Conductors.

whilst as regards snow effects C1 is the worst, and the A arrangement is the best. The B arrangement, however, is equally good if the base of the triangle is tilted slightly as in B3. It would appear, therefore, that the B arrangement with the base of the triangle slightly tilted is the best arrangement for double circuits, as it gives the shortest poles and the shortest cross-arms compatible with the absence of swinging together and snow effects, and incidentally maintains the triangular arrangement—which is desirable if nothing is lostthereby.

Clearance Between Conductors.—The considerations affecting clearance between conductors are as follows:—

1. Mechanical—*i.e.*, the possibility of wires swinging into contact or dangerously close together.

2. Electrical considerations, which with the very high voltages must include the possibility of corona loss.

In regard to (1), the possibility of wires swinging together, this will of course depend upon the relative position of the wires, whether horizontal, vertical or triangular. There seem to be no definite rules in regard to the clearance necessary for mechanical reasons

Wind may blow at any angle to the conductors, and with different velocities at different points in any span; hence a set of sagging conductors of small weight relatively to their wind area (for instance, very small wires, especially if of light small wires, tend to swing irregularly—*i.e.*, out of phase—and might touch or come dangerously close unless well spaced apart. Wires having a greater weight relatively to their wind area (*i.e.*, large wires, especially of heavy material such as copper) will have a more dead-beat action and will tend to swing less out of phase—*i.e.*, more synchronously—and consequently need not be spaced so far apart to obtain the same security against short-circuits.

This out-of-phase swinging is best stated as an angle, and the author suggests 90 deg. as the maximum. For heavier and larger wires it will, of course, be less, depending upon the ratio of wind load to weight. The relationship of wind area to weight might be used as an absolute indication of clearance by making the latter equal to the product of the sag and the sine of the angle made with the vertical by the resultant of the wind area and the weight.

In the vertical arrangement is the possibility of the wires being unequally borne down by ice or snow, or of the wind lifting or depressing the wires unequally. A clearance of 1 ft. per 100 ft. of span would appear to be a good rule.

In the triangular arrangement the final clearance chosen for a given case would be whichever proves to be the greater, that indicated for electrical or for mechanical considerations.

The clearance between a conductor and the cross-arm on a pin insulator should not be less than the distance from the conductor round the insulator sheds to the pin. Reduction in clearance between the conductor and cross-arm may arise through swinging of the suspension insulators, but generally no refinement has been used for the purpose of maintaining this clearance.

Tension and Loading of Conductors and Consequent Effects.

The Board of Trade Regulations assume the maximum conditions of loading to be a wind of 25 lb. per square foot at a temperature of 22° F. without snow or ice on the conductors; and a factor of safety of 5 is required on the conductors under these conditions. Other countries make different assumptions and stipulate other factors of safety. The author gives calculations for a span of 500 ft. These figures show that the United States and Canadian factors of safety, compared on the same basis of loading as ours, are not so low as they seem to be, and in the assumed conditions under which we get a factor of safety of 5, they get a factor of safety in the neighbourhood of 3.

Economical Span Length.—In this country we find span lengths of the order of 150 ft. with a maximum of perhaps 300 ft., while abroad we find a usual span length of 500 ft., and in America and Canada as high as 700 ft.

For the purpose of considering the relative cost of different spans a transmission line can be broadly divided into two parts, viz., (1) the conductors, the cost of which is practically irrespective of the span length, and (2) the supports, *i.e.*, poles, insulators and accessories, the cost of which will vary for different span lengths.

The author gives a number of curves, from which the most economical span can be found for given conditions and the cost per mile. From these curves it at once appears that:—

1. The larger the conductor the longer is the economical span and vice versa.

2. The higher the tension of stringing, the longer is the economical span, and vice versa.

3. The larger the conductors the greater is the difference between the economical span lengths for U.S.A. and Great Britain conditions respectively (this is due to the ice loading on the U.S.A. conductors).

4. The higher the tension of stringing the less is the cost of the transmission line.

5. The greater the number of conductors the shorter is the economical span length.

6. The economical span length is never shorter than 250 ft. for the cases taken.

7. A wooden pole is impracticable for an ultimate strength of 24,000 lb. and over, whereas for ultimate strengths up to 6,000 lb. wooden poles have always the advantage over steel poles.

8. Wooden poles are the more economical up to the points of divergence shown on the curves.

Span lengths of 600 ft. to 700 ft. for U.S.A. and Canadian conditions are, in certain cases, shown to be justified. On the other hand, spans of 150 ft. appear never to be justified on economic grounds even with the low tensions of stringing used in this country. Similar calculations, however, show that the span of 150 ft. is correct in many cases with telegraph lines, and it may be that telegraph practice has influenced our span lengths in transmission-line construction.

Under Board of Trade requirements the cost of supports for spans of 150 ft. is shown to exceed the cost of supports for the economical span lengths by as much as £100 per mile. Similarly for the econo-

Digitized by Google

mical span lengths the cost of supports under Board of Trade requirements is shown to exceed the cost of supports under Canadian and U.S.A. requirements by as much as £100 per mile.

Consequently, and as is also shown, the cost of supports for spans of 150 ft. under Board of Trade requirements exceeds the cost of supports for the economical span lengths under U.S.A. requirements by as much as £200 per mile.

This is on the cost of supports delivered, but the cost of erection will be partly proportional to the number of poles and consequently to the span lengths, so that the above-mentioned differences in cost when taken on such transmission lines completely erected will be greater.

The author shows that the Board of Trade rules lead to a higher factor of safety for the larger conductors. If we assumed the worst conditions, such as an ice load, a lower factor of safety could be used all round, which would give a higher margin of safety on small wires and an equal one on large. This would also tend to reduce the disproportion in the cost of transmission lines embodying conductors of average size or larger in this country compared with those elsewhere.

Earth and Lightning Wires.

The use of a wire or wires to maintain a uniform earth potential throughout the line is desirable. This wire is also employed for sundry other purposes, such as: (1) A catenary wire to carry an insulated pilot or telephone cable. (2) A component of a protecting device against falling conductors, as in the case of the triangular guards. (3) A mechanical stay to help to support certain types of flexible poles. (4) A lightning shield.

Perhaps the most important and interesting function is that of shielding or screening the power wires from lightning and atmospheric disturbances, and in this direction they provide a considerable amount of protection. The use of steel for these wires, particularly when placed above the conductors, has been deprecated on the theory that owing to the shorter life of steel compared with, say,

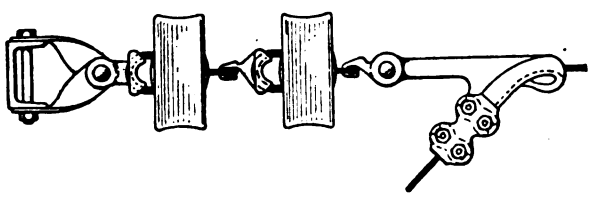


Fig. 2.—Strain Insulator of Disc Type.

copper, such wires may break and by fouling the conductors interfere with the supply. Steel is much cheaper than copper or bronze, and before abandoning it in favour of more expensive metals its life might at least be made a maximum by fixing the wire with the same regard to crystallisation as in the case of any other wire. A flexible clamp for this purpose is described later.

Poles.—The author then refers to terminal poles, angle poles and intermediate poles. The correct strength of the last named in the longitudinal direction is decided by the worst conditions that may arise. It is generally considered that the breakage of one wire out of three, or two out of six, is the worst case that need be considered. If provision be made for the breaking of one wire out of three, this would indicate that the intermediate poles should have a strength in the longitudinal direction of one-third that in the transverse direction. Thus in the remote event of all wires breaking the load would still be within the strength of the poles by virtue of their factor of safety plus their ability to deflect. This is about the strength of the wooden A-pole upon which excellent results have been obtained, and in the author's opinion it provides a good basis of design for all intermediate poles.

Choice of Type of Insulator having Regard to Mechanical Loads and Voltages.

Pin insulators necessarily transmit their load to the structure at a more or less long leverage. The proper function of pin insulators is therefore to support conductors in positions where comparatively small loads are to be dealt with—*e.g.*, on intermediate poles.

The shackle insulator, whilst sound mechanically, becomes excessively large, even at comparatively low voltages, owing to the fact that the upper and lower halves of its insulation are in parallel, so that it is only equal to a pin insulator of one-half its size. This is often lost sight of, with the consequence that the straining points of some lines have only about one-half the insulation of the remainder of such lines.

Comparable insulation can, however, be readily obtained by the use of strain insulators of the disc type (*see* Fig. 2), which can be made up of one, two or more discs as required; and this practice is rapidly superseding the use of shackles.

It is possible to design and manufacture pin insulators of sufficient size to give the tests usually required for a working pressure of 80,000 volts, but very little higher. Compared with suspension insulators, however, such insulators are much weaker, both electrically and mechanically, and cost far more. The economical limit for pin insulators is about 66,000 volts.

(To be continued.)

TRAINING OF DISABLED SAILORS AND SOLDIERS FOR ELECTRICAL SUB-STATION WORK.

Since June, 1916, an important experiment has been in progress which was first conceived in February, 1916, by the Institution of Electrical Engineers, who approached and obtained the sympathetic help of the Education Committee of the London County Council. It was held that a preliminary period of technical training under capable instructors in an institution having up-to-date electrical laboratory equipment might enable men of various grades of education to qualify as sub-station attendants in a much shorter period than otherwise would have been needed, and might give them an enhanced value during the period of station training. The experiment was projected to test the possibility of such preliminary training.

The Northampton Polytechnic Institute was selected as a suitable training centre in London, and the experiment was entrusted to the electrical engineering department of that institute. The training, which is intensive, lasts only three weeks, a new course being held each month, and the number of students in each course is limited to 20. The seventh course of the series ended in March, 1917, and the eighth is now in progress. Statistics of these courses are as follows:—

Statistics.

Number of Applications for Admission.

Course 1.	Course 2.	Course 3.	Course 4.	Course 5.	Course 6.	Course 7.
Jun–July 1916.	Jly–Aug. 1916.	16/10–10/11/16.	20/11–15/12/16.	15/1–2/2/17.	12/2–2/3/17.	12/3–30/3/17.
22	21	22	23	30	22	24
Number Actually Commencing the Course.						
13	20	18	23	19	18	19
Number Approved for Employment.						
15	14	16	20	18	13	18
Number Actually Placed.						
13	12	15	20	18	13	17
Number of Applications from Employers.						
16	42	Over 50	Over 40	Over 45	Over 35	Over 35

Totals for Seven Courses.

Number of applications for admission	164
Number actually commencing the course	130
Number approved for employment	114
Number actually placed	108*
Number of applications from employers	over 205

The disablements which have been found not to disqualify for all posts of the kind at which the training aims are total disablement of one arm or one leg, or a partial disablement of one limb. Disabled men suffering from shell shock, however, cannot be accepted.

Up to the present time the whole of the men who have taken sufficient advantage of the training to secure the recommendation of the joint committee under which the training is being managed have been placed, and there are still many vacancies to fill, but increasing difficulty is being found in placing men with serious arm disablements. It is suggested that in certain cases such men might still be utilised for this work by simple modifications of parts of the switch gear, and an appeal is made to the patriotism of station engineers throughout the country to consider carefully the possibility of employing men who have lost partially or wholly the use of one arm.

Particulars of the course of training and the men available may be had from the Principal of the Northampton Polytechnic Institute, Clerkenwell, London, E.C.1.

* A few of those approved for employment obtained work privately, and one or two had to return to hospital.

Digitized by Google

LEGAL INTELLIGENCE.

Enemy Owned Patents.

Last week a point of interest in connection with the procedure for the suspension of enemy-owned patents came before a Divisional Court (the Lord Chief Justice and Justices Ridley and Rowlatt). The point arose on the return rule nisi for prohibition from proceeding to avoid or suspend letters patent.

The SOLICITOR-GENERAL said it was sought to prohibit the Board of Trade from proceeding with two applications made by Simon-Carves (Ltd.) to avoid or suspend letters patent Nos. 20,870 of 1904 and 16,386 of 1905, on the grounds that it was not shown that the persons entitled to the beneficial interest in the patents were subjects of an enemy State, and upon the evidence it appeared that the benefit was not vested in such person or persons. After dealing with the legislation on the subject, he said that the two patents were granted to Heinrich Koppers (who was resident in Germany), Charles Rudolph Altenheim (a German interned in England), and Albert Victor Derry, a British subject, whose name was formerly Koch, but believed to be of German birth. One of the matters upon which the Board of Trade had to be satisfied was that the persons entitled to the benefit of the patents were not subjects of a State at war with his Majesty, and the committee appointed by the Board of Trade was entitled to report to that effect. It was an impossible deduction that because one of the partners was a British subject, therefore the Board of Trade was precluded from avoiding or suspending the patents. At the inquiry Mr. Derry made a statutory declaration in which he stated he was a British subject, born in Manchester on Aug 9, 1872, and that he was jointly interested in the patent with the two Germans. He took exception to the jurisdiction of the Board of Trade. There was evidence before the committee that the patents were granted to a German subject resident in Germany. Mr. Derry refused to produce any documents to support his position, and the Committee was not only entitled to so report, but was bound to do so.

Mr. H. TERRELL, K.C., said Mr. Derry made an affidavit, which was filed by the Board of Trade. When the proper time came he would be able to produce all kinds of documentary and oral evidence. He had given some evidence, and there had been no cross-examination.

In giving judgment, the LORD CHIEF JUSTICE said it was clear that there was jurisdiction in the Board of Trade to avoid or suspend where it was established that the beneficial interest was in a subject of an enemy State. The mere assertion of such a fact was not enough; it must be supported by evidence, and the only evidence tendered was a statutory declaration by Derry, which stated that the persons entitled to the beneficial results of the patents were the two Germans and himself. Mr. Derry's claim rested upon a partnership agreement, and he could not succeed without giving evidence of that agreement. He refused to do that, and contended that the mere statement that he was, in fact, the beneficial owner with the two others was sufficient, at any rate, to prevent the committee inquiring further unless either the evidence was cross-examined upon, or some evidence to the contrary was produced before the committee. To his Lordship's mind, Mr. Derry failed at the outset. The Controller came to the conclusion that he was entitled to proceed, and he (his Lordship) had no doubt that the Controller was right. The order would be discharged.

Mr. Justice Ridley and Mr. Justice Rowlatt concurred.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 SPECIFICATIONS.

13,788 SUCHOSTAWER. Dynamo-electric machines. (27/3/16.)
Relates to a combined electric motor and dynamo machine, comprising an annular coil supplied with an alternating current, a series of equidistant stator magnets extending from and energised by said coil, said stator magnets and said coil being supported by a stationary frame, and equidistant radial inwardly extending generator magnets supported by said frame and located within said coil, the ends of the U-shaped arms of said generator magnets extending to a short distance from the axis of the structure and forming field magnets of alternate opposite polarities, in combination with a central revolvable shaft from which extends radially outwards carrier arms having magnets at their free ends, each magnet carrying a coil, and means for making and breaking the circuit in each coil at proper times to co-act with the stator magnets to produce rotation of the rotor shaft, and an armature mounted on the rotor shaft and co-acting with the poles of the generator magnets to produce an electric current, and means for utilising the mechanical power given off by the central shaft and for conveying and utilising the electrical current given off from the generator.

1916 SPECIFICATIONS.

2,176 PHILLIPS, R. W. L. Electric couplings. (14/2/16.) 104,702.
3,657 WESTERN ELECTRIC CO. & MCBERTY, F. R. Impulse control systems for automatic telephone exchanges. (11/3/16.) (Addition to 3369/14.) 104,719.
3,736 RELAY AUTOMATIC TELEPHONE CO. & HERINK, H. J. Semi-automatic telephone systems. (13/3/16.) 104,726.
3,859 MAWDSLEY, J. H. ST. H. & JOEL, H. F. Dynamo-electric machinery. (15/3/16.) 104,731.
3,869 HOLT, F. B. Stationary contacts for electric switches or circuit breakers. (15/3/16.) 104,733.
3,896 CONNER, M. S. & KAHL, A. R. Magneto-electric machines for ignition in internal combustion engines. (16/3/16.) 104,736.
4,006 PROKSCH, F. Apparatus for testing electric circuits. (22/3/15.) 100,201.
4,247 B.T.-H. Co. (G.E. Co.) Electric transformers. (22/3/16.) 104,404.
Comprises a primary winding and a main secondary winding on a magnetic core normally highly saturated, and an auxiliary secondary winding on a core normally unsaturated, the two secondary windings being connected in opposition, and so proportioned that their resultant E.M.F. is substantially constant over a working range independent of voltage variations in the source of supply.
4,335 BROWN, S. G. Ionic gas relays or detectors. (23/3/16.) 104,565.
4,348 BROCKIE, J. & JOHNSON & PHILLIPS. Arc projector lamps. (25/9/16.) 104,753.
4,453 BRITISH THOMSON-HOUSTON CO. (General Electric Co.). Electric conductors suitable for sealing into vitreous material. (25/3/16.) 104,758.
4,532 MITCHELL, J. B., SHAW, A. B., & TAYLOR, W. Devices for holding the shades, light reflectors, or diffusers for lamps such as electric incandescence lamps. (27/3/16.) 104,759.
4,620 BAIRD. Spark plugs. (29/3/16.) 104,410.
4,733 MCCOLL, A. E. Protective devices for alternating current electric systems. (31/3/16.) 104,571.
4,941 SMITH, P. F. & ROBINSON, V. S. Automatic voltage regulators as applied to internal combustion engines driving motor vehicles. (4/4/16.) 104,772.
5,464 MCLEOD, T. Electrical signalling and telegraphing systems. (13/4/16.) (Cognate applications, 7,156/16 & 9,750/16.) 104,777.
6,379 MESSERSCHMIDT. Magnetos for ignition purposes. (29/6/15.) 100,782.
7,178 ARMSTRONG, WHITWORTH & CO., WADDINGHAM & THAIN. Electrical rotary switches. (19/5/16.) 104,426.
7,328 CALLENDER, J. O. & CALLENDER'S CABLE & CONSTRUCTION CO. Multicore electric cables. (23/5/16.) 104,793.
7,733 BOSCH MAGNETO CO. Electric starting systems for internal combustion engines. (12/6/15.) 100,684.
8,350 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (Westinghouse Electric & Mfg Co.) Control systems for electric motors. (13/6/16.) 104,439.
A control system for two electric motors of the alternating-current doubly-fed compensated commutator type supplied from a transformer in which each terminal of the cross-field winding of each motor is connected to the supply transformer, and a terminal of the cross-field winding of one motor is connected through the armatures and main field windings of both motors to a terminal of the cross-field winding of the other motor.
8,393 JENKINS, H. C., PATTINSON, H. F., & WELLESLEY, R. Electrolytic cells. (14/6/16. Addition to 2,541/13.) 104,600.
8,436 WALSALL ELECTRICAL CO. & DELEBECQUE. Ammeters and voltmeters. (15/6/16). 104,441.
8,499 ROYCE, F. H., & ROLLS-ROYCE (LTD.). Electrical turning gear for starting internal combustion engines. (16/6/16.) 104,602.
8,831 BRITISH REINFORCED CONCRETE ENGINEERING CO. & HALL, E. B. Electrically welded wire fabric or the like. (23/6/16.) 104,807.
9,137 JOHNSON, F. A. L. Sparking plugs for internal combustion engines. (29/6/16.) 104,807.
9,588 SIEMENS-SCHUCKERTWERKE GRS. Hauling or winding machinery. (4/9/15.) 101,407.
10,361 TILLING-STEVENS, LTD. & SMITH, P. F. Means of control for petrol-electric vehicles. (22/7/16.) 104,819.
10,561 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electric circuit controllers (26/7/16.) 104,457.
11,548 KNUTSON. Spark plugs. (15/8/16.) 104,463.
12,162 RELAY AUTOMATIC TELEPHONE CO. & GRAHN. Automatic and semi-automatic telephone systems. (28/8/16.) 104,467.
12,410 FORSTER, J. P. Means for the control electrically of the signal indicators used in connection with mine hauling engines, winding engines and the like. (1/9/16.) 104,828.
12,420 SOC. ANON. POUR L'ECLAIRAGE ELECTRIQUE DES VEHICULES. Arrangement of regulator and circuit interrupter fixed upon electric generators having a variable speed. (29/11/15.). 102,483
12,616 AUTOMATIC TELEPHONE MFG. CO. (Automatic Electric Co.) Automatic telephone systems. (6/9/16.) 104,640.
12,737 SANDS, CONEY & CONSTABLE. Electric sparking plug. (8/9/16.) 104,468.
12,950 GREEN. Manufacture of electrically welded link chains and cables. (13/3/16.) (Divided application on 3,726/16.) 104,469.
15,443 WALKER. Battery cells. (17/3/15.) (Divided application on 3,161/16.) 102,0566.
16,157 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Mechanical retarding device, applicable to electric supply meters. (18/12/15.) 102,937.
16,944 MARKT, G. Construction of electric switch. (25/11/16.) 104,655.
17,074 HAMILTON, H. E. Electric battery lamp. (25/7/16.) (Divided application on 3,029/16.) 104,847.
17,786 HAMMER, L. G. Electric telephones. (11/12/16.) 104,659.

1917 SPECIFICATIONS.

2,281 SALMSON, E. J. J. Way of mounting cams in magnetos. (14/3/16. Divided application on 3,796/16.) 104,668.

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for the week :—

Officer for the Week.—Platoon Commander H. de P. Birkett.

Next for Duty.—Platoon Commander Bowden.

Appointment.—Company Sergeant-Major Bowden to be Platoon Commander.

Monday, April 30th.—Technical for No. 3 Company, Right-half Company, at Regency-street. Drill, No. 3 Company, Left-half Company. Signalling class. Recruits' drill, 6.30 to 8. Medical examination and attestation, 6 to 8.

Tuesday, May 1st.—Lecture. Demonstration of landscape target, by Platoon Sergeant Hoad, 6.30. Physical drill and bayonet fighting. 7.30 to 8.30.

Wednesday, May 2nd.—Instructional class, 6.15. Drill, No. 1 Company. Right-half Company.

Thursday, May 3rd.—Drill, No. 2 Company, Right-half Company. Ambulance class, by M.O., 6.30. Signalling class.

Friday, May 4th.—Technical for No. 3 Company, Left-half Company. Regency-street. Drill, No. 3 Company, Right-half Company. Recruits' drill, 6.30 to 8.30.

Saturday, May 5th.—Commandant's parade, 2.45; uniform, for drill in Hyde Park.

Sunday, May 6th.—Special work at Bombing School. Parade Clapham Common station (City & S.L. Tube Railway) 9.45 a.m. Uniform, haversacks, water-bottles. Midday rations to be carried. As this work is very important, the Commandant would like to see much larger parades.

Musketry.—For all Companies, see Notice at headquarters.

NOTE.—Unless otherwise indicated, all drills will take place at headquarters (Balderton-street, Oxford-street).

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

The Reconstruction Committee. It is announced that the Reconstruction Committee which was appointed by Mr. Asquith to advise the Government on the problems that will arise at the end of the war, has been reconstructed as follows:—

The Prime Minister (chairman), Mr. E. S. Montagu, M.P. (vice-chairman), Prof. W. G. S. Adams, Mr. J. R. Clynes, M.P., Sir A. M. Duckham, K.C.B., Mr. R Hazleton, M.P., Major J. W. Hills, M.P., Mr. Thomas Jones, Mr. P. H. Kerr, Dr. Marion Phillips, Mr. B. Seebohm Rowntree, the Marquess of Salisbury, Mr. Leslie Scott, K.C., M.P., Sir J. Stevenson, Bart., Mr. J. H. Thomas, M.P., Mrs. Sidney Webb.

The function of the Committee is to recommend to the Government the inquiries which should be made and the steps which should be taken in connection with the restoration of peace conditions.

* * * *

The Excess Profits Tax. Like the great majority of controlled companies, Messrs. Cammell, Laird & Co. are not yet in a position to say what are their standard profits for the past year.

At the meeting last week the chairman (Mr. W. L. Hichens) said that one of the chief causes of the delay was that they were accountable under two Acts. This administrative scandal—for it deserved no other name—had given a vast amount of unnecessary trouble and had caused a great waste of time, labour and money during a period when there was urgent need to economise all three, and he hoped the first financial act of the new Government would be to return to saner and juster methods of taxation. Large sums would have to be spent after the war on renewals if they were to face successfully competition, which he thought they must expect. There was no doubt that far too little attention was paid for many years before the war to the important question of renewals by most engineering firms in the country. They were too apt to take advantage of the comparatively low rates of wages and to use human hands and antiquated machinery in place of the most modern devices. After the war, wages would, he expected and hoped, rule high, and they would have to spend money and intelligence on labour-saving devices.

* * * *

National Smelting. The National Smelting Co. (Ltd.) has been registered with a nominal capital of £500,000 in £1 shares. The new company, which is being formed with Government support, will carry on the business of roasters, smelters, refiners, rollers, galvanisers and manufacturers of and dealers in metals, ores and mineral and metallurgical substances of all kinds.

It is provided that so long as any part of any advances made by the Government remains outstanding or any lease by the Government to the company of any factory remains in force, the Minister of Munitions or the Board of Trade may nominate one director. Also the company may agree (if the directors unanimously consider it in the company's interest) that any person, firm or company with whom the company may enter into any agreement for the supply of raw materials, concentrates or ores, shall have the right to appoint a director. There are the usual Board of Trade clauses to ensure the permanent British control of the company in the articles of association.

* * * *

British Trade With China. Mr. A. Rose, H.M. Commercial Attaché at Shanghai, recently addressed at the London Chamber of Commerce a meeting of merchants and others interested in the Far Eastern trade.

Mr. Rose, after touching on the commercial conditions prevailing in China, and the extent to which trade centred round the Treaty Ports, pointed out that in recent years the Chinese were obtaining more and more of our industrial products in exchange for their raw material. As regards the future, the best advertisement was to show the actual goods to the consumer. The most serious competition prior to the war was that of Japan, America and Germany. Apart from cotton goods, there was a wonderful field for many forms of engineering enterprise, especially machinery, in cotton growing districts, pumps, motors, &c., both on land and water. At present there were only 87 electrical installations in operation in China. It was essential that groups of manufacturers should send out well accredited agents. Great improvements were being made in methods of distribution, and the underlying principle which he recommended was to create demand by supply. There was great need for improved means of communication, financial facilities, encouragement of Chinese co-operation and the elimination of non-British distributors.

Development of Foreign Trade. At a recent meeting of the Advisory Committee to the Board of Trade on Commercial Intelligence it was reported that at the recent British Industries Fair, which was confined to the toy, fancy goods, pottery, glass, printing and stationery trades, the number of exhibitors was 444, compared with 350 in 1916, and the number of separate visitors 15,000, against 13,000 in 1916.

Reports were presented on the work of the Department of Commercial Intelligence for the first quarter of 1917, and on the proposed arrangements for the extension of the official representation of the United Kingdom trade throughout the British Empire. It was stated that over 700 firms had applied for interviews with H.M. Trade Commissioner for Canada, who is here on an official visit.

The Committee approved the arrangements made by the Board of Trade and Foreign Office for special trade inquiries in Spain and Portugal, and for the exhibition in various trade centres of samples of foreign goods which compete with British goods in important foreign markets. The Committee also approved proposals for the co-operation of the Board of Trade with associations of manufacturers for investigation of overseas markets.

* * * *

The Metric System. Under the chairmanship of Lord Balfour of Burleigh a sub-committee of the Prime Minister's Reconstruction Committee is considering the desirability of the adoption of the metric and decimal systems of coinage, weights and measures.

* * * *

South African Industrial Research. The Government of the Union of South Africa propose to give effect to the recommendations of the Industrial Research Committee for the creation of a Government Industrial Research Department, and a sufficient grant of money will be made for inaugurating the work.

At the last meeting of the South African Institute, Prof. Buchanan, who gave a sketch of the progress made by the Institute during the last 12 months, said that in May last the Council agreed to take joint action with other technical institutions in the consideration of recommendations for industrial research. A Central Committee was formed of delegates drawn from seven institutes. That committee submitted proposals which embodied the creation of a salaried staff, together with an honorary technical board with advisory functions. The Government was asked to provide the relatively small funds required to pay for executive work, while the technical and scientific institutions were expected to give the necessary time to advise on the merits of proposals submitted. Prof. Buchanan contended that, although the Development of Resources Committee was at present dormant, it should not be dissolved. A principal function of the proposed Research Department would be to collect and distribute information relating to materials available in the country as well as to appropriate manufacturing methods. It was to be hoped that the proposed department would be but one of a number of similar institutions operating in close relation in various centres of the Empire.

In regard to the advantages of cheap electricity, Prof. Buchanan mentioned the possibilities in connection with the production of fertilisers and the working of the vast deposits of iron ore. The correct and efficient training of our young engineers had now become of paramount necessity for the proper development of the country.

* * * *

Anglo-Italian Trade Development. The first annual meeting of the British Italian Corpn., which was formed some time ago for the purpose of developing Anglo-Italian trade, and supplanting German influence in Italy, was held on the 18th inst.

The chairman (Mr. J. W. B. Pease) gave an outline of the movement which led to the formation of the Corporation and of the Cia Italo-Britannica in Italy. The contracting banks (London County & Westminster and Lloyds) undertook to form the British Italian Corpn. with a capital of not less than £600,0 0, and the Board of Trade undertook to pay to the corporation annually for 10 years £50,000 or the equivalent of 5 per cent. on the capital issued and paid up in cash, should the paid up capital be less than £1,000,000. It was a loan from the Government, which carried no interest, and was only repayable under certain circumstances. As long as the corporation continues in operation and pays no more than a cumulative 5 per cent. to its shareholders, there was no obligation to make any repayment, whatever the amount of profit actually earned might be. The two undertakings had investigated various schemes, including seven railway, three railway electrification, four shipping and shipbuilding, five general imports and exports, four hydro-electric, one gas and one metallurgical projects. Some were "turned down" at once; others were approved of in principle, and would be gone into further when the occasion was ripe. Some, after full investigation, were agreed to and financial assistance promised, but were subsequently withdrawn.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Belfast.—Application is to be made to the Board of Trade to approve the site for a new electricity generating station in Hamilton-road.

Finchley.—The Urban Council has applied to the L.G. Board for sanction to the borrowing of £14,000 for extensions of the electricity supply undertaking.

Poplar (London).—The Electricity Committee report having had under consideration the urgent necessity for extensions of the generating plant to meet next winter's demand.

As the cost of extensions at present would exceed pre-war cost by at least 50 per cent., negotiations are proceeding with the London County Council for linking up with the Greenwich tramway generating station. Failing agreement with the L.C.C. the Committee have under consideration alternative schemes submitted by the engineer (Mr. J. Horace Bowden). Whether interchange of supply with the L.C.C. or the installation of a new generating set be adopted the Committee stated that the erection and equipment of a new sub-station and cable extensions will be necessary, and should be proceeded with at as early a date as possible. The following estimates of this work have been submitted :—erection of new sub-station, £3,000 ; cable ducts and two e.h.t. feeders to sub-station, £9,851 ; two 1,000 kw. converters, switchgear and overhead traveller for substation, £9,162 ; l.t. mains from new sub-station, three 6-core feeders and one 5-core distributor, £7,200 ; total £29,015.

The Committee has approved of the proposed extensions. In regard to the provision and erection of one 1,000 kw. rotary converter the engineer's estimate of the cost of foundation, e.h.t. and machine panels, with necessary switchgear and machine connections, is £850.

Southend.—The Council have decided by a majority of one to apply to the L. G. Board for sanction to borrow £45,520 for additional generating plant.

GENERAL.

Clayton.—Negotiations are proceeding between certain ratepayers and the Bradford Electricity Committee as to a supply of electric current in this district.

The Bradford committee has appointed a sub-committee to go into the question and report to the next meeting of the full committee.

It will be remembered that the Council had already assented to the application of the Electrical Distribution of Yorkshire for a provisional order, but advocates of a municipal supply are agitating for an agreement with Bradford Corporation.

Hackney (London).—The Electricity Committee has decided, subject to the approval of the L.G. Board, to give an annual subscription of £5 5s. to the Engineering Standards Committee.

The employees of the electricity undertaking have asked for a further increase of wages or an increased war bonus, and Sir George R. Askwith is to be asked to consider the matter.

Grants have been made to the following for services rendered during the war :—Mr. P. M. Shears (canvasser), £20 ; Mr. E. Wilkinson (generating engineer), £10 ; Mr. A. G. Hilling (assistant distributing engineer), £5 ; Mr. J. F. Heathman (chief clerk), £5.

Hendon.—At the last meeting of the Council the General Purposes Committee reported that the Council are entitled to acquire the local electric supply undertaking 15 years after June 6, 1904, upon giving 12 calendar months' notice.

If taken over at that period the Council would be required to pay the value of the undertaking as a going concern, with an addition in respect of goodwill of a sum equal to the net profit earned by the company during the preceding five years.

The report was merely received.

King's Lynn.—The Council is now giving a supply of electric current for power to Messrs. Dodman's and the Cooper Co's works, and a further application for a large power supply is anticipated.

Linking-up in South Wales.—At the last meeting of the Swansea Tramways and Electric Lighting Committee the electrical engineer (Mr. J. W. Burr) reported having attended a meeting at Cardiff with regard to inter-connection of electric supply undertakings.

As regards the question of funds for providing the preparation of plans, reports, &c., it is proposed that each undertaking shall guarantee a maximum amount of 1½ guineas per £10,000 of gross revenue.

Mr. Burr also reported that he had interviewed the Director of Electric Power Supply of the Ministry of Munitions, and had obtained permission to order for Swansea a feed pump and a mechanical draught fan, but not a water-tube boiler, as proposed.

Mansfield.—The Electricity Committee is obliged to make a smaller contribution than usual—the amount in the current year is £500—from the profits of the undertaking towards the general district rate.

Owing to the Summer Time Act the consumption of electricity for lighting has been reduced to a material extent, the revenue for three-quarters of the past year having fallen by over £1,000.

Marylebone (London).—It was reported to the Council last evening that the staff of the electric supply department was carrying out the work, estimated to cost £750, of bringing in certain cables to the new main switchboard in order to cut out an unnecessary complication of street pillars in Aybrook-street.

The committee also submitted the revenue statement for the December quarter and the estimates for the year ended March, 1918, which are abstracted in another column.

Midhurst and District Electric Lighting Order, 1914.—The Board of Trade have extended by one year from May 8, 1917, the periods of two years and 18 months respectively limited for laying mains, &c., in streets specified and in the remainder of the area of supply.

Mytholmroyd.—The Urban Council have consented to Halifax Corporation applying to the Board of Trade for an order to give a supply of electricity to several firms in this area on condition that they discontinue the supply on the written request of the Mytholmroyd Council.

Yorkshire Provisional Orders.—The Board of Trade has given its decision on various applications for provisional orders made by Electrical Distribution of Yorkshire (Ltd.).

Orders have been granted for the following districts : Featherstone, Garforth, Horbury, Otley, Penistone and Rawdon, but the application for an order for Wortley has been refused. The company has also applied for orders for Luddendenfoot and for Clayton and Queensbury.

HYDRO-ELECTRIC NOTES.

Canadian Hydro-Electric Progress.—The Shawinigan Water & Power Co. report that in 1916 the output from the company's own power station and from that of the Laurentide Power Co. reached 478,540,000 kw.-hours, an increase of 19 per cent. over the production of 1915 as applying to the Shawinigan system.

During the year the St. Maurice district, including the cities of Grand Mere, Shawinigan Falls and Three Rivers, witnessed remarkable growth, the construction of the mill of the St. Maurice Power Co. and extensive additions to the plants of the Wayagamack Pulp & Paper Co. and the Canada Iron Corpn. greatly stimulating the growth of Three Rivers, whose population has materially increased, while at Shawinigan Falls the establishment of several new industries and the operations of the Belgo-Canadian Pulp & Paper Co., and the Aluminium Co. to the fullest extent, resulted in an extraordinary increase in population, which now numbers 11,000. The total amount of power used at Shawinigan Falls is now nearly 100,000 H.P., and this amount will be increased by the new industries. The various subsidiary concerns of the company also made good progress, especially the North Shore Power Co., the Three Rivers Traction Co., the Public Service Corpn. of Quebec, and the Canada Carbide Co. Two new undertakings, the Canadian Electrode Co. and the Canadian Electro Products, were organised with promising results. The Sherbrooke extension was put into operation in January, and will deliver power to all the larger cities and towns in the Province of Quebec, and it is expected that the La Loutre storage dam will be completed by the end of December next. The new business for 1916 was larger than that in any previous year, and should (it is estimated) increase the demand for power on the company's generating station by 25,000 H.P.

Last year's gross earnings increased over those for 1915 by $405,730 to $2,325,873, and net earnings by $202,840 to $1,897,945. The dividend on the share capital has been increased from 6½ per cent., absorbing $787,131, to 7 per cent., absorbing $989,006, while reserves and sinking funds have been increased by $231,141 to $2,400,000. The paid-up and outstanding share capital is $15,000,000.

Tasmanian Hydro-Electric Power.—Mr. J. H. Butters, manager of the Tasmanian Government's hydro-electric undertakings, has stated that in addition to the Great Lake and the King River schemes, others are likely to be put in hand as opportunity offers.

There will be (according to Mr. Butters) no difficulty in developing on the West Coast all the power needed there, even if the demand grows much larger than at present. Over 10,000 H.P. can be developed at Lake Rolleston, near Zeehan, and the Franklin River and other possible sources of power were being prospected. Later, when copper gets cheaper, an inter-connecting cable can be run from the West Coast to the Great Lake. In the region of the central plateau there are several schemes, quite apart from the Great Lake, now being inquired into. 40,000 H.P. or more can be developed on the River Derwent. The works will probably be some distance below Lake St. Calir, which will serve as a reservoir. The Arthur Lakes also should yield 40,000 H.P. or 50,000 H.P.

U.S.A. Water-Power.—A new 45,000 H.P. hydro-electric plant of the Wisconsin-Minnesota Light & Power Co. on the Chippewa River

Digitized by Google

was recently inaugurated. The dam has caused the foundation of a lake covering 7,000 acres, and the head of water at the dam is 58 ft. There are seven 6,500 H.P. three-phase generators and energy is transmitted 72 miles to St. Paul and Minneapolis.

It is proposed to merge the undertakings of the Housatonic Power Co. and the Rocky River Power Co. into the Connecticut Light & Power Co., for the purpose of developing the water power of the Housatonic and its tributaries. The ultimate horse-power will be about 50,000, but an auxiliary steam plant will be provided as a stand-by.

Water-Power in Russia.—At the recent meeting of the Russo-British Chamber of Commerce a report on the best method of using water-power was submitted.

The report stated that progress in the use of water-power should follow two directions. On the one hand, it should use the unappropriated water-power for Imperial, social and private needs; on the other, by improving and extending existing water turbine installations, particularly if they are working for concerns providing for the national defence, in districts experiencing a scarcity of fuel. In order to fulfil the first object, it would be necessary to introduce stimulating legislation on the use of water-power and the transmission of electric current, and a general plan should be prepared for the use of "white coal" corresponding to the requirements of the defence of the country, industry, ways of communication, agriculture, &c.; and, lastly, the establishment of a permanent bureau to give effect to the plan indicated for using water-power. In the general scheme for using the water-power of the country it would be most natural to deal first with the north-western district, which requires imported fuel, but finds it scarce, and also to facilitate the development of industry in the large populated centre of Petrograd. The chief application of hydro-electric current will be for the supply of large engineering, metallic, metallurgical and cement works, mines, electro-metallurgical and elecro-chemical production, the production of wood pulp and cellulose, spinning and weaving factories, sawmills, railways, waterways, agriculture and factories.

LIGHTING AND INDUSTRIAL POWER.

Electric Power in Russian Collieries.—It appears that considerable progress was made between 1909 and 1914 in the introduction of the use of electric power in the Donetz coal mines, and in several cases additional plant was installed.

The average number of prime motors per plant increased from 2·64 to 5·08., and the average horse-power per motor from 240·4 H.P. to 299·7 H.P. The average output per generator increased from 144 kw. to 368 kw. at the end. There has been also a change from d.c. to a.c. generation.

Electricity in Gold Mining.—At the recent meeting of the Cregon Gold Mining Co. it was reported that the electric power from the Cauvery Falls had worked satisfactorily throughout the year, the interruptions being few and brief; also that the Kolar Mines' power station had continued to distribute electric current with complete regularity.

ELECTRIC TRACTION.

Belfast.—The Tramways and Electricity Committee has now adopted the revised proposals of the general manager, Mr. J. S. D. Moffet, in regard to tramway fares and stages.

Cross-town stages and return tickets have been abolished, and children's fares are to be modified.

The accounts of the tramway undertaking for the year ended March 31 last show a deficiency of about £6,000.

Darlington.—The Darlington Light Railways Order, 1917, has been submitted to the Board of Trade for confirmation. Objections to the Board of Trade by May 15.

Maidstone.—The Council recently decided that the County Council be asked to negotiate for the following contributions from motor omnibus owners for the use of new routes:—

Id. per 'bus-mile in respect of waterbound macadam roads, ¾d. per 'bus-mile in respect of tar macadam or other bituminously bound surfaces, ½d. per 'bus-mile in respect of roads having concrete foundations, with a minimum of £10 per route mile per annum from each omnibus proprietor.

Manchester.—It is announced that the revenue of the Manchester Corporation tramways for the past financial year was £978,000, the highest figure on record. As the Committee is paying £100,000 a year in war service allowances the amount in aid of rates will be reduced next year from £100,000 to £50,000.

Metropolitan Association of Electric Tramways Managers.—A meeting of the members was held at the Municipal and County Club, Whitehall Court, Whitehall, S.W., on the 19th inst., when there were present—

Messrs. Ullmann (East Ham), chairman; Hammond (M.E.T.), vice-chairman; Bruce (L.C.C.), Harvey (Ilford), Mason (South Met.), Mackinnon (London United); and Goodyer (Croydon), hon. sec. Letters of inability to attend were received from Messrs. Murray (Walthamstow), Slattery (West Ham), Williams (Erith), Stokes (Bexley Heath) and Schofield (Leyton). Various matters of interest were discussed.

Southport.—The salary of the tramways manager, Mr. T. J. Kendrew, has been increased from £250 to £300 per annum.

Swansea.—The Board of Trade has extended for one year from Aug. 28, 1917, the time limited by the Swansea Corporation Light Railways (Extensions) Order, 1914, for the compulsory purchase of lands for railway No. 2 and the completion of railways Nos. 1 and 3.

Women Tramcar Drivers.—At present there are 250 women acting as drivers in Glasgow, 1,293 as conductors, 470 as car cleaners, 193 as clerks and 60 as storekeepers and wood-workers.

The number of conductors has decreased since February, because men have returned from the war and resumed their former posts. The manager (Mr. James Dalrymple) is anxious to train more women as drivers, because a further draft of men will be called up for military duty. It is said that the women drivers show themselves cool and competent, and have fewer accidents than the men drivers.

IMPERIAL NOTES.

Australasia.—Mittagong (N.S.W.) municipality has practically agreed to take current for an electric installation from the Public Works power-house at Port Kembla and has asked the N.S.W. Government Works Department for the necessary permit.

The Wollongong (N.S.W.) correspondent of the "Australian Mining Standard" states that the Broken Hill Proprietary Co. is adopting electric haulage of the canisters used to fill its coke ovens.

The Melbourne Tramway Co., which owns the cable tramways in Melbourne, is appealing against the award of Mr. Justice Cussen fixing £335,000 as the assessment of the property to be handed over by the company to the Melbourne Tramways Board. The company claimed £438,000.

A deputation from the Melbourne Trades Council recently waited upon the Minister of Mines, Mr. T. Livingston, to urge the Government to take immediate steps to utilise the Morwell brown coal deposits. The deputation reminded Mr. Livingston that Mr. C. H. Merz had expressed the opinion that the whole of Victoria could be lighted by energy obtained from the Morwell brown coal and that current for power could be generated cheaply enough to sell at ⅛d. per unit. Mr. Livingston said it had been found that as much gas could be got from 1 ton of brown coal as from 2 tons of black coal. He hoped the Premier would be sufficiently impressed by the prospects to induce him to find the money required. The Premier, the Minister of Mines and other ministers subsequently visited the coalfield accompanied by Mr. Harper (city electrical engineer of Melbourne), Mr. A. MacNicol (consulting engineer) and other technical advisers. The Premier said it had been found that 10,000 ft. of gas could be produced from a ton of Morwell coal, its calorific value was two-thirds of that of black coal gas, and 2 tons of the brown coal could be landed in Melbourne for less money than 1 ton of imported black coal. Investigations would be pursued, and any reasonable cost would be incurred to bring the matter to a successful issue.

The revenue of the Melbourne Electric Supply Committee for 1916 was £197,100 (increase £14,505) and expenditure £94,849 (increase £12,104), leaving gross profit of £102,250 (increase £2,402).

Ald. Cabena, in presenting the statement, said but for the coal strike the revenue would have exceeded £200,000. The principal item in the increased expenditure was coal, which cost £9,000 more. Deductions for capital charges and depreciation amounted to £54,338, leaving a net profit of £47,911. Against this amount were charged sinking fund, £6,540; payments to employees who have enlisted, £3,654; energy, &c., supplied free for patriotic purposes, £634; and sundry items, £820; making a total of £11,648. Of the balance (£36,263) the committee allocated £36,000 to the town fund. The sinking fund is now £141,828 and outstanding liabilities are £670,283. The great success of the undertaking was largely due to the energy and ability of the electrical engineer (Mr. H. R. Harper) and his staff. The council referred the report to the Finance Committee

India.—In the review of the Government of Madras of the Madras Corporation's last report, it is stated that the proposals for the extension of the tramways involve the widening of bridges at considerable cost and are still under examination.

The Bombay Municipal Commissioner has forwarded to the Corporation for sanction the proposals submitted by the Bombay Electric Supply & Tramways Co. for extending the tramways system along Esplanade and Sandhurst-roads, and for doubling the present single track along Colaba-road.

According to last year's report of the Madras P. W. D., there has been a steady increase in the use of electricity in Madras City. There are 48 local industrial concerns worked by electric power, including saw mills, oil mills, flour mills, printing presses and cement works, and many more await connection. Works are in progress for supplying current to the suburbs of the Kilpauk Adyar and Royapuram.

FOREIGN NOTES.

Italian Imports.—In virtue of a Royal Decree published in the "Gazzetta Ufficiale" for April 5, the importation of all foreign goods into Italy has been prohibited.

The prohibition does not apply, however, to goods imported for account of the State, to raw materials for use in manufacture, or to articles of food; and in special cases licences to import may be obtained

Digitized by Google

Morocco.—A recent Presidential decree authorised the expenditure of 2,293,000 fr. (£91,720) for the provision of telegraphs and 3,070,000 fr. (£122,800) for telephones in the French zone of Morocco.

Netherlands Prohibition of Exports of Metals.—The exportation of metals in any form from the Netherlands has been prohibited as from April 10. This prohibition does not, however, apply to iron and steel, in respect of which the Royal Decree of Oct. 13, 1916, remains in force unaltered.

Norway.—The "Anglo-Norwegian Trade Journal" says Det Metallurgiske Aktieselskab (The Metallurgic Co., Ltd.), Bergen, has increased its capital from 30,000 kr. to 500,000 kr. The company's object is to manufacture zinc electrolytically. A large zinc factory will be established in the near future in West Norway.

The Stavanger Electro-Staalverk is increasing its capital to 4,000,000 kr. to provide for running the works by electricity. The Ryfylke Waterfalls, which have been leased by the company, are being harnessed to produce about 7,000 H.P. The company also intends to extend its steel works, and to erect rolling mills.

Swedish Prohibition of Exports.—The exportation of the following goods from Sweden is prohibited as from the dates mentioned.

Accumulator plates and wooden boxes (lined with lead) for accumulators; Bergmann and similar insulating tubes and boxes for insulating pipes; Rontgen apparatus, wrought tool steel and high speed steel and w.i. bars (as from March 18, 1917).

Copper and alloys thereof with non-precious metal; aluminium, nickel and metals not specially mentioned in the Swedish tariff; lamps not specially mentioned; manufactures of lead, machines and apparatus belonging to Sec. III. of the Customs tariff (other than electric), also electrical machines such as generators, motors, converters transformers and damping-rollers; stators, rotors, current collectors, magnet coils, brush holders and armature coils exported separately—all these, provided that they are composed mainly of materials (other than iron) of which the exportation is prohibited; and zinc (as from March 31, 1917).

MISCELLANEOUS.

After-war Employment.—A report by Birmingham General Purposes Committee on projects likely to give employment after the War states that schemes of tramway extensions have been prepared and the estimated cost is put at £198,714.

The most important project is the construction of new tramways authorised in 1914 and estimated to cost £142,455, with £16,259 additional for land. The work will afford employment for 1,500 men for two years. The committee also propose the repair and reconstruction of a considerable portion of the existing tramways, which are badly out of condition, due to shortage of labour and materials. The expenditure involved is £40,000, and it will be met out of tramways reserves. About 1,000 men would be employed for 9 months on this work.

Colonial Prohibited Exports.—The Supplement to the "Board of Trade Journal" of the 19th inst. contains complete lists of articles which, according to the latest information received by the Board of Trade, are prohibited to be exported to various destinations from British India, Canada, New Zealand, South Africa, Newfoundland, Egypt, Malta, Cyprus, Mauritius and Ceylon.

Enemy Firms Wound Up.—The Controller of the Alphons Custodis Chimney Construction Co. (Ltd.) has applied for a release. Objections to Board of Trade by April 28.

The Controller of Eisterk (Ltd.) has applied for a release. Objections to the Board of Trade before May 2.

Engineering Wages.—The Government Productions Committee has made the following award on the application of the joint committee of the engineering and kindred trades, on behalf of the piece workers, for a bonus on all earnings.

In lieu of and in substitution of the increase of 3s. per week, the piece rate of the men concerned shall be advanced 7½ per cent. The increase is to come into operation as from the beginning of the first full pay following the day of this award, and is to be regarded as war wages. The increase is independent of and distinct from the advance awarded by the Committee on March 1 for the engineering and foundry trades generally included in the Manchester district.

Exports to China.—The "London Gazette" of April 24 contains a further list of persons and firms in China to whom goods may be consigned from the United Kingdom, including the Wuchow Electric Light Co., Wuchow.

Institution of Petroleum Technologists.—At the recent annual general meeting Mr. Chas. Greenway was elected president and Prof. John Cadman a vice-president.

Unemployment Insurance.—The Umpire has decided that contributions are payable in respect of the following:—

Workmen employed on metal work in connection with the manufacture of X-ray and electromedical apparatus.

Workmen (other than those insurable under Part II. of the National Insurance Act, 1911) engaged wholly or mainly in making (removable) lamps for buoys or beacons.

Wholesale Traders' Association.—At the annual meeting of the Wholesale Traders' Association for the Protection of the Hardware, Furnishing and Metal Industries on Monday the chairman (Major J. H. Cartland, J.P.) reported that 138 new members had joined during the past year, bringing the total membership to 3,195.

The number of status inquiries sent in during the year had reached the enormous total of 72,772, involving a credit of over £6,000,000, thereby showing that there was still a good general trade being done by the various manufacturers and merchants throughout the country, and that a large number of orders had been received from foreign and colonial markets which they were unable to execute at present. The debt recovery department had 22,690 cases for collection, aggregating in value £224,137, and out of that sum only about 8½ per cent. proved irrecoverable or bad. There had been a considerable decrease in arrangements, bankruptcies and companies' liquidations, but a large number of cases had been reported to the association during the year where meetings had been attended and combined action taken in the interest of members. A report was made on the action of the association in regard to the Registration of the Business Names Act. It was announced that up to date about 75,000 firms had already registered.

The secretary also reported that the working of the Registration of Names Act had shown the importance of some amendment being made in the Companies Acts to bring in a number of the provisions of that Act, and the secretary was instructed to take whatever steps he thought necessary, in conjunction with others, to bring about this result.

EDUCATIONAL.

Education Reform.—In introducing the Education estimates in the House of Commons on Thursday last, the President of the Board of Education (Dr. H. A. L. Fisher) gave an interesting outline of certain educational reforms which are projected.

Dr. Fisher explained that the sum to be voted was £3,829,048 more than in 1916-17 and included an additional grant for secondary schools. He hoped to include in next year's estimates provision for such future development as could be made in the ordinary course of administration, but for other developments legislation would be necessary. No scheme of University development would be satisfactory which did not make ample provision for the prosecution of free and independent post-graduate research, for scholarships, for science, technology and modern subjects. Every type and grade of school in the country must be properly co-ordinated. The estimates introduced the principle of area grant, and they attached to it general conditions, one of which was the due provision of higher education. He thought the time had now come when the country should no longer be content to leave so important a matter as that to the discretion of the local authority, and no Bill would be satisfactory which did not require committees of the County Councils and County Boroughs to submit schemes to the Board concerning both secondary and elementary education.

Having referred to the deficiency in our educational arrangements for the care of adolescents, he said the country did not get full value out of its elementary system of education, because so much of the training and instruction was subsequently lost, and that it did not get the full value out of its higher technical colleges because those who attended their classes had "learnt little and forgotten much."

Scholarships.—As a result of the Scholarship Examinations held at Faraday House Electrical Engineering College, Southampton-row, London, W.C., on the 11th, 12th and 13th inst., the following awards have been made by the Governors of the College:—

To John Arnold Gundry (St. Bees School), a Faraday Scholarship of 50 guineas per annum, tenable for three years; Arthur Leslie Long (Hertford Grammar School), a Maxwell Scholarship of 50 guineas per annum, tenable for two years; Harold Charles Reeves (County School, Wood Green), an exhibition of 30 guineas per annum, tenable for three years; Eric Gledhill (County School, Fishguard), an exhibition of 30 guineas per annum, tenable for three years; Cecil Corbin (The Philological School, Southsea), a special prize of 25 guineas.

Workshop Training.—Recently Sir T. T. Shann, chairman of Manchester Education Committee, handed leaving certificates to the first group of boys admitted to the Openshaw Junior Technical School.

The school was established in 1915 in order to provide a sound practical education, extending over two years, for boys who intend to become apprentices, at 15 or 16 years of age, to the mechanical and electrical engineering, building and other allied trades. The boys are taken about 13 years old, when they are completing their general education in the elementary schools, and are given a sound preparatory training which will be of service to them on entering the works. They are taught the practical drawing, measurements and calculations needed in the workshop, the uses of the various tools in the working of wood and metals together with the elementary principles of mechanics, physics and chemistry. At the same time the general education of the boys is carried on. The teaching staff includes men who have had actual workshop experience as well as experience in teaching, and the school is in close touch with the local industrial firms.

Sir Thomas Shann said 35 boys were leaving and going to situations where they would become skilled workers, and even something better if they took advantage of the opportunities offered to them. Through the kindness of the firms engaging them, 16 of the boys would attend the school all day on Mondays for a further course, and their wages would be paid as if they were at work. In addition to the school at Openshaw, there was a similar school at Newton Heath, which was doing equally good work. The Education Committee desired to open more of these schools, because there was a great demand for them, but the Treasury would not allow the necessary money to be spent at present. As soon as possible, however, the work would be proceeded with. There were now only 20 places in the school to fill, and for those 80 applications had been received.

Digitized by Google

TENDERS INVITED AND ACCEPTED.

Cables and Meters.

Glasgow Corporation invite tenders for the supply of Cables (including small i.r. cables and flexibles) and Meters for a period of 12 months from May 31 next. Specifications and forms of tender from the engineer, Mr. W. W. Lackie, 75, Waterloo-street, Glasgow, and tenders must be lodged with the town clerk, Mr. J. Lindsay, by 10 a.m. of Tuesday, May 1. *See an advertisement.*

Electrical and General Stores.

Glasgow Corporation require tenders by May 1 for three months' supply of c.i. boxes and six months' supply of Troughing, Oils, &c., to their electricity department. Specifications from the Engineer, 75, Waterloo-street, Glasgow.

Glasgow Corporation Cleansing Dept. also require tenders by May 2 for six months' supply of Electrical Material, Ironmongery, Oils, &c. Specifications from the Supt., 20, Trongate, Glasgow.

Carbon Brushes and Gear Wheels.

Johannesburg Municipal Council require tenders by April 30 for supply of 10,000 Traction Carbon Brushes, and by noon May 21 for supply of Steel Gear Wheels for tramcars (contract 241). Specifications, &c., from the Town Clerk.

Metallic Filament Lamps.

Hoylake and West Kirby Council require tenders by April 28 for one year's supply of Metallic Filament Lamps. Specifications, &c., from the Engineer and Surveyor, Town Hall, Hoylake, Cheshire.

Coal-Conveying Plant.

Manchester Electricity Committee require tenders by 10 a.m. May 11 for the supply and erection of coal-conveying plant at Stuart-street generating station. Specification from Mr. F. E. Hughes, Town Hall, Manchester.

Hydraulic Accumulator and Electric Pump.

Manchester Corporation require tenders by 10 a.m. May 11 for the supply and erection of a hydraulic accumulator and an electrically-driven ram pump at Stuart-street generating station. Specification, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Marylebone (London).—The Electric Supply Committee recommend the acceptance of the tender of the Underfeed Stoker Co. (Ltd.) for fitting two additional boilers with travelling grates, combined with forced draught, at £1,809.

Poplar (London).—The Council has accepted the tender of the General Electric Co., at £3,074, for a 1,000 kw. rotary converter.

Bedford.—The Corporation have accepted the following tenders: British Thomson-Houston Co., switchgear, £1,650; J. P. Hall & Son, feed pumps, £340; T. & T. Vicars, coal handling plant, £718.

Derby.—The Corporation have placed orders with the General Vehicle Co. for an electric tip wagon, at £1,260; and with A. Wiseman (Ltd.), for tramcar gear wheels and pinions, at £102.

Glasgow.—The Tramways Committee has accepted the tender of the Pirelli General Cable Works (Ltd.) for cable and that of E. Allen & Co. and Hadfields (Ltd.) for special track work.

Government Contracts.—The following tenders were accepted by the British Government Departments during March:—

War Office.—Evershed & Vignoles, bridge meggers; British Insulated & Helsby Cables, Callender's Cable & Construction Co., Connolly Bros., Craigpark Electric Cable Co., I. Frakenberg & Sons, General Electric Co., W. T. Glover & Co., W. T. Henley's Telegraph Works Co., Hooper's Telegraph & India Rubber Works, India Rubber, Gutta Percha & Telegraph Works Co., Johnson & Phillips, Liverpool Electric Cable Co., C. Macintosh & Co. and St. Helens Cable & Rubber Co., electric cable and wire; London Electric Wire Co. & Smiths and C. A. Vandervell & Co., telephone cords; Litholite (Ltd.), insulator cups and caps; Kartret Engineering Co., distribution boards; Bullers (Ltd.), Electric & Ordnance Accessories Co., Gutherie & Co., W. Kent, J. Macintyre & Co., E. Stevens (Ltd.) and J. Stevens (Ltd.), electric light fittings; A. Lyon & Wrench and Smart & Brown, generating sets; British Thomson-Houston Co., Edison-Swan Electric Co., General Electric Co. and Siemens Bros. Dynamo Works, electric lamps; Kerr, Stuart & Co., W. Sanders & Co., Sperryn & Co., Wandsworth Electrical Mfg. Co. and W. White & Co., switches; Automatic Standard Screw Co., Davis & Timmins, Croggon & Co., F. Giles & Sons, L. Herve, Houghton-Butcher Mfg. Co., Ingram & Kemp, Sperryn & Co. and C. J. Thursfield & Co., electric terminals, &c.; Liverpool Electric Cable Co., tinned copper wire; H. J. Cash & Co. and Cecil Cooper & Co., electric lighting.

India Office.—Bullers (Ltd.), brackets; Callender's Cable, &c., Co., cable; Siemens Bros & Co., cells; Lancashire Dynamo, &c., Co., dynamos; Bullers (Ltd.) and Taylor, Tunnicliff & Co., insulators; Peel-Conner Telephone Works, telephones.

Post Office.—British L. M. Ericsson Mfg. Co., Peel Conner Telephone Works, Walters Electrical Mfg. Co. and Western Electric Co., telephone apparatus; Bayliss, Jones & Bayliss and Bullers (Ltd.), arm grips for wood poles; Taylor Tunnicliff & Co., bodies and covers for insulators; Telegraph Construction & Maintenance Co., submarine cable; British Insulated & Helsby Cables, Henley's Telegraph Works Co., Johnson & Phillips, St. Helen's Cable & Rubber Co., Telegraph Construction a Maintenance Co. and Union Cable Co., telegraph cables; Peel-Conner Telephone Works and Western Electric Co., telephone cable; India Rubber, Gutta Percha & Telegraph Works Co., coating castings with ebonite; British Insulated & Helsby Cables and Western Electric Co., telephone cords; Siemens Bros. & Co., wire drums; S. G. Bailey & Co., manganese; Crystalate Mfg. Co., telephone mouthpieces; Bullers (Ltd.), felt rings; E. Austin & Sons, solder; Bullers (Ltd.), insulator spindles; Peel-Conner Telephone Works, telephones.

Commissioners of Public Works, Ireland.—J. F. Keatings & Sons, electrical works and supplies.

APPOINTMENTS VACANT AND FILLED.

A shift engineer is required at Stepney Electricity Works. Applications to the engineer and manager (Mr. W. C. P. Tapper), 27, Osborn-street, Whitechapel, E.1, by first post May 2. *See advertisement.*

An experienced draughtsman is required for war work. Applications to Commanding Officer, Hawkcraig, Aberdour, Fife. *See advertisement.*

A shift engineer is wanted for a h.t. station, with Diesel engines. Applications to Engineer, Electricity Works, Sundridge, Sevenoaks.

The Walthamstow Higher Education Committee of Essex County Council require a headmaster for their engineering and trade school. Commencing salary £300. Forms from Mr. J. H. Nicholas, County Offices, Chelmsford. Applications by May 5.

London County Council require a development superintendent (£500 to £800) for the traffic branch of their tramways department. Applications by May 7.

Mr. H. W. Gepp, acting manager of Amalgamated Zinc (De Bavay's) Ltd., who is superintending the erection of works near Hobart (Tasmania) for the Electrolytic Zinc Co., of Australia, has now been permanently appointed as general manager of Amalgamated Zinc (De Bavay's) Ltd.

BUSINESS ITEMS.

The style of the firm of consulting engineers, previously known as Kirkland & Capper, is now Kirkland & Kiernan, and not Kirkland & Capper, as stated in our issue of April 13. The partners are now Messrs. Thos. Kirkland & T. J. R. Kiernan, Mr. D. S. Capper having retired from the firm.

Wm. B. Garstin and Walter R. Scott, formerly trading as the Auto-Flash Sign Co., at High-street, Rickmansworth, and 119, High Holborn, London, W.C., and lately as the Patent Distributor & Times Switch Co., at 4 & 5, Glebe-road, Dalston, London, N.E., have dissolved partnership.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of June 14. ***Further particulars are set out in an advertisement.***

CATALOGUES, &c.

The British Aluminium Co. (Ltd.) have issued two neatly printed and well-illustrated pamphlets—one in Russian and the other in Spanish—on the use and advantages of aluminium cables in the electrical transmission of energy.

The enterprise of the company is to be commended for in Russia, in Spain and South America there are many long-distance power transmission undertakings, and on the restoration of peace various new schemes will be brought forward. The pamphlets contain a number of useful tables, including one giving a comparison of the physical properties of aluminium and copper, also the dimensions, weight, &c., of aluminium cables. The S.W.G., Verband Deutscher Elektrotechniker and metric figures are included.

Callender's Cable & Construction Co., Ltd., Hamilton House, Victoria Embankment, E.C., have recently issued their new catalogue of dividing boxes for electric cables. The list is a very comprehensive one and gives illustrated particulars and prices, information as to shipping weights and measurements, &c.

The Z Electric Lamp Mfg. Co. (Ltd.), Southfields, S.W. 18, notify that they are carrying a large stock of electrical accessories, including ceiling roses, cutouts, holders, &c., and special terms are offered to the trade.

Messrs. Scholey & Co., Ltd., 56, Victoria-street, London, S.W., have recently issued a series of four small leaflets on the Taylor stoker, which set out clearly and concisely its advantages and the economy effected by its use. Copies may be obtained from the firm.

Messrs. Dick, Kerr & Co., Abchurch-yard, Cannon-street, E.C., have issued a folding card giving prices of their Britannia drawn wire lamps, which are manufactured at the firm's factory at Preston.

BANKRUPTCIES, LIQUIDATIONS, &c.

Correction.—We regret that in a note on page 127 of our last issue we referred erroneously to the Anchor Cable Co. (Ltd.). This should have been the "Anchor Electric Co. (Ltd.)." The Anchor Cable Co. (Ltd.) is not, and has not been, in liquidation, and is carrying on business as usual.

A second dividend (3s. 6d.) will be payable on April 30 at 6, Coleman-street, London, E.C., in the liquidation of the Adnil Electric Co. (Ltd.), Artillery-lane, Bishopsgate-street Without, London, E.C.

A meeting to receive an account of the winding up of the Universal Light & Sign Co. (Ltd.) will be held at 35, Coleman-street, London, E.C., on May 25.

Digitized by Google

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Indo-European Telegraph Co. (Ltd.)

The fiftieth ordinary general meeting was held on April 24, Mr. J. H. Herbert Tritton (the chairman) presiding.

The ACTING SECRETARY (Mr. T. O. Stevens Perry) read the notuce convening the meeting, after which the seal of the company was affixed to the register of members.

The CHAIRMAN: I beg to move: "That a final dividend be and is hereby declared for the year ending Dec. 31, 1916, of £1. 2s. 6d. per share, free of income tax (making, with the interim dividend already paid, 7 per cent. for the year); and that a distribution out of interest received be made of £1. 10s. per share, also free of income tax, both payable on May 1, 1917, subject to the terms of the Trading with the Enemy Proclamations, to shareholders registered on April 27, 1917." In moving this resolution I have only a short statement to make. Owing to general postal delays and shortage of staff, the directors are unable at present to submit the report and accounts for the past year. Having regard, however, to the figures which are available, they see no reason why the final dividend should not be paid on the usual date. They further think it necessary to hold only one meeting instead of two, as was the case last year; the directors' report and accounts with balance-sheet will be circulated amongst the shareholders at the earliest possible date. It is some satisfaction to the directors to be able to pay the final dividend and distribution for the year without encroaching upon reserves and without diminution of the total amount, and they believe there will remain sufficient to allow of the provision again out of earnings of an adequate sum of money on account of depreciation. When the accounts are available the shareholders will see that the holding of the company in British Government securities is a large one, totalling 58 per cent. of the company's capital, and when all calls shall have been paid on this year's subscriptions it will stand at £255,981—a percentage of 60. At our last general meeting I informed the shareholders that under a new arrangement between this company, the Indo-European Telegraph Department, and the Eastern Company, there would be secured to this Company a sufficient sum after payment of all expenses to provide a dividend of 7 per cent. on the share capital. It would lie with the board of directors to recommend any additional dividend by drawing on the fund established some years ago for equalisation of dividends, a proceeding which has not been called for this year. The new arrangement with our partners did not come into force until August 1st last year, and the company benefited very considerably by revenue derived from the first seven months of the year, with the financial result I have already indicated. I informed the shareholders at the last meeting that th directors had decided to enter into a combination of interests with Creed & Co. (Ltd.) for the development of the wireless patents owned by the Indo and Galletti Companies. I am sorry to say that arrangement has fallen through. It became apparent that the interests of Creed & Co. (Ltd.) were not compatible with our interests, and the agreements that had actually been entered into have, by mutual consent, been cancelled. This does not in any way affect the future development of our wireless assets, and I shall hope to give you fuller information on the extension of the wireless side of our business next year. I would add that in addition to the Government work to which I referred last year, we have fulfilled important war contracts for the supply of wireless material for our Government. The company's telegraph through service remains interrupted owing to the conflict raging in Europe, but we continue to handle considerable local traffic, which is of great importance just now. We have done our utmost to assist our Allies, the Russian Government, and have every reason to believe that our assistance has been of considerable value to them. The shareholders will be glad to hear that 37 members of our English staff are serving with our armies, of whom four have obtained commissions with the South Persian Police Force. I greatly regret to tell you that four members of the staff have lost their lives in the service of their country.

Mr. CHARLES HOLLAND seconded the resolution, and in the absence of questions, it was put to the meeting and carried unanimously.

It was also agreed to place the sum of £2,500 at the disposal of the Board to be distributed amongst charitable institutions at the discretion of the Board. The retiring directors, the Rt. Hon. Sir Francis Mowatt, G.C.B., and Sir William R. Brooke, K.C.I.E., were unanimously re-elected, and the auditors, Messrs. Kemp, Sons, Sendell & Co., were also re-appointed. The proceedings terminated with a vote of thanks to the chairman, directors and staff.

AIRDRIE & COATBRIDGE TRAMWAYS CO.—The total receipts for 1916 amounted to £16,695, and after meeting all expenses (including £750 for debenture interest), and setting aside £1,200 for renewals, the surplus is £4,768, making, with £482. 5s. 9d. brought forward, a total of £5,250. The directors propose to place £1,200 to reserve, to pay a dividend of 5 per cent. per annum on the preference shares, and a dividend of 12s. per share on the ordinary shares (£2,700), carrying forward £1,263. The increase in traffic receipts during the second half of 1915 was maintained throughout the year, the revenue from this source showing an increase of £2,458. 3s. 3d. over the preceding year. Owing to labour difficulties, the enhanced cost of materials, &c., the expenses were £1,261 more than in 1915.

ALDERLEY & WILMSLOW ELECTRIC SUPPLY (LTD.)—On the past year's working the profit was £2,815, compared with £3,064 in the previous year. After deducting £1,691 interest and adding £1,242 brought forward, the balance is £2,366. The directors recommend that £1,200 should be put to reserve, and the balance carried forward. The total receipts for Alderley are £3,116 and for Wilmslow £2,465. The connections have increased from 1,092 kw. to 1,133 kw.

BARNSLEY & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The revenue for 1916 amounted to £29,499, and after providing for all expenses (including £1,639 for debenture and loan interest) and setting aside £4,500 to renewals fund, the balance is £4,573, which, added to £166 brought forward, makes £4,679. The directors recommend that £1,143 be applied to reserve, payment of the dividend on the 6 per cent. preference shares (£1,320), and a dividend of 6 per cent. per annum on the ordinary share capital (£1,202), leaving to be carried forward £1,014.

BELL TELEPHONE CO. OF CANADA.—The net profit for 1916, after setting side $2,310,000 for depreciation, was $2,469,243. Dividends amounting to the usual 8 per cent. for the year have been paid, leaving $470,450.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—In a circular to the shareholders the figures of the gross and net revenue for 1915, 1914 and 1913 are given. The gross earnings from operation in Brazil in 1915 were 77,119,208 milreis, in 1914 73,184,714 milreis, and in 1913 71,911,974 milreis, the net earnings being 44,176,866, 41,879,569 and 39,312,729 milreis respectively. The decline in the surplus available for dividends compared with 1913 is due almost wholly to the fall in the exchange value of the milreis, which for some years before the war was maintained at slightly above 16d. During the last half of 1914 the rate averaged approximately 13d., and during the last two years slightly over 12d. The consequence is that, notwithstanding that the gross and net earnings during the past two years have been greater than at any previous period, the net earnings from operation, when converted into Canadian currency, are actually much less than they were before the war. The available net revenue in gold for the three years was $5,394,802, $7,666,532 and $8,112,264 respectively. The accounts for 1916 are not yet completed, but the gross and net earnings in Brazilian currency from operation have exceeded those of the previous year by 7,823,000 milreis and 2,367,000 milreis respectively, notwithstanding the abnormal high freights, which on coal increased from 15s. per ton before the war to as high as 80s. per ton last year, and it is estimated that the net revenue for the year (after payment of all fixed charges and expenses) will be approximately $5,654,000 (at exchange about 12d.), or $259,000 in excess of 1915, but $2,458,000 less than the net revenue of the year immediately preceding the war. Since the date of the last report the company has issued and sold in New York $7,500,000 6 per cent. three-year notes, and a portion of the proceeds has been applied in discharging the temporary loans raised in connection with the acquisition of telephone properties in the city and State of Sao Paulo, which, if the war had not intervened, would have been provided in the usual way by the sale of funded securities. The balance of the proceeds of the notes ($2,600,000) is being used for the development of the telephone undertakings, and this expenditure should result in a considerable increase in the revenue. Early in 1914 the board decided to extend and consolidate its telephone system by the acquisition of the further properties referred to above, and assumed the obligation of the extensions now in progress. Negotiations for the sale of a bond issue to provide the necessary funds were in progress when the war made the proposed financing impossible. The physical properties in Brazil have been maintained in a highly efficient state, but in addition to the maintenance of the property it is necessary in each year to expend considerable sums for extensions and improvements. These during the last three years have amounted to $8,600,000, and it is estimated that in 1917 the sum of $1,700,000 will be required. Under normal conditions this would have been provided for by the sale of the company's securities, the interest on which would have been met by the increased earnings derived from such expenditure; but, owing to the abnormal conditions arising from the war, it has been necessary to meet this capital expenditure, so far as same has not been paid out of earnings, by temporary loans, with the result that the floating indebtedness of the company and its subsidiaries at March 31 amounted to $4,850,000. The amount required annually for a dividend on the preference share capital is $600,000, and for a dividend on the ordinary share capital at the rate heretofore paid (viz., 4 per cent.) is $4,250,000, making a total of $4,850,000, which sum deducted from the estimated net revenue leaves only a relatively small balance available. It will therefore be seen that, so long as the company continues to pay a dividend on its ordinary share capital and exchange remains at approximately its present rate, it will not be possible to provide sufficiently for the necessary capital expenditure and to reduce the floating indebtedness. The board have, therefore,

Digitized by Google

decided not to pay a dividend in June next, and propose to continue this policy throughout the remainder of the year, unless there should be such improvement in exchange as to justify the resumption of the dividend at an earlier date.

BRITISH WESTINGHOUSE ELECTRIC & MFG. &C. (LTD.)—The directors' report for the year 1916 states that the improvement in the business of the company has been maintained. The net profit was £199,346, and with balance brought forward (£44,632) the total was £243,978. After writing £25,000 off patents, goodwill, &c., and appropriating £44,243 to special depreciation of plant, machinery, &c., and £10,000 to additional reserve for employers' liability, it is proposed to pay a dividend of 7½ per cent. on the preference shares (£75,000), and to carry forward £89,735. There have been charged against revenue the usual expenses for maintenance of works, plant, &c., and in addition there has been applied to depreciation of the same items an amount of £91,144, which includes the special sum above referred to of £44,243 to cover abnormal wear and tear of plant due to war conditions. The position under the Finance and Munitions of War Acts being still uncertain, it has been thought desirable to increase the amount carried forward.

CANADIAN GENERAL ELECTRIC CO. (LTD.)—During the year 1916 a gross profit of $2,225,912 was earned, which is in excess of any previous year in the history of the company. The sum of $405,887 has been reserved for depreciation of buildings, machinery and patterns, and $631,603 has been reserved for the amortisation of munitions plants and equipment, leaving a net profit of $1,185,420. From this sum $779,843 has been paid in dividends, leaving a surplus of $406,577, and making a total surplus of $1,112,696. From this total the sum of $500,000 has been transferred to reserve, leaving $612,696 to credit of profit and loss. The total liquid assets, including cash on hand, accounts receivable, &c., amount to $8,340,014.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The total receipts of the 12 months ended Dec. 31 last were £51,746. 14s. 9d., while the expenses amounted to £15,812. 11s. 10d. To the latter has to be added £2,177. 19s. 2d. for income tax, making together £17,990. 11s. and leaving a balance of £33,756. 3s. 9d. After adding £7,580. 17s. 8d. brought forward, an amount of £41,337. 1s. 5d. remains to be dealt with. The sum of £14,000 has been added to general reserve fund and £2,500 to pension fund. Interim dividends were paid on Oct. 19 (at rate of 10 per cent. per annum, less tax, on the preference shares, and at rate of 5 per cent. per annum, tax free, on the ordinary shares), which absorbed £7,000, and leave £17,837. 1s. 5d., out of which the directors recommend payment of final dividends at the same rates, and a bonus of 4s. per share on the ordinary shares, tax free, the balance (£7,637. 1s. 5d.) being carried forward. The general reserve fund, which last year stood at £100,000, has been charged with £24,000, the balance of the depreciation to date on the investments. The directors refer with regret to the death of Mr. Geo. Keith, and Mr. Frederic Edward Nosworthy has been appointed director and engineer in his place.

DIRECT UNITED STATES CABLE CO. (LTD.)—The report for the year ended March 31 states that the reserve fund account shows a balance of £502,512, compared with £487,705 in March, 1916, an increase of £14,807. Three quarterly interim dividends of 2s. each per share (less tax), amounting to £27,319. 10s., have been paid during the year, and a final dividend of 2s. per share (less tax) will be paid on the 30th inst., making a total distribution of 4 per cent. for the year.

EVERED & CO. (LTD.)—The directors state that they are not yet able to issue the accounts for the year 1916, as they are still under consideration by the Ministry of Munitions; but the figures that have been prepared show a satisfactory result. At the meeting on the 18th inst. Mr. R. G. E. Freeman was appointed managing director, and agreements with Messrs. R. G. E. Freeman, S. Evered and H. Evered were approved.

W. T. GLOVER & CO. (LTD.)—The directors' report for the year 1916 states that the result of the trading is a credit balance of £49,811 and with £11,701 brought forward, the total is £61,512. Deducting directors' remuneration and interest on the 4½ per cent. first mortgage and 5 per cent. second mortgage debenture stocks and after transferring £4,000 to trustees of second mortgage debenture stock, the balance is £48,740 13s. 5d. It is proposed to pay the dividend on the 5 per cent. cumulative preference shares, less tax (£3,875), to transfer £2,500 to the first mortgage debenture redemption fund, to pay a dividend on the ordinary shares at rate of 6 per cent., less tax (£5,341), to transfer £10,000 to reserve and £5,000 to cable maintenance reserve, leaving to be carried forward (subject to payment of excess profits duty for the years 1915 and 1916) £22,025. Many of the conditions referred to in last year's report continue, by which it is still necessary to strengthen the Company's reserve, in order to provide further working capital. The development of the land referred to in the last report is proceeding rapidly, and will involve considerable capital expenditure in the near future. As a "Controlled Establishment," the works are entirely at the disposal of the Government in the manufacture of wires and cables for the prosecution of the war.

GREAT NORTHERN TELEGRAPH CO. (LTD.)—At the general meeting, which will be held at Copenhagen on the 25th prox., the board will propose to pay a total dividend and bonus of 24 per cent. for the year 1916, including the 5 per cent. already paid, and to transfer the following amounts—namely, £83,333. 6s. 8d. to reserve and renewal fund, £27,777. 15s. 7d. to renewal fund for cable steamers, £55,555. 11s. 2d. to dividend equalisation fund, and £27,777. 15s. 7d. to pension fund. It is further proposed to set aside £111,111. 2s. 4d. for extraordinary income taxes.

GREENOCK & PORT GLASGOW TRAMWAYS CO.—The total receipts for 1916 were £56,510. 10s. 3d. After providing for all expenses, including £2,137. 10s. for mortgage interest, payments to Corporations amounting to £1,473, and setting aside £4,000 to renewals fund, the surplus is £14,826, making, with £4,054 brought forward, a total available balance of £18,880. The directors propose to appropriate £1,778 to sinking fund for loan redemption, £1,200 reserve, and to pay a dividend of 5 per cent. per annum on the preference shares (£3,500), and a dividend of 16s. per share on the ordinary shares (£9,200), leaving to be carried forward £3,201.

JOHNSON & PHILLIPS (LTD.)—The profit for the year 1916 on trading accounts, &c., after making provision for bad and doubtful debts, and after charging to revenue upwards of £8,000 for maintenance of buildings, plant, &c., amount to £56, 61. Adding balance from 1915 (£34,050) and deducting the dividend paid in May (£8,750), the total is £81,361. Deducting remuneration of directors, auditors' and trustees' fees (£1,897), interest on debenture stock (£5,345), reserve re debenture sinking fund (£7,557), interest on second debentures (£2,500), depreciation on machinery and plant, &c. (£12,139), interest on loan (£1,709), amount transferred to reserve (£10,000), income tax and excess profits duty (£8,928), amount written off patents (£2,575) and amount transferred to special reserve (£10,000), the available balance is £18,711. The directors recommend payment of a dividend at rate of 5 per cent. per annum on the ordinary shares (tax free), requiring £8,750, leaving to be carried forward £9,961.

MARCONI WIRELESS TELEGRAPH OF AMERICA (LTD.)—The report states that before allowing for reserves, the net income is $336,040, as compared with $288,994 in 1915. Receipts for message traffic with ships increased by 9 per cent. over previous year, and the income from investment of surplus funds ($98,107) decreased $6,824. After setting aside all reserves, the net profit was $259,888, an increase of 46·56 per cent., and this amount has been added to the surplus.

NORTHERN GENERAL TRANSPORT CO. (LTD.)—The report for 1916 states that after providing £5,515 for renewals the net profit is £21,471. A dividend of 6 per cent. is recommended, and after placing £1,410 to sinking fund for redemption and debenture stock, £8,688 is carried forward.

PETERBOROUGH ELECTRIC TRACTION CO. (LTD.)—The revenue for 1916 was £14,539, against £12,560 in 1915. After deducting all expenses (including repairs and maintenance and debenture interest) and setting aside £1,950 to renewals fund the balance is £1,640, which, added to £422 brought forward, makes a total of £2,062. The directors recommend that this balance should be applied in payment of one year's arrears of preference dividend (£1,320), leaving £742 to be carried forward.

RIVER PLATE ELECTRICITY CO. (LTD.)—The net revenue for 1916, after providing for administration expenses, &c., amounts to £43,558. With balance from 1915 (£18,387) the total is £61,945. The board proposes a dividend of 7 per cent. on the ordinary stock and to carry forward £18,695. Owing to the war no interest or amortisation payment has been received in respect of the 5 per cent. obligations of the German Trans-Oceanic Electric Co. Interest has been duly paid upon the £66,667 5 per cent. debentures of the Tucuman Tramways Light & Power Co., and a dividend of 4½ per cent. has also been paid upon the company's shareholding in the Argentine Electricity Co. Trading conditions in the Province of Tucuman and in the Province of Santiago del Estero are still most unfavourable, and the outlook is uncertain.

ROTHESAY TRAMWAYS CO. (LTD.)—The receipts for 1916 amounted to £9,589, and after providing for all expenses (including £2,134 for debenture and other interest, and payments to local authorities amounting to £270), and providing £1,800 for renewals fund, the balance (with £829 brought forward) is £1,740. The directors recommend placing £600 to reserve, payment of a dividend of 5 per cent. on the preference shares (£1,000), leaving to be carried forward £140.

SHAWINIGAN WATER & POWER CO.—The gross earnings for 1916 were $2,325,872, an increase of $405,729 over 1915. From the net earnings there have been declared dividends of 7 per cent. for the year. There was set aside from net earnings $232,141 as additions to reserve and sinking funds, which now amount to $2,400,000.

SOUTHPORT TRAMWAYS CO. (LTD.)—The report for the year 1916 states that negotiations for the sale of the company's tramway undertaking have been re-opened with Southport Corporation. The surplus on the year's working showed an increase of £668 compared with 1915. The total revenue for the year (including £141 brought forward) was £17,699. 13s. 6d. After deducting the expenses, including sums payable to the Corporation under the leases, and making a provision of £500 for renewals, a balance of £1,799. 13s. 6d. remains. The directors recommend £250 be placed to reserve and £1,550 be carried forward.

TYNEMOUTH & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The total revenue for the year 1916 was £15,236, an increase of £420 over 1915. The expenditure, including a provision of £1,600 for renewals, was £11,199, an increase of £676, due mainly to increased work on repairs and maintenance. The year's surplus is £4,036, making with £597 brought forward, a total of £4,634. The directors propose to place £1,000 to reserve, to pay the dividend on the 5 per cent. cumulative preference shares for the year (£1,525) and a dividend on the ordinary shares at rate of 4 per cent. (£1,856), leaving to be carried forward £252.

Digitized by Google

WOKING ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting it was reported that the total revenue for 1916 was £21,185, and the expenditure £11,609, showing a balance of £9,576. With amount from 1915 (£693) and income tax accumulations (£72) the total was £10,342. After paying interest on debenture stock (£2,524) and on temporary loans (£359) and dividend on the 6 per cent. cumulative preference shares, the balance was £4,459. Out of this sum £2,000 has been placed to depreciation and renewals fund, and after writing down certain items, including £68 on cost of free wiring and £500 to reserve account, a dividend of 5 per cent. was declared on the ordinary shares, and £638 carried forward. The chairman (Mr. J. Ashby) said that, owing to the extra cost of fuel, the outlay for generating electricity had increased by £4,167. 11s. 2d.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

A. F. S. (LTD.) (147,135.)—Private company; reg. April 14, capital £6,000 in 5,000 preference shares of £1 each and 10,000 ordinary shares of 2s. each, to carry on the business of motor, mechanical and electrical engineers, draughtsmen, vehicle spring makers, &c.

E. ARMSTRONG & CO. (LTD.) (147,182.)—Private company; reg. April 18, capital £5,000 in £1 shares, to carry on the business of merchants, importers, exporters, contractors, brokers and suppliers of materials in connection with the manufacture of cable and wire, electric telegraph, telephone, engineering, rubber and rubber goods, &c. First directors are H. C. Rose (chairman) and H. D. Douglas. Reg. office, 3, Cloak-lane, E.C.

BRITISH METALLURGIC CO. (BIRMINGHAM) (LTD.)—Private company; reg. March 31, capital £6,000 in £10 shares, to take over the business of tool makers and repairers and general engineers carried on as the "British Metallurgic Co." First directors are S. T. Nunn, R. W. Bill and R. Gries (all permanent).

BROOKE ENGINEERING WORKS (LTD.) (147,056.)—Private company. Reg. April 5, capital £5,000 in 4,500 preference shares of £1 each and 2,000 ordinary shares of 5s. each, to take over the business of engineers, metal workers and aeroplane constructors carried on as Brooks Motor & Engineering Works. Mr. C. Sandys Ball signs as managing director. Reg. office: Lawrence-buildings, Brooke-road, Stoke Newington, N.

DINNING & COOKE (LTD.) (147,000.)—Private company; reg. March 31, capital £15,000 in 10,000 preference shares and 5,000 ordinary shares of £1 each, to take over the business of heating and sanitary engineers, &c., carried on as "Dinning & Cooke." First directors are R. W. Cooke, R. P. Cooke and W. W. Cooke. Reg. office, Percy Iron Works, Percy-street, Newcastle-upon-Tyne.

ENGINEERING ACCESSORIES CO. (LTD.) (147,012.)—Private company; reg. April 2 capital £4,000 in £1 shares to take over the business carried on at Coventry as the Engineering Accessories Co., and to carry on the business of manufacturers of and dealers in armaments and war equipment, engineers, electricians, motor car accessory manufacturers, &c. First directors are: T. Hancock and J. J. Creasey.

FARRINGDON PROPELLER & ENGINEERING CO. (LTD.) (147,158.)—Private company; reg. April 17, capital £10,000 in £1 shares (500 founders), to carry on the business of engineers, ironfounders, manufacturers of and dealers in railway, tramway, electric, magnetic and other apparatus, &c. Agreement with F. M. T. Lange and J. E. Temple. First directors are J. S. Cotman (chairman), F. M. T. Lange, J. E. Temple and J. C. McLelland. Reg. office, 39, Victoria-street, S.W.

NATIONAL SMELTING CO. (LTD.) (147,115.)—Private company; reg. April 12, capital £500,000 in £1 shares, to carry on the business of roasters, smelters, refiners, rollers, galvanisers and manufacturers of and dealers in metals, ores and mineral and metallurgical substances of all kinds and by-products thereof, manufacturing chemists, &c. Reg. office: 4-6, Copthall-avenue, E.C.

RUSSIAN INDUSTRIES (LTD.) (147,167.)—Private company; reg. April 17, capital £30,000 in 28,500 ordinary shares of £1 each, and 30,000 management shares of 1s. each, to carry on the business of engineers, contractors, concessionaires, merchants, shippers, financiers, &c., in relation to Russia and the British Empire.

A. W. SAINSBURY (LTD.) (147,082).—Private company; reg. April 7, capital £3,000 in £1 shares, to take over the business of an engineer, electrical contractor, engineer's furnisher, &c., carried on by A. W. Sainsbury, of Sheffield, also to carry on the business of motor engineers, &c.

THRUTCHLEY, PERCIVAL & CO. (LTD.) (147,004.)—Private company; reg. March 31, capital £2,000 in £1 shares, manufacturers of and dealers in electric equipment, magnetos, motor accessories, small tools, &c., also to act as representatives for manufacturers of such commodities in the U.K., Russia, France and elsewhere, with particular regard to markets of German or Austrian origin. First directors are E. P. Booth, S. T. Craven and T. Tripp.

MORTGAGES AND CHARGES.

LANCASHIRE ELECTRICAL ENGINEERING CO. (LTD.)—Equitable charge on Volt Works, Ashton-under-Lyne, dated March 20, 1917, to secure all moneys due or to become due from company to Union Bank of Manchester.

RECEIVERSHIPS.

BESTS' SAFETY LAMPS (LTD.)—Notice of appointment of L. E. Brown, 26, East-parade, Leeds, as receiver on April 3, 1917, under powers contained in debentures dated May 28, 1914, has been filed.

BIRMINGHAM ELECTRICAL ACCESSORIES MFG. CO. (LTD.)—Notice of appointment of E. Fisher, 12, Cherry-street, Birmingham, as receiver, on April 4, 1917, under powers contained in mortgage debenture bond dated March 2, 1917, has been filed.

DERBY LAMP WORKS (LTD.)—Notice of appointment of H. C. Rabbidge, 32, Poultry, E.C., as receiver and manager by Order of Court dated March 30, 1917, has been filed.

CITY NOTES.

MEMORANDA.—(April 24).—Consols, 55¼. Consols Pay Day, May 4. Stocks and Shares Ticket Day, May 4. Pay Days, April 27 and May 5. Price of Silver, 37 3/16d.

AUCKLAND ELECTRIC TRAMWAY CO. (LTD.)—The directors have declared an interim dividend of 7d. per share (less tax) on the ordinary shares for the year ending June 30 next.

CLYDE VALLEY ELECTRIC POWER CO.—At the meeting last week the chairman (Mr. F. C. Gardiner) said the net profit for the past half-year showed an increase of £11,008 over the corresponding period of 1915, and of £18,123 over the preceding half-year. Contracts for power supply showed an increase during the half-year of 8,201 H.P.

CREED & CO. (LIMITED & REDUCED).—A petition for confirming a resolution reducing the capital of this company from £130,000 to £90,000 has been presented to the High Court.

EASTERN TELEGRAPH CO. (LTD.)—It is announced that in consequence of delays arising from the war in obtaining the necessary returns from foreign stations and administrations, it will be impossible to present the accounts and balance-sheet duly audited in respect of the year ending Dec. 31, 1916, during the month of May, when it has been usual to hold the annual general meeting. The directors, however, having satisfied themselves that the net earnings of the year will be sufficient for the purpose, have decided to make an additional payment to the stockholders on the 5th prox., on the ordinary stock equal to a dividend of 1½ per cent. and a bonus of 2 per cent., making the distribution for the year 1916 8 per cent. (tax free), the same rate as was paid for the previous year. The usual distribution at the rate of 3½ per cent. per annum, less tax, on the preference stock, for the first quarter of 1917 will be paid on the same date. The transfer books of the ordinary stock will be closed from May 7 to 14 inclusive. As soon as the full accounts can be submitted the directors will convene the annual general meeting.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—It is notified that, in consequence of delays arising from the war in obtaining the necessary returns from foreign stations and administrations, it will be impossible to present the accounts and balance-sheet duly audited, in respect of the year ending Dec. 31, 1916, during the month of May, when it has been usual to hold the annual general meeting. Having, however, satisfied themselves that the net earnings of the year will be sufficient for the purpose, the directors have decided to make an additional payment to the shareholders (tax free) on the 15th prox., of 7s. per share (equal to a dividend of 1½ per cent. and a bonus of 2 per cent.), making the distribution for the year 1916 8 per cent. (tax free). The share register will be closed from the 7th to the 14th prox. inclusive.

ELECTRIC SUPPLY CO. OF VICTORIA (LTD.)—This company's tramway and lighting receipts for the three months ended Dec. 31 last were £21,945 and expenses were £13,903.

ELECTRICAL UTILITIES CO. (LTD.)—A dividend of 1¼ per cent. has been declared on the preferred stock for the quarter ended March 31.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—The directors have declared a dividend on the preference shares at rate of 4 per cent. per annum for the six months ended 31st ult.

LIMA LIGHT, POWER & TRAMWAYS CO.—A dividend of 1¼ per cent. has been declared, payable against coupon No. 12, at Messrs. Grace Bros. & Co., 144, Leadenhall-street, E.C. (less tax).

MELBOURNE ELECTRIC SUPPLY CO. (LTD.)—An extraordinary general meeting of the shareholders was held on the 23rd inst. when the issue was authorised of 70,000 seven per cent. preference shares of £5 each, to rank pari passu with the cumulative preference shares already issued.

PARA ELECTRIC WORKS CO. (LTD.)—The directors have declared a final dividend of 4 per cent., making 6 per cent. for the year 1916.

SAO PAULO TRAMWAY LIGHT & POWER CO. (LTD.)—The directors have declared a dividend of 2½ per cent. on the common stock.

SUBMARINE CABLES' TRUST.—Notice is given that, in accordance with the terms of the trust deed, 68 certificates will be redeemed by a drawing, which will take place on the 1st prox. at the offices of the Trust, 34, Electra House, Finsbury-pavement, London, E.C.

TELEPHONE COMPANY OF EGYPT (LTD.)—A dividend of 6 per cent. (6s. per share), tax free, has been declared on the preferred and deferred shares, making 10 per cent. for 1916. A sum of £150,000 has been placed to reserve and £37,376 forward.

Digitized by Google

THE ROUND TABLE.

By "KVA."

Event of the Week.—The following from "Manchester Dispatch":—

During the hearing of an appeal at the Shropshire County Appeal Tribunal, on Saturday, the manager of the Oswestry Electric Light Co. said his salary was 35s. a week and commission, a total of £2. The military representative said that this did not strike him as a decent wage for the post Conditional exemption was confirmed

* * * *

Economies of the Moment.—Aberdeen Corporation saves £300 a year by the Electrical Engineer's Army pay, and distributes £50 among three assistants who do the chief's work while he is with the forces.

* * * *

It is unofficially announced that Lord Devonport has been presented with a "Tricity" cooker, but is so busy controlling the food that he has not had time to use it.

* * * *

"Substitution in Electricity Works," says a headline. Since the disclosures of "body boilers" in Germany, substitution is really not a nice word. Substitutes will always be looked on with suspicion in future.

* * * *

We are likely to make the pace with electricity in farming The "Journal of Electricity," San Francisco, says that in one small Californian town 10 million chicks were hatched out last year with an expenditure of 3 million kilowatt hours! This sounds as if the local electricity mains had been put "under the yolk"! (Help!)

* * * *

A reader of the Round Table sends me the following amusing comment on an advertisement in "The Engineer." The advertisement reads as below:—

DROP-FORGINGS, AS FOREMAN OR CHARGE HAND. Practical, experienced dies, tools, stamp shop. Free shortly.—Address, P475, "The Engineer" Office.

He says:—

Why suffer from a shortage of men? Standard sizes always in stock, 4′ 0″ to 7′ 0″. All parts guaranteed to be interchangeable.

We also carry large stocks of spare arms, legs, heads, &c., to replace worn out parts. Conserve our food supply by using our mechanical men.

We hope soon to place on the market our electrically-operated works managers and directors. All are guaranteed to work 24 hours per day, seven days per week. We also stock a special lubricant, *** brand, in bottle or cask, suitable for above (and others).

* * * *

A correspondent who is a holder of a "Lektrik" Switching Control Certificate sends me the following verse:—

Out of the bed where his wife lay still,
On to the lino, cold and chill,
Steps poor old father in the dead of night,
Groping for a switch to turn on the light.
He had no luck, as it was at the door,
So he had to stumble across the floor,
Upsetting things which came in his way.
Knocking his shins, you *might* hear him say—
"If I'd but have had two-way control
I shouldn't have been in this blank hole."
A switch at the door and one by the bed,
Many things would have been left unsaid.
"Hang these arrangements!"
"Most inconvenient!"
"Certificated wiring's the stuff for me!"

At Bervie (N.B.) the local council discussed the question of electric lighting, and the following dialogue took place:—

The Provost said an engineering and electrical expert had been in Bervie and had examined and measured the flow of the Bervie water and he had given assurance that it would be perfectly possible to produce electric light at 6d. per unit.

Councillor Burness: Is not 6d. per unit pretty dear?

The Provost said it worked out at the equivalent of gas at between 5s. and 6s. per 1,000 ft. The expert measured the water and estimated it as being able to supply 1,000 lights.

In the course of further discussion the Provost indicated that the Messrs. Gibb's upper mill was standing idle, and might be acquired as a power station.

Bailie Couper: The gas is may be bad, but I think that would be worse.

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician, April 24, 1880.]

Boston Again.—Some enthusiast now proposes to erect in Bostor a series of towers, to place on the summit of each powerful electric lights; and by means of reflectors to light the city.

Magnetic Attraction for Elder Pith.—M. Ader finds that elder pith is, of all other so-called non-magnetic bodies which he has tried, the most strongly attracted. The effect is much more strong when the two poles of the magnet are brought very close together.

A New Electric Marvel.—"Nature" hears that Prof. Graham Bell has deposited in the Smithsonian Institute a sealed packet containing the first results obtained by a new and remarkable instrument conceived by him while in England in 1878. It has to do with the transmission of light by means of electricity, we believe.

Notice.—Notice has been received at the Hydrographic Office from the Chinese Government that two telegraph cables have been laid down at Taku at the entrance to the Peitto river. The first of these cables connects the upper corner of Taku south fort with the lower corner of the north fort; the other connecting the China Merchants Steam Navigation Co.'s landing pier with the north bank of the river. Vessels are cautioned not to anchor near the cables, the locality of which will be indicated by beacons.

Electric Supply Concessions in Panama.—The Government of Panama has decreed that only the executive may grant concessions for the use of land and water for the generation of electric power.

The law as published in the Gaceta Official stipulates that concessionaires, in return for specified exemptions, must agree to grant the Government a part of their gross proceeds from electric services, and to furnish electricity for public purposes at a reduction of not less than 25 per cent. from the rates charged to private consumers. Companies installing electric light in a city of at least 45,000 inhabitants must use underground cables. Contracts executed by the executive in conformity with this law will not require legislative approval.

Electric Vehicles in Madrid.—It is considered probable that there will shortly be a good opportunity for pushing the sale of electric vehicles in Madrid, as the cobble pavements of the city must be replaced by asphalt or other similar surface within two years.

The ordinary animal drawn carts and heavy wagons are injurious to asphalt pavements, and it should not be difficult to get a footing for the smooth-running and reliable electrically-propelled vehicle. The duty on motor trucks is 40 pesetas (about £1. 16s. at present rate of exchange) each 220 lb. net weight, but a motor truck chassis without the body pays a duty of 80 pesetas (£3. 12s.) per 220 lb. gross weight if less than 2,200 lb., and 100 pesetas (£4. 10s) per 220 lb. if more than 2,200 lb.

Municipal Industrial Development.—Councillor J. Haley has given notice of the following motion:—

That a special committee of nine members of the Council (three of each party) be appointed to consider the question of the formation of a committee for the purpose of promoting the industrial development of the city, with instructions to submit for the Council's consideration at an early date recommendations as to the desirability of establishing such a committee, and as to its constitution, powers and duties.

IGRANIC MASTER CONTROL SWITCHES

Simplify the operation of all kinds of electrically driven machines.

No. 450-55.—Watertight Pedal Switch for use with "Igranic" Self-Acting Capstan Starter.

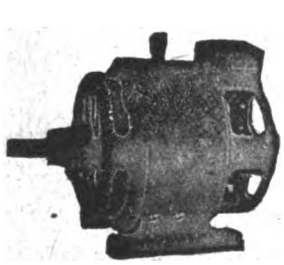
IGRANIC ELECTRIC Co LTD
147, Queen Victoria Street,
LONDON.

No. 450-71.—Master Switch with 'start' and 'inch' button and lever for stopping. Used with Printing Press Controllers.

Digitized by Google

SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current.

For Three-phase Current.

for
ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
Head Office: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: Western 6349. Telegrams: "Siembralos, Kens, London."
Lamp and Supplies Dept. 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: City 5350. Telegrams: "Siemotor, Cent., London."
HOME BRANCH ADDRESSES:
Birmingham—Central Ho., New St.
Bristol—30, Bridge Street.
Cardiff—89, St. Mary Street.
Glasgow—66, Waterloo Street.
Manchester—196, Deansgate.
Newcastle—64-68, Collingwood Bldgs.
Sheffield—22, High St.
Southampton—46, High Street.
Branches in Principal Towns Abroad.

J. P. DEVINE CO., BUFFALO.

MANUFACTURERS OF

Vacuum Drying and Impregnating Plant.

(PASSBURG SYSTEM.)

The Devine Co. are well known in the United States and Canada as the leading manufacturers and experts in Vacuum Drying and Impregnating Plant and have over 1,500 such plants in successful operation.

AIR PUMPS, COMPRESSORS,
VULCANISERS,
CONDENSING PLANT.

Solvent Recovery and Derisinating Plant a Speciality.

Sole Representative:

JAMES LIVINGSTON, LTD.,

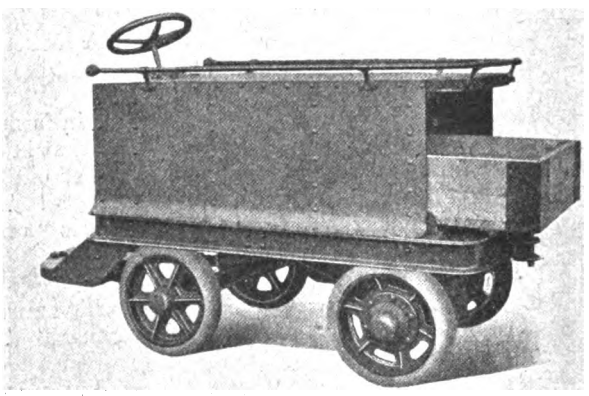
IMPERIAL HOUSE, KINGSWAY, W.C.

Telegrams and Cables: "Cinerary, London."
Telephone: Gerrard 2300.

PLATFORM ELECTRIC TRUCK.

Owing to the shortage of labour, railway companies, manufacturers and others are being compelled to adopt mechanical devices for the handling of luggage and goods. The Lansing Co., of Michigan, has placed on the market an electric truck which should effect a considerable economy of labour, and should prove useful for the transport of baggage, heavy packages on platforms, in warehouses, stores, &c. The Lansing has extensive experience in connection with the handling of materials, and the fact that it has added the electric industrial truck to its manufactures is proof of the progressive character of the company and of its desire to keep abreast of the times. As the motor vehicle is rapidly supplanting the horse, so will the power truck replace man power for haulage work for short distances.

Load-carrying Trucks.—The electric power truck fills two distinct uses—one is a complete unit carrying its own load, the other a tractor hauling a train. Both machines are identical in the essential features of drive and control. The load carrying truck must be able to make



Battery Box being Rolled In.

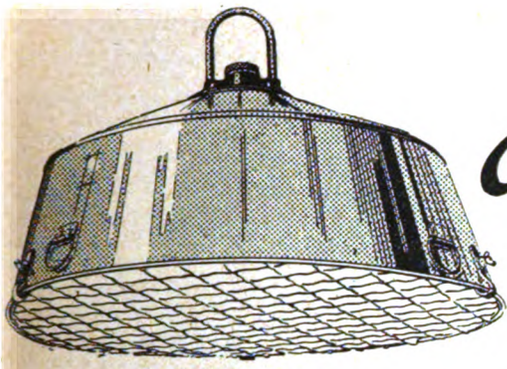
very short turns, and the control must be both easy and quick. Its dimensions, capacity and speed are fixed by the width of car doors, ships' gang planks and factory aisles, size of freight elevators and steepness of grades. The wide range in shape, size, weight and conditions of material to be handled makes necessary a number of different forms of truck frames. There are two distinct types of frame—viz., first, the standard or flat top with a frame about 22 in. high and of width and length to meet the requirements of the user, and with battery suspended underneath; second, the low platform for handling heavy or bulky pieces. The frame is only 10 in. high, and the tail board is so arranged that it can be lowered to form a sharp edged lip similar to a two-wheeled hand truck.

Tractors and Trailers.—The highest efficiency in operation is frequently secured by the use of tractors and trailers instead of load-carrying power trucks. The tractor is exceedingly compact, with short wheel base and consequent short turning radius. Both tractor and load carrier are worm driven. The Lansing Co. has two types of trailers—one the Reynolds tuck with caster wheels in front,

VULCANIZED FIBRE. ELECTRICAL. MECHANICAL.
DYMFYBR
LARGE STOCK. PROMPT DELIVERY.
J. BURNS, Ltd., 187 & 189, Central Street, LONDON, E.C.

For Effective Impregnation use "LACWATT" Black or Golden Brown.
JENSON & NICHOLSON, Ltd., Insulating Varnish Department, Goswell Works, Stratford, E.15

Digitized by Google



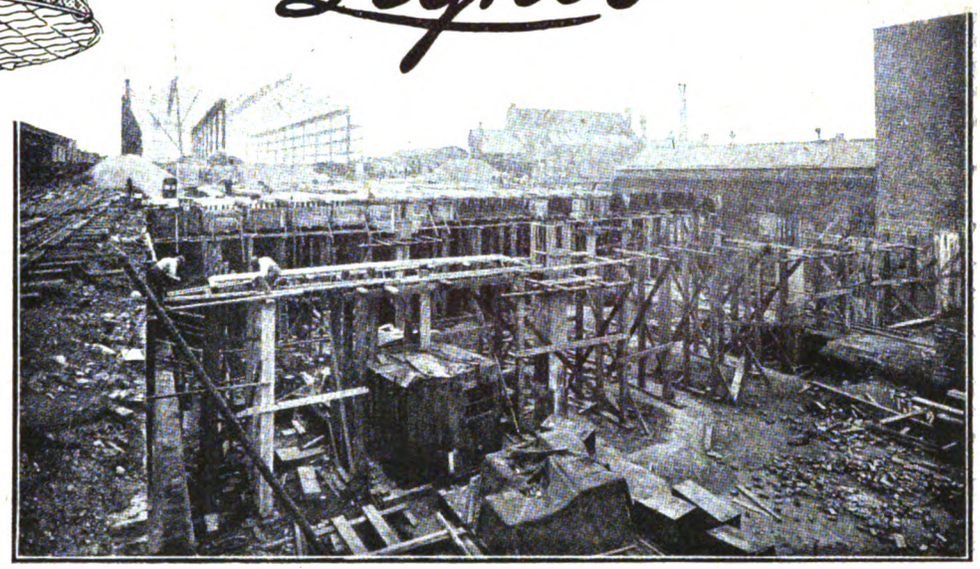
Simplex Cargo Cluster Lights

Simplex Cargo Lights

for:

Dockyards, Factory Construction, Permanent Way Repairs, and other special conditions where strength is demanded.

Mechanically and electrically a sound engineering job.



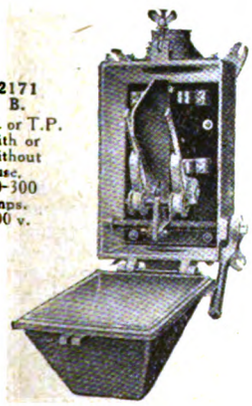
SIMPLEX CONDUITS, Ltd., Works—GARRISON LANE, B'HAM.

LONDON—113-7, Charing Cross Rd. BRISTOL—10-11, Denmark St. NEWCASTLE—61-5, High Bridge. GLASGOW—72A, Waterloo St.
LEEDS—6, White Horse St. CARDIFF—4, Westgate St. MANCHESTER—16, Corporation St. LIVERPOOL—96, Whitechapel.
SWANSEA—14, Heathfield St. SHEFFIELD—281-3, Attercliffe Common.

M·E·M

IRONCLAD SWITCH & FUSE GEAR

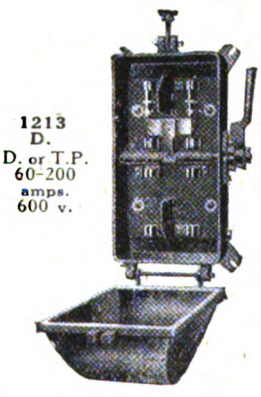
M.E.M. "Gear" is produced in a highly-organized BRITISH Factory, possessing ample resources, from Best-class BRITISH Materials, is designed by highly-trained BRITISH experts, and made by entirely BRITISH labour. Mark here two M.E.M. "high-efficiency" examples:—



2171 B. D. or T.P. with or without Fuse. 30-300 amps. 600 v.

2171 B. Improved "GLASGOW" Ironclad Switch. Made to H.O. Regulations; Standardised and Interchangeable Units; breaks to Glasgow Corp. Rules; High Insulation to withstand 2,000 volts alternating current; Parts easily renewable; Contacts undamageable by quick closing; Detachable glands tapped for standard conduit; Lids provided with asbestos packing gaskets; Silicate enamelled inside case.

1213 D. "MEMCO" Ironclad Changeover Switch. Base built of special insulating material with high insulation test; Standard drilling; other features included above.



1213 D. D. or T.P. 60-200 amps. 600 v.

Buyers should particularly note that

We give the PROMPTEST DELIVERIES in the Trade.

Remember—"M.E.M." signifies "the Products of Highest Efficiency." Get our informative Catalogue placed before you—ask us to forward you copy NOW.

The MIDLAND ELECTRIC MANFG. CO., Ltd.,

Head Office & Works: - - - - BARFORD STREET, BIRMINGHAM.

'Phone: Mid. 671 & 672. *'Grams: "Kilowatt, B'ham."*

Branches:—

LON: 2, Gresham Bgs., Basinghall St., E.C. 'Phone: Lon Wall, 723. 'Grams: Tribord, Lon.
MANCH'R: 4, Carr St., Blackfriars. 'Phone: City 1391. 'Grams: Conduits, Manch'r.
GLASGOW: 40, Wt. Campbell St. 'Phone: Cen. 4187 & 4188. 'Grams: Cathode, Glas.
NEWCASTLE-ON-TYNE: Milburn House. 'Phone: Central 2524.

-the QUALITY products

R.H.S.

Digitized by Google

REGULATING RESISTANCES

"BACK OF BOARD" TYPE—FOR FIELD REGULATION.

ISENTHAL & CO., Ltd.

(Department 4)

Denzil Works,

Willesden, LONDON, N.W.10.

Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, &c.

LIST ON REQUEST.

FOR

High and Low Tension SWITCHGEAR

THE

NEW SWITCHGEAR CONSTRUCTION CO., Ltd.

SUTTON, SURREY, ENGLAND.

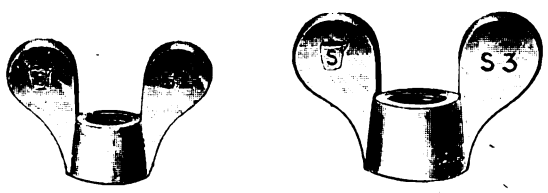
ABC Code 5th Edition. Telephone: Sutton 773.

E. SHOWELL & SONS, LTD.,

STIROHLEY, BIRMINGHAM.

SOLID FORGED BRASS WING NUTS.

Tapped Standard Whitworth and B.A. Standard.



Made from No. 1 tapped ¼" to No. 9 tapped ⅜".

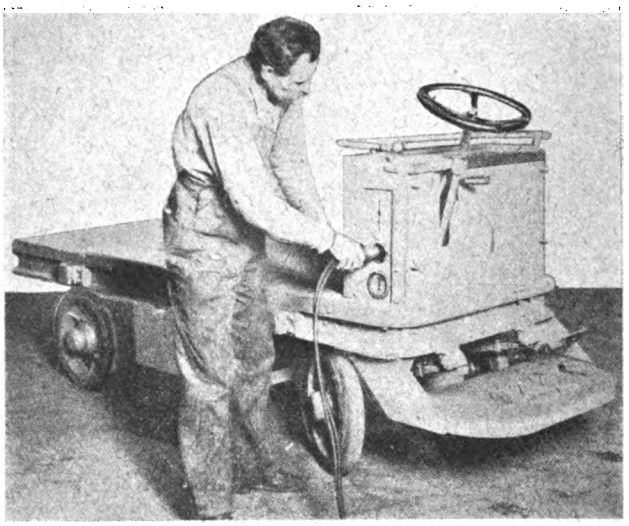
Sole Agent for the Electrical Trade:—

LIONEL ROBINSON, 3, STAPLE INN, LONDON, W.C.

Telephone: *Holborn* 6323.

the other, the Lansing four-wheel steer trailer developed for this particular service.

The tractor is made in two sizes—viz., for hauling loads of 2½ and 6 tons respectively. The rectangular frame is strongly made of rolled steel joists, is carried at its front end on a pair of elliptical springs (supported



Pushing the Charging Plug into Socket.

by a substantial forged axle), and at its rear end by a pair of strong cast brackets on the rear axle case. The front axle is similar to that for ordinary road vehicle design, with Ackermann steering, and the rear axle resembles a commercial motor worm-drive axle in miniature. A machine-cut worm and wheel carried on new departure ball bearings is contained within the

Lansing Load Carrier in Use.

cast-steel axle case. It drives the rear wheels through the medium of floating axle shafts. A bracket formed integral with the rear axle case extends forward, and serves as a support for the Westinghouse motor, which is directly coupled to the worm. A feature of the tractor is its accessibility, the whole of the worm gear and bevel differential gear being

"ANTI-SULPHURIC" ENAMEL

Should be used in all **ACCUMULATOR ROOMS** For Protection from Acid Fumes.

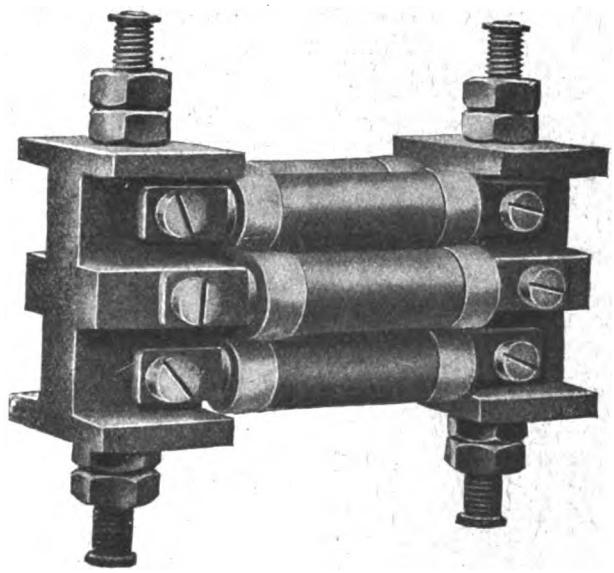
SOLE MAKERS: **GRIFFITHS BROS. & CO., LONDON, LTD.,** Mack's-rd., Bermondsey, LONDON, S.E.

LOWERING GEAR FOR ARC & METAL FILAMENT LAMPS ELECTROLIERS ETC
IN STOCK
THE LONDON ELECTRIC FIRM, CROYDON.
IN STOCK
WINCHES FOR ARC LAMPS
GENERAL LIFTING PURPOSES

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.



Prescot Multiple Enclosed Fuses
(Patent No. 28872/11).

Built up of easily replaceable units disposed round terminal blocks, these fuses are particularly suitable for high capacity currents.

By a simple re-arrangement of the units, circuits can be protected for a current capacity of from 25 amperes to 900 amperes.

See Pamphlet P. 121.

BRITISH INSULATED & HELSBY CABLES, LTD.

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

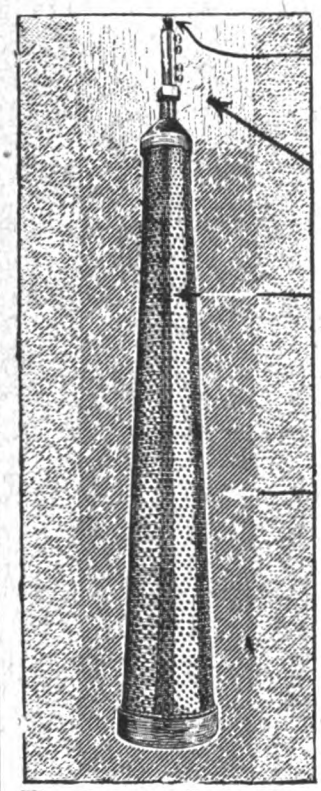
Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Vicmaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.
ELECTRICAL MACHINERY
Engineers, Edinburgh. *See our Illustrated Advt. April 13.*

Digitized by Google

The Question of Reliable Earthing



The Paragon Earth Cone.

THE earth plate usually employed is effective but requires a good deal of care in installing and its lasting properties are uncertain.

The PARAGON EARTH CONE

is easily installed and ensures a certain and permanent earth. It is a perforated Copper Cone filled with charcoal which attracts moisture, keeping the surrounding earth damp.

The PARAGON EARTH CONE

is extensively used all over the world for Electric Railways, Tramways, Telegraph, Telephone, Lighting and Power Stations, etc.

Write to-day for Illustrated Folder.

SCHOLEY & CO., Ltd.,
56, Victoria Street,
LONDON, S.W.

Wherever there is a brake or clutch

there is a need for Ferodo fabrics. The high co-efficient of friction of these fabrics ensures a more efficient transmission of power than can be obtained by any other friction surface, and is a safeguard against breakdowns. This means a speeding up in production and a consequent reduction of cost. Moreover, Ferodo linings are the most durable, having three times the life of chilled cast-iron, so that efficiency is combined with economy. There is no guesswork when using Ferodo fabric. Exhaustive tests have given us exact scientific data, so that engineers can design clutches and brakes to carry any load or absorb any horse-power. May we send you these figures?

FERODO

CLUTCH AND BRAKE LININGS.

Contractors to the War Office and Admiralty, London General Omnibus Co. and Underground Electric Railways of London and Paris. List "X" from

The Herbert Frood Company, Ltd.

Works: CHAPEL-EN-LE-FRITH.

'Phone: 19 and 20 Chapel. Wires: "Friction, Chapel."

We hold stocks at London, Birmingham, Belfast, Bristol, Cardiff, Edinburgh, Glasgow, Liverpool, Manchester and Newcastle.

C5. Φ

removable en bloc from underneath. The motor also, although totally enclosed, is nevertheless accessible in regard to its important points, such as the brushes and commutator. On the top of the framework, at the front end, is the metal casing within which is contained the control box switch, ampere-hour meter, steering gear and brake gear. The rest of the space is taken up by a battery of Ironclad Exide cells. These are contained in a wholly enclosed box, and can readily be removed and replaced, the box itself running on rollers. A large door in the top allows ready access to the batteries for inspection. The driver sits on the front end of the machine, his feet resting on a specially prepared platform, which projects forward and below the frame. The steering wheel is at his right hand, and close by is the control lever, which has three positions for motion in each direction, forward and reverse, besides the neutral notch. At his left foot is the brake pedal, which operates on drums bolted to the rear wheels, and is interconnected with the control switch to the motor. It is claimed that with this arrangement it is not possible for the driver to throw a sudden overload on the batteries and motor merely by putting on his brake; that after the machine has been brought to rest by means of the brake the current is automatically cut off, and any accidental release would not cause the machine to be set in motion. It also allows quick control of the vehicle in case of emergency. The weight of the 6-ton tractor is 3,000 lb.; length, 7 ft. 8 in.; width, 3 ft. 3 in.; height, 4 ft.; wheel base, 3 ft. 6 in.; wheel track, 30 in.; turning radius, 6 ft. 6 in. The same diameter wheels are fitted as on the smaller tractor (2,500 lb.), the tyres being, however, 5 in. wide on the rear wheels and 3 in. wide on the front.

The agents in this country for the Lansing Company are Messrs. Baxter & Caunter (Ltd.), 219, Tottenham Court-road, W., who will furnish full particulars of the trucks, tractors and trailers and the various accessories supplied in connection therewith.

THAWING OF FROZEN PIPES BY ELECTRICITY.

The "Electrical Review and Western Electrician" gives particulars of an electrical outfit used by the North Adams (Mass.) Gas Light Co. for thawing frozen water pipes and street mains.

The apparatus is owned by the city, and is said to be in constant use there and in surrounding towns during the winter. The outfit consists of a 30 kw. oil-cooled transformer with a movable-core type regulator for use in the secondary circuit. These are connected as one unit. A switchboard panel accommodates the two primary fuse plugs, a hot-wire primary ammeter, and an integrating recording watt-hour meter. One thousand feet of No. 00 wire is used for connecting with the pipe to be thawed. The regulator is of great value in the control of current. In practice, fire hydrants are used if within reach of the outfit, since it is cheaper to heat the whole length of pipe than dig up the frozen ground for a place to attach the wires. Pipes from ¾ in. to 8 in. in diameter are thawed by this method, the length of time required varying with the size of pipe. The customary charges for house services are about $10, while the cost of thawing street mains runs as high as $50. Each winter several hundred services are successfully thawed by the electric process.

ELECTRIC SAFETY LAMPS.

At the last meeting of the Midland Branch of the National Association of Colliery Managers there was a further discussion on the question of "Oil v. Electric Safety Lamps." The matter was before the meeting of the Association on March 31, when various lamps were exhibited. It was then decided to adjourn the discussion and to invite other manufacturers to submit their lamps for inspection.

The branch president (Capt. Muschamp) said the members regarded the electric lamp question as a timely and important one. They were anxious to get all the information they could, and if manufacturers cared to assist he thought it would be mutually advantageous. They would be perfectly satisfied with a lamp which gave 1 c.p. for 12 hours under ordinary working conditions, the candle-power being certain.

The undermentioned firms placed exhibits before the branch: Messrs. John Davis & Son (who exhibited the "Davis-Edison" accumulator electric miners' safety lamp), Pearson's Electric Miners' Lamp Co., and Ackroyd & Best. Technical particulars of the exhibits were obtained in replies to questions by the branch president and the members.

ELECTRIC LAMPS IN U.S.A. COLLIERIES.

It is reported by the U.S.A. Bureau of Mines that at the end of 1916 there were about 90,000 portable electric lamps in use in the mines of the United States, and of these 70,000 have been approved for safety and practicability by the Bureau of Mines. This is an increase of about 60,000 over the number in use in 1915, and 75,000 over 1914.

It is also announced that at the present time about 2,000 approved lamps per week are purchased for colliery work. A suitable number of approved flame safety lamps for gas testing are used in all mines generating fire damp or black damp, but for general use the electric lamp is recognised to be safer, more convenient and more effective as a source of light. The use of approved portable electric lamps in combination with safety lamps for gas testing is given as the reason for the decrease in the coal mine fatalities during the past year, and it is certain that where electric lamps are used men will no longer lose their lives as the result of the ignition of gas pockets, or as the result of fires started by open flames.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,033. [Vol. LXXIX. No. 5.] FRIDAY, MAY 4, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 175
Arrangements for the Week 177
High-Tension Overhead Transmission Lines. By G. V. Twiss. Illustrated.—*Continued* 178
Range of Wireless Stations. By Capt. R. Chenevix Trench, R.E. Illustrated.—*Concluded* 181
Indicating and Recording Demand Meters. Illustrated 183
The London and North-Western and Bakerloo Electrification. Illustrated.—*Concluded* 184
Note on the Rating of Intermittent Motors of Large Output. By H. H. Broughton. Illustrated 187
On a Precision Method of Uniting Optical Glass—The Union of Glass in Optical Contact by Heat Treatment. By R. G. Parker, B.Sc., A.C.G.I., and A. J. Dalladay 188
THE EXCESS PROFITS DUTY 190
REVIEWS 193
The Future of the British X-Ray Industry.—*Discussion* 194
Machine Switching Telephone Gear.—*Discussion* 194
British Science Guild 195
CORRESPONDENCE 195
A.T.-H. Motor Control Panels. Illustrated 197
Spraco Products 197
PARLIAMENTARY INTELLIGENCE 198
LEGAL INTELLIGENCE 198
Volunteer Notices 198
Patent Record 198
COMMERCIAL AND INDUSTRIAL SECTION 201
Electricity Supply 202
Tenders Invited and Accepted 204
Financial Matters 205

NOTES.

The British Science Guild.

THE annual meeting of the British Science Guild always furnishes an interesting summary of general scientific progress during the past year, and at the meeting on Monday last the proceedings were rendered specially attractive by the addresses of Lord SYDENHAM, Mr. H. A. L. FISHER and Mr. H. G. WELLS. Reviewing the steps that have been taken towards the development of scientific knowledge and method since the beginning of the war one is encouraged by the feeling that a good deal has really been done, and that so much constructive work must bear good fruit in the future. Yet immediately one reaches this point, one is depressed by the evidence, in current events, of how little the scientific spirit has permeated the country, and how small apparently its influence still is upon those who have the guidance of national affairs. It is easy to quote numberless instances of the lack of foresight and neglect to utilise efficiently the scientific resources of the country. Nevertheless we believe that substantial progress has been made towards overcoming our defects in this respect, at least as regards the direct utilisation of science in connection with the war. Where one finds less sign of encouragement is in the general conduct of affairs, in the daily evidence that those in authority, who may presumably be regarded as characteristic of the nation as a whole, are still willing to embark upon gigantic problems without proper systematic plan and forethought and in a "hand to mouth" manner which could not conceivably be adopted by the man of science in his own field. Lord SYDENHAM mentioned the Dardanelles episode and the confusion in the national utilisation of man power as instances of this lack of system and scientific method, but the same might be said of many movements emanating from the Government.

Still a Question of Education.

IN all this, however, we see only evidence that we are still living under the conditions inevitably developed by the old style of education. It must be recognised that any improvements which scientific bodies may recommend, and Mr. FISHER may institute, can only bear fruit slowly and in time to come. For the moment we must hope that the leaven is working, and be grateful that we have in Mr. FISHER a Minister of Education who may be trusted to do as much as the "scambling and unquiet times" enable him to perform. With Mr. WELLS' diatribe against the classical system of education scientific men must needs feel sympathy. Yet we think that even here patience must be exercised. The more enlightened classical scholars, we believe, now recognise that the system of compelling all boys, irrespective of their inclination and aptitude, to spend their days in studying Greek and Latin grammar, is bad. But we cannot expect to change the old deep-rooted conditions other than slowly. Meantime we think there is a danger in pursuing the classical tradition too vindictively, and in leaving its protagonists no loophole. By so doing men of science raise up opposition and convert into enemies those who might, by more judicious treatment, be converted into friends or at least into "benevolent neutrals." The case of science is so strong, its star so clearly in the ascendant, that it can afford to bestow on educational reform a little of the patience it must needs exercise in its own domain. And, as we pointed out in these columns a short time ago, men of science and engineers have their own special limitation—a certain inability to descend from their pedestal and clothe their ideas in clear and concise language. The progress of science during recent years has certainly been hampered by the fact that it has few distinguished literary exponents of the type of HUXLEY and TYNDALL.

Intermittent Rating.

IN another column will be found an article on this subject in which an appeal is made for uniformity in the method of rating large intermittent motors. The author gives as an example the motor required for driving a single-stage winder for a compound shaft, and shows that the three methods in use give widely different results. Thus by the true R.M.S. method it is found that a motor of 667 H.P. is required. Making allowances for the lower efficiency of the cooling surfaces during the reduced speed and standstill periods of the cycle, according to one method results in a rating of 761 H.P., and according to another method the rating is 741 H.P. Since the duty is known and as the temperature rise is limited by the specification this means that what one firm calls a 761 H.P. motor another firm will call a 667 H.P. motor. This tends to give the user the impression that he is getting better value for his money from one firm than from another, whereas both motors are alike. In view of the large number of motors rated by this method in use it would appear desirable for the Engineering Standards Committee to frame rules so as to get rid of the feeling of uncertainty which prevails among those who use this method of rating.

Digitized by Google

Teaching the Teacher.

From time to time in these columns reference has been made to the inability of teachers of physics, and allied subjects, to construct for themselves the apparatus used by them in their lectures, and by their students in the laboratory. As to the desirability of this there can be no question, but as far as we are aware neither the Board of Education nor local education committees appear to attach much importance to this side of a teacher's training. In addition to giving instruction to teachers we should like to see the Board of Education give increased grants to those colleges and schools in which the making and maintenance of apparatus and plant is part of the training. The ease with which young students acquire a considerable degree of skill in working in wood and metal leads to the conclusion that little difficulty would be experienced in turning such skill into useful channels. Under existing conditions many teachers find it impossible to obtain apparatus at all, and in normal times the apparatus is very often either too expensive or is unsuitable for the work in hand.

Safety Rules for Mines.—The Bureau of Mines, Washington, U.S.A., has issued a bulletin entitled "Some Suggested Safety Rules for Installing and Using Electrical Equipment in Bituminous Coal Mines." The preparation of the code of rules given was extended over nearly three years in the course of which conferences were held with mining engineers, supply companies and manufacturers of electrical equipment, with a view to systematising the procedure to be adopted in order to avoid electrical accidents.

Composition of the X-Rays from Various Metals.—At a recent meeting of the Royal Society a Paper was read by Dr. G. W. C. Kaye on this subject. The author finds that the X-rays from a bulb excited by low voltages (10,000 to 50,000 volts) are rich in the characteristic radiation of the anti-cathode. In the case of iron, nickel and copper the amount of K-radiation lies between 80 and 90 per cent., and in the case of platinum the proportion of L-radiation is from 40 to 60 per cent. Evidence of characteristic radiations softer than the K and L radiations has been obtained.

Hydraulic Electric Transmission Systems.—In a recent Paper before the Institution of Automobile Engineers Mr. F. L. Martineau drew attention to the analogy existing between hydraulic and electric transmission. Hydraulic transmission was stated to have many of the advantages of electric transmission, and Mr. Martineau anticipates that hydraulic methods may be applied in the future to the transmission systems of automobiles, particularly heavy tractors and similar vehicles. The cost should not be excessive, and from the user's standpoint the system is very simple and requires little supervision.

Institute of Chemistry.—At a meeting held at the Institute of Chemistry on April 27, the President and Council presented a silver rose bowl to Mr. Richard Bertram Pilcher, registrar and secretary, in appreciation of 25 years' faithful service. The meeting was well attended, and the presentation was made by the President, Sir James Dobbie, Principal of the Government Laboratories. Mr. Pilcher, who joined the staff of the Institute as clerk in 1892, was appointed assistant secretary in 1894, secretary in 1895, and has held the joint offices of registrar and secretary since 1900.

Blind Operators in the Siemens-Schuckert Works.—According to the "Elektrotechnische Zeitschrift," the authorities in Brandenburg have been endeavouring to find occupation for men who have lost their eyesight, and a number are now being employed in the Siemens-Schuckert Works. They are found quite serviceable for such work as gauging small parts, stamping numbers, packing small articles, and testing fuse-plugs acoustically. A room is given up to their working, and special precautions are taken in the location and fencing of machines and the elimination of sharp projections, such as might cause injury. The workers are paid a minimum wage of 28 pf. (about 3d.) per hour, but some earn as much as 55 pf. (5½d.). It is stated that they prefer machine work to hand work, the noise of the machine being apparently a useful guide to the progress of each operation.

Expansion of Output of Electrical Supply Undertakings in 1916.—Statistics are now available not only for the output and income of electric supply concerns in the United States during 1916, but also for the first month of 1917. During the past 10 years there has been remarkable progress. A comparison of January, 1917, with January, 1916, shows that the aggregate output has increased by 27·7 per cent., while the income has increased 14·3 per cent. The "Electrical World," in commenting on these figures, attributes the increase largely to the great development of motors for industrial work. Another factor has been the shortage of coal, which has induced many consumers who previously generated for themselves, to take electricity from the company's mains.

Institution of Electrical Engineers.—The following officers of committee have been elected by the Birmingham Local Section: *Chairman*, S. T. Allen; *Vice-Chairmen*, N. B. Rosher and Dr. C. C. Garrard; *Ordinary Members of Committee*, F. H. Clough, F. Forrest, W. H. Heaton, E. J. Kipps, W. A. Jackson, S. James, W. Marsden, A. Pearson, B.A., T. Plummer, Dr. W. E. Sumpner, F. Thursfield, E. O. Turner and J. M. Walshe.

The following officers of committee have been elected by the Scottish Local Section: *Chairman*, A. Page; *Vice-Chairmen*, E. T. Goslin and A. S. Hampton; *Ordinary Members of Committee*, F. H. Whysall, W. W. Lackie, W. B. Hird, Prof. M. Maclean, A. Lindsay, A. S. M'Whirter, D. M. Macleod, A. Wilson, J. E. Sayers, S. Mavor, and J. F. Nielson; *Hon. Secretary and Treasurer*, J. Taylor; *Assistant Hon. Secretary*, W. F. Mitchell.

Influence of Stray Radiation on Rontgen Images.—In a recent issue of the "General Electric Review" W. D. Coolidge and C. N. Moore describe some experiments on the stray radiation from Röntgen tubes. It has long been known that appreciable radiation from other parts of the tube than the focus exists, and may have an influence on the image on the fluorescent screen. In some cases overlapping occurs, impairing the sharpness. The authors have therefore investigated the effect of various devices to confine the radiation strictly to that derived from the true focussing point. The most important factor, however, appears to be the exposure. If the smallest exposure consistent with satisfactory density of the image is employed, special tubes eliminating extraneous radiation show no advantage over ordinary tubes. The explanation appears to lie in the nature of the curve of sensitiveness of the ordinary plate and the narrow range of densities employed in making radiographs of the human body.

Royal Institution.—The annual meeting of the members of the Royal Institution was held last Tuesday afternoon, the Duke of Northumberland, K.G., President, in the chair. The annual report of the Committee of Visitors for the year 1916, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The report of the Davy-Faraday Research Laboratory Committee was read, from which it appeared that 23 new members were elected in 1916, and 62 lectures and 19 evening discourses were delivered. The books and pamphlets presented amounted to about 316 volumes, making, with 510 volumes (including periodicals bound) purchased by the managers, a total of 856 volumes added to the library in the year.

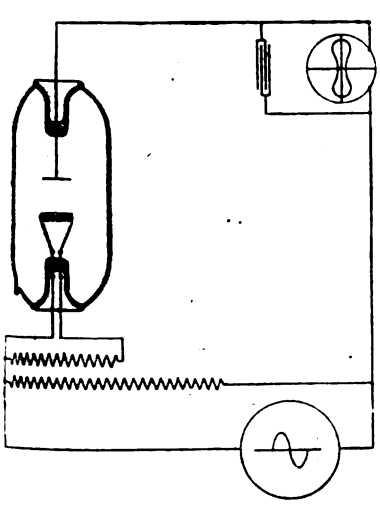
The following were elected as officers for the ensuing year: *President*, The Duke of Northumberland; *Treasurer*, Sir James Crichton-Browne; *Secretary*, Col. Edmond H. Hills; *Managers*, Henry E. Armstrong, Sir William Phipson Beale, Bart., Charles Vernon Boys, J. H. Balfour Browne, John Y. Buchanan, W. A. B. Burdett-Coutts, Sir James Mackenzie Davidson, Donald W. C. Hood, the Rt. Hon. Viscount Iveagh, Sir Charles Nicholson, Bart., the Hon. Richard Clere Parsons, Sir James Reid, Bart., Alexander Siemens, Samuel West, the Rt. Hon. Lord Wrenbury; *Visitors*, Ernest Clarke, John F. Deacon, Edward Dent, Lieut.-Col. Henry E. Gaulter, James Dundas Grant, W. B. Gibbs, W. A. T. Hallowes, Henry E. Jones, H. R. Kempe, Francis Legge, James Love, Richard Pearce Sir Alexander Pedler, Hugh Munro Ross, Joseph Shaw.

Digitized by Google

Card-representation of Variations in Electrical Supply.—M. A. Ticier, in a recent issue of the "Revue Générale de l'Electricité," describes an ingenious method of representing the variations in central station supply. Each day the draughtsman responsible for the tabulation of data relating to supply cuts out a sheet of cardboard the contour of which represents the scale of the load at each moment during the previous 24 hours. The contour cards thus prepared are mounted side by side, the complete set for a year being easily contained in a box 50 cm. long and 20 cm. wide. In this way the station secures an exact representation of all load fluctuations. Such models are very useful not only in recording the variations in different seasons of the year, and between different localities, but as presenting the results of any temporary breakdown. They have also furnished a useful lesson to members of the general public who would not otherwise have appreciated the fluctuations in load to which a station must accommodate itself, and the resulting necessity for the several special methods of charging.

Three-Phase Winder at Ebbw Vale.—Particulars and drawings of an electrically-driven winder installed at the Victoria Colliery, Ebbw Vale, Mon, were given recently in the "Iron and Coal Trades Review." The winder is designed to deal with a net unbalanced load of 3 tons of coal from a depth of 564 ft., with an output of 240 tons per hour. The plant is arranged on the straight alternating-current system, and a rope drum of the spiro-cylindrical type was employed as being the most suitable. The supply of current available is 2,000 to 2,200 volts, three phase 50 cycles, and the motor, of 400 B.H.P. to 800 B.H.P. continuous rating, at full load has a speed of 360 revs. per min. Speed reduction is obtained through Citroyen gear, ratio 8·6 to 1, the gear being mounted in an oil-tight gear case. The plant was installed by the British Westinghouse Co., the sub-contractors for the mechanical parts being Douglas & Grant, Kirkcaldy, and the installation was carried out under the supervision of Mr. Walter Dixon, consulting engineer to the Ebbw Vale Steel, Iron & Coal Co.

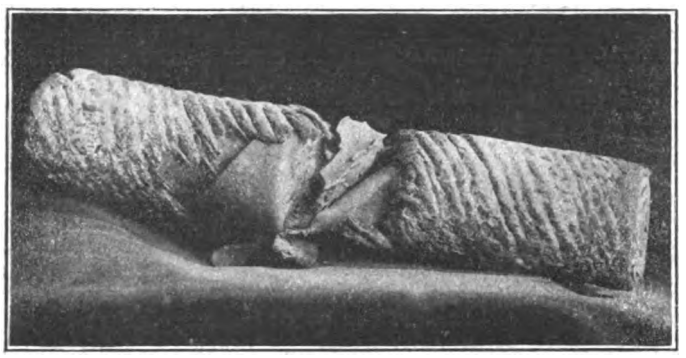
Crest-Voltage Detector for Insulation Tests.—In testing insulating materials for dielectric strength or puncture value, where it is probable that the maximum value which causes the breakdown depends on the wave form it is often desirable to know the maximum or crest value of the alternating voltage wave. The "Electrical World" describes a patent, No. 1,209,766, due to Dr. Clayton H. Sharp, embodying a method by which a crest-voltage indicator can be made to maintain its reading for a considerable period after the puncture pressure has been established.



ARRANGEMENT OF FLEMING VALVE CONDENSER AND VOLTMETER FOR CREST-VOLTAGE MEASUREMENTS.

A Fleming valve is placed in series with an electrostatic voltmeter connected across an alternating-current line. If the current through the valve during the first quarter cycle has not been sufficient to raise the potential of the voltmeter to the full-peak voltage of the wave, a certain amount of electricity will flow into the voltmeter during the fifth quarter cycle of the voltage wave, and similarly a smaller amount may flow during the ninth, thirteenth, &c., quarter cycles until the potential indicated by the voltmeter has become the same as that of the peak of the voltage wave. Thereafter no current will exist except such as may be necessary to supply the leakage from the voltmeter and connected apparatus shown. A condenser having a considerably larger electrostatic capacity than that of the ordinary apparatus is placed in parallel with the voltmeter in order to serve as a storage reservoir of charge flow.

A Bombarded Cable.—The accompanying illustration shows a piece of cable which suffered from the effects of bombardment at Scarborough in 1914, being punctured by a fragment of German shell, weighing $\frac{5}{12}$ oz. This cable continued



0·025 IN. BRITISH INSULATED ARMOURED CABLE.

in service on 200 volts without giving trouble, and the fault was only recently discovered by the steel tape becoming heated, and giving evidence of this by heating the snow on the footpath some 16 ft. away from the actual fault.

OBITUARY.

R. H. BURNHAM.—The death of Mr. Richard Henry Burnham, late telegraph superintendent of the South-Eastern & Chatham Railways, occurred on the 24th ult.

A. W. STAVELEY.—We regret to record the death of Mr. A. W. Staveley, senior director of Messrs. Gent & Co., Leicester. Mr. Staveley, who was 58 years of age, joined the late Mr. J. T. Gent in 1880, and took an active part in the management of the business.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported :—

Major Howard C. Symmes (S. African Inf.), aged 43, who was killed on April 1, was inspector of machinery and electricity for the Orange Free State Government Mines Department, a Fellow of the S. African Institute of Engineers and an Associate of the Institutions of Electrical and Mechanical Engineers. He had served with the Canadian Artillery in the South African War.

Sec.-Lieut. R. E. E. Chaplin (R.E.), aged 21, who was killed on April 22, was head of Winchester School in 1915 and obtained a mathematical and chemical scholarship for Clare College, Cambridge.

Gnr. J. Bates (R.F.A.), aged 19, who has been killed, was formerly employed in the Birmingham Electric Supply Department. He enlisted in the spring of 1915.

Warrant Telegraphist J. Cade was killed at sea on April 19. He joined the R.N.R. in October, 1914.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, May 5th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, Piccadilly, W. Lecture on "The Electrical Properties of Gases," by Prof. Sir J. J. Thomson, O.M. (Lecture I.)

MONDAY, May 7th.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, W.C. Howard Lecture on "Works Organisation and Efficiency," by Prof. W. Ripper, D.Eng., D.Sc. (Lecture III.)

TUESDAY, May 8th.

ASSOCIATION OF SUPERVISING ELECTRICIANS.

7.15 p.m. At St. Bride Institute, Bride Lane, E.C. Paper on "Motor Control," by Mr. J. T. Mould.

WEDNESDAY, May 9th.

YORKSHIRE LOCAL SECTION, INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. At the Philosophical Hall, Leeds. Annual General Meeting.

FRIDAY, May 11th.

ROYAL INSTITUTION.

5.30 p.m. At Albemarle-street, Piccadilly, W. Paper on "Radioactive Haloes," by Prof. J. Joly, M.A., F.R.S.

Digitized by Google

HIGH-TENSION OVERHEAD TRANSMISSION LINES.

BY G. V. TWISS.

(*Continued from p.* 155.)

Summary.—The author discusses the subject comprehensively. Dealing first with the general design of transmission lines, a comparison is drawn between the factors of safety required in this country and those in Canada and the U.S.A. Curves are given for facilitating calculations of cost. In dealing with line materials, a comparison is drawn between the pin-type of insulator and the suspension type. The Hewlett and metal hooded insulators are discussed at some length. Finally, the mechanical design and the testing of insulators are considered.

SPECIAL ARRANGEMENTS FOR MERZ-HUNTER SPLIT-PHASE SYSTEM.

The two conductors of each split phase are sometimes supported on separate insulators as if they belonged to separate circuits, but more often they are supported on the same insulator specially made with two side grooves. This necessitates insulators having specially deep heads, and whilst this is permissible with the smaller sizes, it is questionable with large sizes for the reason of expansion and contraction stresses referred to later.

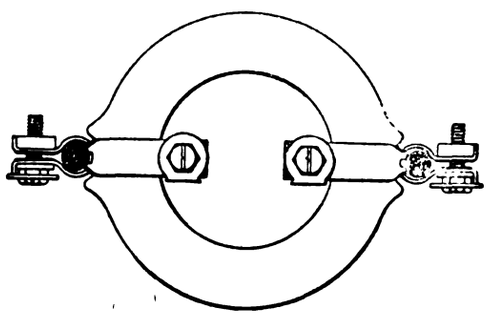


FIG. 3.—SPREADER.

When suspension insulators are used, the split conductors are attached to reel insulators attached to the lowest unit. It is important to short-circuit the insulation of one of the reels or to make it of a conducting material, otherwise the effect is that of a small capacity in series with the larger capacity of the disc, and the reel may be in a state of continuous flash-over even at working voltage.

When the two conductors making one split conductor are mounted on one insulator it is necessary to provide insulating distance pieces, known as spreaders, in the span. The usual spacing of these is from about 30 ft. to 40 ft., depending upon the size of, and tension of stringing the conductors. The form of spreader now largely adopted consists of a porcelain ring with two grooves in the periphery for the conductors, which are fastened thereto by means of small "stirrup" clips of copper (*see* Fig. 3). In view of the vibration the bolts and nuts are locked by a soft copper locking device, which is pressed over the head of the bolt. To obtain the exact adjustment of sag in the two conductors, an adjusting device has been provided on some recent lines.

2. PARTICULAR DESIGN OF TRANSMISSION-LINE MATERIAL POLES.

It seems to be the general idea that wooden poles are not efficient for spans of more than 200 ft. or so, but the curves given in the Paper show that in some cases they can be used at their greatest efficiency for much longer spans.

Tubular poles have not been greatly used for transmission lines. The author draws attention to the Kay tubular pole, as meriting consideration.

Most lattice steel-work poles (or masts) fall within one or other of two classes, namely, narrow base structures and broad base structures.

Narrow Base.—In this class of structure the load is transmitted to the foundations by the lift on the one side and the thrust on the other side of the base, forming relatively to the structure an inverted T (*see* Fig. 4). This class of structure is usually designed to transmit its load down to the horizontal base members and thence to the ground. There is, therefore, slight movement and considerable horizontal force at the ground-line, point A, and if this slight movement be resisted by placing, say, rocks or baulks of timber at this point, very considerable stresses will be introduced in the bracings B far beyond those which they will otherwise have to carry. The author has seen tests on masts of this design where the mast has failed at a very much lower load than its designed load owing to this slight movement of the ground-line being resisted, causing failure of the bracings in the earth bay.

It is quite possible that something may inadvertently resist the movement at the ground-line or be deliberately placed there with the erroneous idea of strengthening the foundations; it would, therefore, seem to be sound practice to design the base members as for the assumed condition of the structure acting about the point A, which, of course, would require the introduction of a suitable strut at the ground-line C.

Broad Base.—With this design of structure, owing to the wide spread, there is usually little horizontal reaction at the ground-line, and the base members —*i.e.*, stub ends—have merely to take thrust and pull (*see* Fig. 4). This type lends itself to efficient design.

The author calls attention to the desirability of taking the factor of safety on the elastic limit, instead of on the ultimate strength in the case of tension members owing to the alteration in the entire stresses when the elastic limit is exceeded.

Testing.—The usual practice is to test lattice steel-work poles by applying a pull at the top representing the load in the wires+the wind load on the pole itself equated to the top. One point, however, in regard to this practice of applying a load at the top to represent wind load, is that the wind load is naturally distributed over the structure, and the design of a mast to be correct must therefore deal with this wind load as it occurs.

ELECTRICAL DESIGN.

Abiltity to withstand a flash-over test without puncture is not necessarily a criterion of good design in an insulator, as an insulator of indifferent design may still give such tests. An indifferently designed insulator may have badly balanced shells and air spaces, causing some portions to be unduly stressed electrically. Under increasing test pressure the air contiguous to such over-stressed portions breaks down, *i.e.*, becomes ionised and glows. Such ionised air being a conductor tends to increase the capacity of such portions and decreases the over-stressing, so that when the insulator is at its flashing-over point, it may be quite well balanced, not by its design but by the corrective balancing action of the ionised air. Air, however, takes a definite (though minute) period to ionise, and a steep

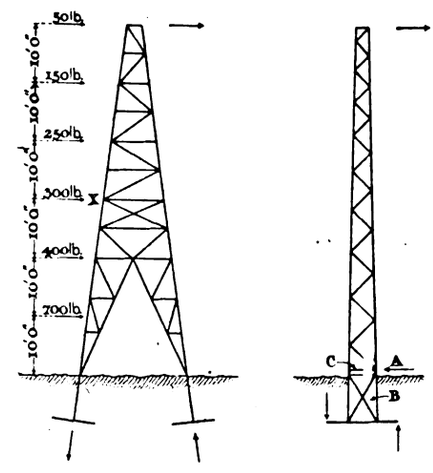


FIG. 4.

wave-front condition may not give time for the corrective balancing action of the ionised air, and the over-stressed part may break down and result in the puncture of the entire insulator. It would seem, therefore, that an insulator should be designed for surges with steep wave front rather than for normal conditions. It is therefore desirable briefly to review the possible surges with a view to their effect upon the insulator and its design.

Surges.—Earth-wires cannot be considered to be an infallible protection, and an insulator may still conceivably receive a direct stroke

Digitized by Google

and may occasionally receive the impacts of surges induced by lightning. An actual stroke of an insulator is fortunately not very frequent, and there is therefore no very great necessity to attempt to make actual provision against a stroke, which provision in any case seems impossible.

Lightning may give rise to a rapidly travelling wave with very steep front. Also switching and arcing surges may rise to a potential of twice the line voltage and will set up oscillations with a frequency depending upon the constants of the line or, say, 1,000 to 5,000 periods per second, which indicates the steepness of the front; but whereas the switching surge may only continue long enough to permit of two or three wave-trains, the arcing surge may continue for much longer, depending upon how quickly the arc is suppressed.

One must, therefore, endeavour to design insulators having regard to these lightning surges with their steep front and high-frequency oscillations which may follow the lightning surge and which will be set up by switching and arcing. As already shown, poorly designed or badly balanced insulators may behave well under normal frequency owing to the automatic balancing action of the corona. Such an insulator under a steep wave-front condition, however, might puncture at a voltage even lower than its flash-over voltage under normal frequency. Hence the first requirement is to balance the parts of the insulator so that under steep wave-front conditions it does not depend upon corona to relieve the over-stressing. To obtain correct balancing the following considerations must be taken into account:—

The mutual capacity of the parts.

The concentration of flux upon a relatively small electrode, as, for instance, the pin. (This tends to increase the potential gradient on the shells near such small electrode.)

The capacity of parts to earth. (This increases the capacity current and hence the potential gradient on the shells nearest to the line.)

In addition to being balanced, the insulator should be proportioned to withstand the surges and oscillations of limited potential and frequency as set up by switching and arcing with an adequate margin against flash-over or puncture, and also so that when the almost unlimited rises of lightning surges occur, the insulator will be protected therefrom. This protection may be obtained by making use of the low dielectric strength of the air surrounding the insulator as a protecting gap or safety valve through which it may arc to earth and thus relieve the stress before damage can occur to the porcelain.

The thickness of porcelain must be determined with regard to the air gap, or vice versa, and the shaping and disposition of parts should be such that, when the air gap breaks down, the arc will be thrown out from the shells so as to minimise damage by the heat of the arc. In proportioning the air gap and the thickness of porcelain, that which might be termed the "time lag" of the air gap under steep impulses must be taken into consideration.

Mr. F. W. Peek, Jnr.'s investigations on this subject have shown that under impulses of steep wave front the voltage required to break down air between spheres does not materially alter, but between needle points the air requires a higher voltage to break it down. The electrodes on a line insulator are certainly not of the character of spheres, and though they are not as sharp as needles, yet there will be an appreciable time lag.

To introduce spheres into the insulator design is feasible, but it is more practical to provide for the time lag by considering it as the extra voltage required to break down a given air gap, and to adjust the air gap and thickness of porcelain accordingly. In common with most insulation, the porcelain itself will withstand a greater voltage under a single impulse, but under a series of wave trains porcelain may break down by the cumulative effect of the continuation of the impulses. Hence, a lightning surge of very high potential is not necessarily the most severe condition, as it may only cause a single impact, whereas a surge of lesser potential setting up oscillations may do the most damage.

In regard to this cumulative damage an impulse above a certain value would appear to break down the porcelain over a minute distance without breaking down the whole, just as the phenomena of corona breaks down a small amount of air without sparking across. With air, however, when the stress is removed, good air closes in on the fault, whereas with porcelain the fault remains and reduces the distance, thus increasing the gradient for the next impulse, which therefore extends the fault, and so on until complete rupture occurs.

All well-designed insulators will be recognised under test by the small amount of corona formation prior to flash-over.

Electrical Design of Pin-type Insulators.—Pin-type insulators were first designed many years ago without great regard to the balance of dielectrics and their ability to withstand surges. These designs are generally tall, small headed and elegant looking. If, however, these requirements are regarded, the resulting design becomes more squat and wide to obtain the protecting air path and free arcing characteristics, whilst maintaining electrostatic balance, and thicker in the head to obtain the puncture strength and reduce the flux.

Suspension insulators are usually of one or other of two types, viz., the Hewlett or interlinked type, and the metal hooded or cemented type.

Hewlett Type.—From the electrical standpoint the interlinking of the fittings causes a concentration of flux at the point where the interlinked fittings come closest together, *i.e.*, at the point of crossing. Practice has proved, however, that provided the insulators are made of high-quality porcelain, as for instance English porcelain, they give satisfactory service. The insulators as supplied in this country are fitted with endless steel-wire grummets connected together by an S-shaped fitting devised by the author (*see* Fig. 5). The grummets are made on the insulator itself and then cemented in to prevent the wearing of either the porcelain or the grummet. The cement being hygroscopic also has the effect of what amounts to increasing the area of the electrodes and thereby reducing the flux density, and consequently improving the electrical characteristics of the insulator. This type of insulator is eminently suitable for use in conjunction with pin insulators on the straining points of the line. This design of insulator is also used on very high voltages, as, for instance, on the 88,000-volt lines of the Victoria Falls & Transvaal Power Co., and those made of sound porcelain, *e.g.*, the English ones, have given good service. On the very high voltages, however, the metal-hooded insulator is more generally used, presumably owing to its better electrical characteristics.

Metal-hooded Type.—The characteristic of the metal-hooded or cemented insulator is the concentric arrangement of the parts and the even distribution of flux which makes the insulator very good from the electrical point of view. Considered individually, the suspension insulator is of very simple electrical design, but when arranged in a string in series, as for working at high voltages, some interesting features arise.

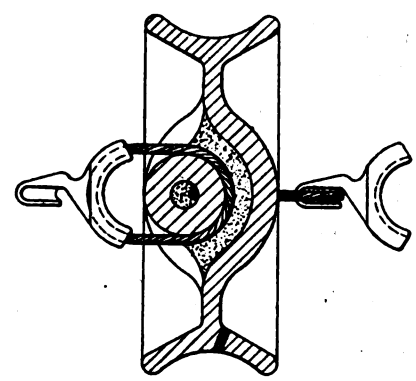


FIG. 5.—HEWLETT TYPE OF INSULATOR.

Distribution of Potential.—That the distribution of potential along a string of suspension insulators is not equal is well known, but it is desirable briefly to refer to it here in order to lead up to other matters. Suspension insulators arranged as a string have a capacity to one another which might be called "series capacity," and a capacity to earth which might be called "shunt capacity." The unit nearest to the line has therefore to carry the "series capacity" current, which is uniform throughout the string, plus the "shunt capacity" current of the units above it. Each successive unit above has a lesser amount of "shunt capacity" current to carry. The voltage gradient will therefore be steepest on the line unit and less on each successive unit, the topmost unit nearest to the cross-arm having the least potential across it. The unbalancing will be the greater, the greater the ratio of shunt capacity to series capacity. Insulators, therefore, with large thicknesses of porcelain, such as a double piece or an extra thick single piece, will have the smallest series capacity; and though such insulators may be of excellent design, considered individually, yet a string of them in series may have very bad characteristics.

Such extra thickness becomes necessary with poor qualities of porcelain which have a relatively low dielectric strength, but such porcelain has a relatively low specific inductive capacity so that the effect of bad porcelain in increasing the out-of-balance is cumulative. Inversely, the better the porcelain the higher the capacity due to the material itself and the thinner it can be for a given strength.

Effect of Spacing on Flash-over.—One effect of the uneven potential distribution is that the flash-over of a string of, say, *n* units is less

Digitized by Google

than the flash-over of one unit $\times n$. The ratio of these two figures has been called the "string efficiency ratio," and is an indication of the out-of-balance of the string. It is to be noted, however, that just as with pin insulators, the effect of corona is to increase the capacity of the most stressed shells or automatically to grade them, so that under test at normal frequency the string efficiency ratio may indicate a better potential balance than is actually the case under normal working voltage. If the units are spaced over a certain length apart, flash-over will take place between the metal-work of each unit and further spacing apart will not materially alter the flash-over of the string. If, however, the spacing is reduced, the flash-over will take place over the entire string, and when this condition is first reached the flash-over of the string might be slightly increased, due to the better flux distribution. The spacing can, however, be further reduced up to the limit of the minimum spacing required by the fittings, and if this is done, the flash-over will be decreased, thereby lowering the string efficiency ratio.

The spacing of the units closer together will have the following effects:—(1) The flux distribution will be better, due to the shortening of the path for such parts of the flux as pass through the air between the units; (2) the arc will be thrown out from the porcelain instead of drawn in, and so will reduce the possibility of shattering the shells; (3) the stresses on each unit will be reduced.

The latter reason is a very important one. Under pin insulators it was shown that it is desirable to reduce the air gap or increase the thickness of the porcelain. The necessity for not increasing the thickness of porcelain in the suspension-type insulator has been discussed, so that the only course open is to reduce the air gap and thereby the stress which can come on any unit including the line unit, and at the same time to reduce the time lag under high-frequency conditions. Yet that which provides the above important advantages and efficiency is to be stigmatised as bad efficiency, as judged by the string efficiency ratio.

Under rain conditions the balance of the string is improved owing to the increase of series capacity due to the wet conducting surfaces and also due to the leakage current over such surfaces, which adds itself to the series capacity current. In consequence, after a certain number of units are added to the string, the flash-over under spray may become even greater than the dry.

Mechanical Design.

A line insulator in performing its normal function must encounter considerable variations of temperature. Expansion and contraction stresses may therefore occur. The problem is to shape and proportion the various parts of the insulator so that these stresses are kept as low as possible, and, in conjunction with the stresses set out by outside loads, well within those that the materials can continuously withstand without deterioration.

Metal parts do not generally fit in close contact with porcelain parts, nor do porcelain parts fit in close contact with other porcelain parts. There is always a layer of cement, generally neat Portland cement. Any stresses set up by the expansion and contraction of the parts will therefore be transmitted through such cement layers. Cement has, however, a low modulus of elasticity and a strength under compression very much less than either iron or porcelain, so that it will act to some extent as a cushion. From this point of view the cement layers should be made reasonably thick. On the other hand, however, neat Portland cement, unless very sound, *i.e.*, thoroughly burned and skilfully gauged, is liable to a slight expansion of its bulk, which may take several years to develop.

It is also possible that such gradual expansion might be increased by some subtle chemical action causing crystalline growths. From this point of view the cement layers should be kept thin.

Between two parts, such as two shells of porcelain, which have the same coefficient of expansion, the desirable thin layer of cement can be used without corresponding disadvantage. When, however, there are solid and bulky metal parts, the expansion stresses will be appreciable and the cement layers must be of greater thickness so as to give the cushioning effect.

Mechanical Design of Pin Insulators.—A pin insulator may be heated to a considerable temperature by the sun shining directly upon it—probably more on one side than on the other—during which time the parts tend to expand; and it may then be subjected to a sudden downpour of rain, which suddenly cools the top shed, causing it to contract. With small pin insulators, nothing is likely to happen under these conditions. In large pin insulators, such as those for 50 kv., designed with the top shell shaped as A in Fig. 6, considerable stresses may be set up at the corners, thus causing the side to split and fall off.

It is, however, possible to design the top shed in the form of a continuous disc, with the head formed on the upper side and a flange on the underneath side for fixing to the other shells (*see* B in Fig. 6). The flange is given a slight slope and the cement space is kept thin, and as porcelain is a poor conductor of heat, this arrangement of head and flange largely obviates this trouble.

Attachment of Pin Insulators to Pin.—Many different methods have been employed for fixing pin insulators to spindles, including such devices as the Cordeaux screw, hemp fixing, cementing, or cementing in a separable metal thimble into which the thimble is screwed. The desirable fixing is a detachable one which permits of the insulators and spindles being transported and handled separately and of insulators being replaced. The Cordeaux screw and metal thimble both possess this advantage.

The Cordeaux screw fixing has been extensively used in this country, presumably because of its detachability, and also perhaps because it is inexpensive. The Cordeaux fixing, however, is certainly not good from an electrical point of view, owing to the presence of sharp edges and small air spaces between the metal and porcelain. From a mechanical point of view the Cordeaux fixing is much weaker than any other.

Hemp fixing was presumably the outcome of the necessity for a method of fixing to certain foreign porcelain, a characteristic of which is its brittleness. With brittle porcelain the use of hemp may or may not be necessary, but with English porcelain—or American for that matter—which is tougher and more resilient, the use of hemp is not at all necessary.

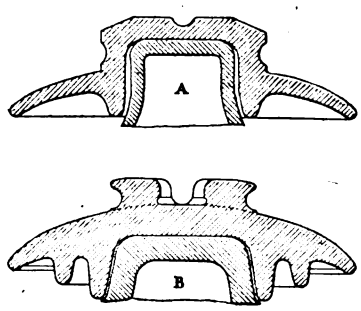


FIG. 6.—LARGE PIN INSULATOR.

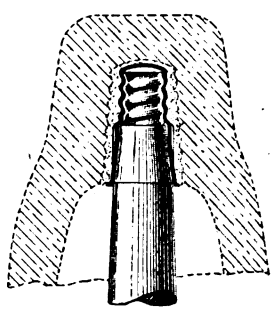


FIG. 7.—THIMBLE.

The fixing of metal pins by cementing them direct into insulators makes a very sound job, but as the pins are of solid metal a good cushion of cement is necessary.

To ensure that the metal-work is correctly centralised and that proper materials are used, it is desirable that the cementing should be done at the maker's works, where these facilities exist. If, however, a separable metal thimble is cemented into an insulator, the advantages of proper centralisation, materials, &c., are obtained, but the extra expense and risk of breakage in transit are obviated. Moreover, if the thimble is made in stamped sheet metal as opposed to a casting, the expansion stresses are kept low, and smaller clearances of cement can therefore be used.

A thimble of this nature is shown in Fig. 7. In this design of thimble the joint is made on a cone seat, the screw in the upper half of the thimble being chiefly for the purpose of bringing the cone seats of the thimble and spindle into close contact. The cone-seated joint develops the full strength of the full section of the spindle and the small taper of the cone, requiring at least a half turn to release properly, prevents looseness. This would appear to be one of the best methods of attaching an insulator to a pin.

(*To be concluded.*)

The Weathering of Coal.—We note that a report has recently been issued by the Canadian Department of Mines summarising information on the conditions giving rise to deterioration of coal during storage. Such deterioration, it appears, is due mainly to oxidation, and this depends largely on the presence of moisture in moderate amount. Quite dry coal can be safely stored, and coal can also be kept under water. But some coals, especially those containing much sulphur, are readily affected by a damp atmosphere. The effect is less in winter than in summer; shallow heaps give less trouble than deep ones; and perforation pipes, allowing for ventilation, are desirable.

Digitized by Google

RANGE OF WIRELESS STATIONS.

BY CAPT. R. CHENEVIX TRENCH, R.E.

(*Concluded from page* 149.)

Summary.—The author introduces modifications into the Austin-Cohen empirical formula for the range of wireless stations so as to take into further account the effect of actual working conditions. The results obtained are illustrated by means of a number of curves, and the use of these curves is finally illustrated by the working out of certain empirical examples.

(4.) *Sending Apparatus.*—The curves apply to a sending set of 25 per cent. efficiency between the alternator output and the power developed in the aerial. Where this efficiency in any particular case is known, or known approximately, the value of $h_1h_2\sqrt{P}$ should be multiplied by $\sqrt{25/E}$, where E is the known efficiency.

If continuous waves are used there is a gain in resonance effect. The increase in efficiency due to this is discussed at some length by Dr. Eccles,* and depends on the decrements of the various circuits; it is shown that modern spark systems are capable of such a high standard of resonance that the gain in using continuous waves is small; about 25 per cent. gain in efficiency is probably a fair allowance, or $h_1h_2\sqrt{P}$ must be multiplied by 0·9. This, of course, is subject to the modifying factor $\sqrt{25/E}$ mentioned in the preceding paragraph.

The effect of continuous waves in receiving is discussed in the following section under Receiving Apparatus.

(5.) *Receiving Apparatus.*—The efficiency of a receiving set, especially with a crystal detector, is by no means constant. There may be temporary dullness in the detector; there is room for minor errors in tuning, coupling, potentiometer adjustments, &c., and the operator's personal factor is involved. The large factor of 64 times audibility power which is taken should cover such variations (since 16 times audibility is considered to give good communication), and so long as there is nothing seriously wrong with the receiving set the curves may be applied without modification for all ordinary purposes.

With relays or amplifiers, the increased effect depends on the type used and whether two or three are used in tandem or one only. A single Brown telephone relay is said to make otherwise inaudible signals clear and readable; a valve amplifier used singly may multiply the received power five times, or 120 times with three valves in cascade. Beat reception with continuous wave transmission may give tenfold multiplication or more, and this may, in turn, be combined with amplifiers. Similar or greater results are claimed for various other devices.

With a perfectly reliable amplifying device and no atmospheric or other interference, the sending power could be reduced in the exact amplification ratio. In practice, with interference to be considered, the effect of this might be to reduce the strength of signals below the strength of normal unavoidable interference, so that there would be no gain in magnifying both. At the present stage of development it may be said that the perfection of the amplifier, interference preventer and atmospheric eliminator is well within sight. When it is achieved we may look for a great modification of the sending power and height now considered necessary for any range, and the value of $h_1h_2\sqrt{P}$ obtained from the curves may be modified by a factor of $\sqrt{U/600}$, where U is the minimum audibility power in the aerial, in micro-microwatts, for the particular receiving device employed.

Meanwhile, where such devices in their present state are used, we may apply some lesser factor depending on the amount of interference expected; we might, for instance, count on four-fold amplification only, modifying P by a factor of 0·25, or $h_1h_2\sqrt{P}$ by 0·5.

(6.) *Time of Day.*—The question of "freak" signals by night, sunset and sunrise effects, &c., will not be considered here. Although there is no doubt that short waves travel better by night, there is some difference of opinion as to the night effect on long waves. It is probable, however, that all wave lengths travel better by night, and for general purposes this may be allowed for by replacing the absorption coefficient 0·0015 by a smaller coefficient 0·001, or by multiplying the daylight value of $h_1h_2\sqrt{P}$ by the factor $\varepsilon^{-0·0005x/\sqrt{\lambda}}$. This method is only approximately correct, since the night absorption appears to depend on the range and is less at the longer ranges.

(7.) *Atmospheric Conditions.*—In conditions under which little or no atmospheric interference may be expected, such as is the case with small capacity low aerials, or in districts notedly immune from atmospherics, a smaller power than 64 times audibility, may safely be taken, but the minimum power received should not be less than 16 times audibility. That is, in such favourable cases, the value of $h_1h_2\sqrt{P}$ given by the curves may be modified by $\sqrt{0·25}$, or 0·5.

The question of seasonal fluctuations of signal strength is not treated here. It is considered that such fluctuations are covered by the "reliability factor" of 64.

(8.) *Degree of Reliability.*—It may often be the case that a smaller margin of signal strength than that assumed is sufficient; such may occur when there are only a few short messages to be expected daily, or when one may count always on the best operators working under the best conditions. In such cases the received power may be reduced to about 16 times audibility, or $h_1h_2\sqrt{P}$ modified by a factor of not less than 0·5.

A table of all the modifying factors discussed above is appended:—

Summary of factors by which the value of $h_1h_2\sqrt{P}$ under the assumed normal conditions should be modified for variations from those conditions:—

1.	For screening by mountains	$\epsilon^{(2x\chi_1\chi_2/\lambda)\frac{1}{2}}$
2.	For intervening surface	$\epsilon^{Kx^{\frac{1}{2}}/\lambda}$
3.	For effective height of sending aerial	$1·8h/l$
4	For effective height of receiving aerial	$1·8h_2/l$
5.	For capacity of receiving aerial	$0·0018/C_a$
6.	For sending on wave-length less than 1·5 times natural wave	$(1·5\lambda_n/\lambda)^2$
7.	For directive aerial, one end	0·8
	For directive aerial, both ends	0·6
8.	For bad earth at sending end	1·7
	For moderate earth at sending end	1·2
	For counterpoise earth at sending end	1·2
9.	For bad earth at receiving end	1·2
	For counterpoise at receiving end	1·4
10.	For efficiency of sending apparatus	$\sqrt{25/E}$
11.	For use of continuous waves in sending (not allowing for beat reception in receiving)	0·9
12.	For use of more sensitive receiver than crystal detector used without amplification, where interference need not be conaidered	$\sqrt{U/600}$
13.	For use of above under normal conditions of interference	0·5
14.	For sending by night	$\epsilon^{-0·0005x/\sqrt{\lambda}}$
15.	For absence of atmospheric interference	0·5
16.	For reduction of "reliability factor" to lowest limit consistent with successful communication	0·5

The foregoing is a partial attempt to deal with a subject which cannot be treated fully without a great deal more investigation and research than is yet available for reference. It is treated from a severely practical point of view, and to this end many approximations have been made which are open to criticism and some considerations treated separately which are really inter-related. In conclusion we will take a few examples of results.

EXAMPLES.

Example 1.—What power and height are necessary for 400 km. by day over sea at 600 m. wave-length, with flat top non-directive aerials, modern apparatus without amplification?

From the curves $h_1h_2\sqrt{P}=36,600$, assume a two-wire T-aerial of length equal to twice the height in which distance apart of wires is about 1/40 of their length. Then we must

* "Wireless Telegraphy and Telephony," by W. H. Eccles.

Digitized by Google

apply the following modifying factor for aerial capacity in receiving :—

$$0{\cdot}0018/C_2.$$

So that $h_1h_2\sqrt{P}=36{,}600\dfrac{0{\cdot}0018}{C_2}$.

Now, from the above,

$$C_2=3h_2\times9{\cdot}4\times10^{-6}\text{ mfd.}$$

$$\therefore\quad h_1h_2\sqrt{P}=36{,}600\times0{\cdot}0018/3h_2+9{\cdot}4\times10^{-6}.$$

$$\therefore\quad h_1h_2^2\sqrt{P}=2{,}340{,}000.$$

Take $P=2$ kw.$=2{,}000$ watts.

Then, $h_1h_2^2=2{,}340{,}000/45=50{,}000.$

Taking aerials of equal height, we have :—

$$h=\sqrt[3]{50{,}000}\text{ m.}$$
$$=36{\cdot}8\text{ m.}$$

So that 2 kw. sets with 37 m. masts are required.

Example 2.—What power and height are required under the same conditions, but over hilly land, where good earths are not attainable ?

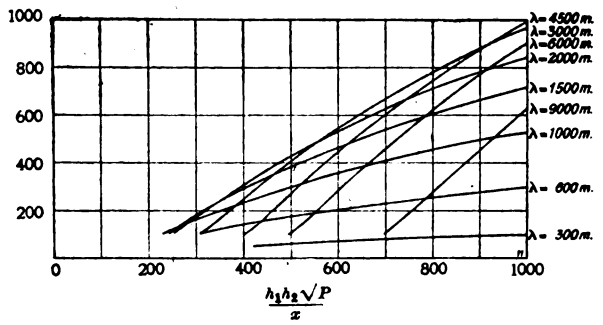


FIG. 11.—OVER MOUNTAINOUS LAND.
h_1h_2 in metres. P in watts. x in kilometres.

From equation (31) or Fig. 8, 1,000 m. is seen to be a suitable wave-length.

From Fig. 8 also

$$h_1h_2\sqrt{P}/400=270.$$

$$\therefore\quad h_1h_2\sqrt{P}=108{,}000.$$

To this we must apply the following modifying factors : (*a*) For moderate earth at sending end, 1·2 ; (*b*) for capacity of receiving aerial, $0{\cdot}0018/C_2$.

$$\therefore\quad h_1h_2\sqrt{P}=108{,}000\times1{\cdot}2\times\frac{0{\cdot}0018}{C_2}.$$

And $C_2=3h_2\times9{\cdot}4\times10^{-6}.$

$$\therefore\quad h_1h_2\sqrt{P}=\frac{108{,}000\times1{\cdot}2\times0{\cdot}0018}{3h_2\times9{\cdot}4\times10^{-6}}.$$

$$\therefore\quad h_1h_2^2\sqrt{P}=8{,}300{,}000.$$

Take $P_2=5$ kw.$=5{,}000$ watts.

Then, $h_1h_2^2=8{,}300{,}000/70.$
$=120{,}000.$

Taking aerials of equal height, we have—

$$h=\sqrt[3]{120{,}000}=49{\cdot}3\text{ m.}$$

That is, 5 kw. sets, with 49 m. masts are required.

Example 3.—How would the case of Example 2 be affected by the employment of an arrangement of value amplifiers, giving a magnification of 100, or a minimum audibility power of 6 micro-microwatts, if no interference need be anticipated, and if work is carried on under most favourable conditions, where " reliability factor " may safely be reduced ?

Here we may modify our value of $h_1h_2\sqrt{P}$ by the following factors : (1) For sensitiveness of detector, by $\sqrt{600}=0{\cdot}1$; (2) for reduction of reliability factor, by 0·5.

That is, if we use the same 49 m. masts we could modify our value of $\sqrt{P}$ by 0·05 or P by 0·0025, so that we should only require 12·5 watts in the generator. And since our assumption is 25 per cent. efficiency, this entails about 3 watts in the aerial.

Example 4.—What power and height are necessary for 4,000 km. over sea, directive aerials, crystal detectors without amplification ?

From equation (17) or Fig. 1 9,000 m. is seen to be the most economical wave-length, and on this wave at 4,000 km. the value of $h_1h_2\sqrt{P}$ obtained from the curves is 18,500,000. Whatever the size of the sending aerial, the receiving aerial of such a station would very likely be a single wire aerial of about a kilometre in length, with a capacity of about 0·005 or 0·006 mfd.

We must then modify our value of $h_1h_2\sqrt{P}$ by the following factors : (1) For directivity by 0·6 ; (2) for effective height of aerials by $(1{\cdot}8/2)^2=0{\cdot}8$; (3) for capacity of receiving aerial by $0{\cdot}0018/0{\cdot}0055=0{\cdot}33$.

This gives us—

$$h_1h_2\sqrt{P}=18{,}500{,}000\times0{\cdot}6\times0{\cdot}8\times0{\cdot}33$$
$$=2{,}960{,}000.$$

Take $P=100$ kw.$=100{,}000$ watts.

Then $h_1h_2=2{,}960{,}000/\sqrt{100{,}000}=9{,}300.$

$\therefore$ With equal heights $h=\sqrt{9{,}300}=96$ m.

That is, 100 kw. sets with 96 m. masts are required.

Example 5.—What would be the screening effect of a range of mountains 4,000 m. high with the crest 20 km. from one station, if the stations are 2,000 km. apart, on 2,000 m. wave ?

Here $\chi_1=0{\cdot}2$ radians.

$\chi_2=0{\cdot}002$ radians.

$$\therefore\quad \varepsilon^{(\alpha\chi_1\chi_2/\gamma)^{\frac{1}{2}}}=\varepsilon^{(2\times2000\times0{\cdot}0004/2)^{\frac{1}{2}}}=2{\cdot}5.$$

So the value of $h_1h_2\sqrt{P}$ must be multiplied by 2·5 to allow the height of intervening land, apart from any other modifying factors.

Example 6.—What ranges by day could be relied upon between two portable stations with counterpoises and umbrella aerials ; mean height of spokes, 60 ft. (18 m.) ; capacity of aerial, 0·001 mfd. ; alternator, 2 kw. ; crystal detectors ; quenched gap sets of 50 per cent. efficiency—

(*a*) Over flat land at 1,000 m. wave-length.
(*b*) Over hilly land at 1,000 m. wave-length.
(*c*) Over flat land at 600 m. wave-length.
(*d*) Over hilly land at 600 m. wave-length.
(*e*) Over flat land at 300 m. wave-length.
(*f*) Over hilly land at 300 m. wave-length.

Here $h_1h_2\sqrt{P}=18^2\sqrt{2{,}000}=14{,}500.$

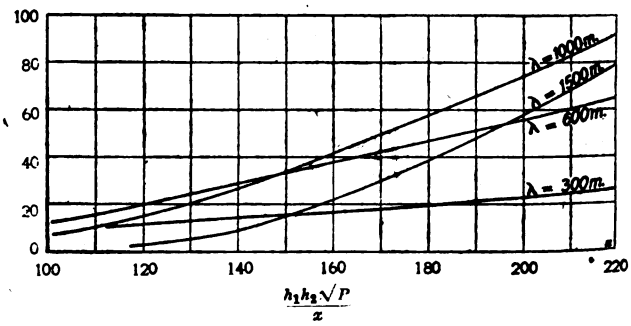


FIG. 12.—OVER MOUNTAINOUS LAND.
h_1h_2 in metres. P in watts. x in kilometres.

To this we must apply the reciprocals of the following modifying factors to get its equivalent value for application to the curves :—

1. For counterpoise sending, 1·2.
2. For counterpoise receiving, 1·4.
3. For receiving aerial capacity, 0·0018/0·001.
4. For 50 per cent. sending efficiency, 0·7.

This gives us $14{,}500\times\dfrac{1}{1{\cdot}2}\times\dfrac{1}{1{\cdot}4}\times\dfrac{1}{1{\cdot}8}\times\dfrac{1}{0{\cdot}7}=7{,}000.$

To find the range given by this value of $h_1h_2\sqrt{P}$ on any curve we must find by trial a point on the curve such that $7{,}000/x$ in the abscissa gives x in the ordinate.

Digitized by Google

Following this method, and using Figs. (5) and (6) for flat and (9) for hilly land, we get the following results :—

(*a*) For flat land at 1,000 m., wave range is 86 km.
(*b*) For hilly land at 1,000 m., wave range is 65 km.
(*c*) For flat land at 600 m., wave range is 120 km.
(*d*) For hilly land at 600 m., wave range ia 76 km.
(*e*) For flat land at 300 m., wave range is 165 km.
(*f*) For hilly land at 300 m., wave range is 73 km.

Example 7.—How would these ranges be affected by the use of a combination of amplifiers in receiving, giving a magnification of 100, if no interference need be anticipated ?

Here we may replace our figure 7,000 by $7{,}000\sqrt{100}$ or 70,000.

Following the same method as in Example 6 and using Figs. 5 and 8, we get :—

(*a*) For flat land at 1,000 m. wave, range=470 km.
(*b*) For hilly land at 1,000 m. wave, range=330 km.
(*c*) For flat land at 600 m. wave, range=540km.
(*d*) For hilly land at 600 m. wave, range=320 km.
(*e*) For flat land at 300 m. wave, range=530 km.
(*f*) For hilly land at 300 m. wave, range=240 km.

INDICATING AND RECORDING DEMAND METERS.

We have received from the British Thomson-Houston Co. particulars of a new line of indicating and recording demand meters, now being made by the General Electric Co., of Schenectady. They operate on the same general principle and are furnished for use with alternating-current or direct-current watt-hour meters.

The two essential parts of these meters are demand registering and timing mechanisms connected and mounted in the same case. The demand registering element is electrically driven from the register of the watt-hour meter in which is mounted a contact device, consisting of a contact-making cam, of insulating material, and two parallel leaf-springs, equipped with platinum-iridium contacts. Rotation of the cam by the watt-hour meter closes the circuit through the electromagnet coil of the indicator and operates the registering mechanism as described below.

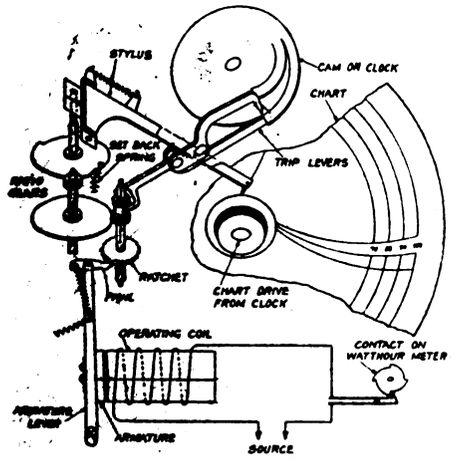


FIG. 1.—MECHANISM FOR RECORDING TYPE OF DEMAND METER.

When the contact device closes the circuit through the magnet coils of the demand meter, Fig. 1, the armature of the electromagnet is attracted and moves forward engaging the pawl at its end with the ratchet wheel, turning the latter. When the contact device opens the circuit, a spring returns the armature lever and pawl to their original positions. The motion of the ratchet wheel is transmitted through gearing to the stylus, or the pointer, moving it forward for each closing of the circuit until the end of the time interval is reached. At this point a cam driven by the timing element has rotated to such a position that a trip lever disengages a sliding pinion from the gear with which it meshes, thus opening the gear train and allowing a spring to return the stylus or pointer advancing mechanism to the zero position. Further rotation of the cam returns the sliding pinion to its former position and re-establishes the gear train. The mechanism is now in a position to measure the energy consumption during the next time interval.

The indicating type demand meters, Fig. 2, are made for direct and alternating current. The alternating-current meter device utilises a constant-speed motor for the timing element and the direct-current meter uses an eight-day clock movement. In the operating mechanism the indicating meter differs from the recording meter in the return mechanism operating at the end of each interval. With the indicating type it is not necessary to keep absolute time, and the mechanism is simplified on this account, leaving a short interval of time between each measurement.

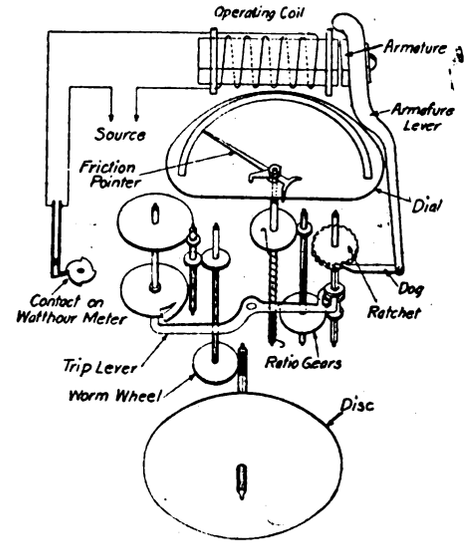


FIG. 2.—MECHANISM FOR INDICATING TYPE OF DEMAND METER.

In the graphic device the timing mechanism needs attention only when the paper is renewed and a time-setting disc is provided to synchronise the chart with the correct time. These charts are arranged to cover one week, and the divisions show the current consumption hour by hour and day by day during that period. The record takes the form of a saw tooth polar curve, and the distance of the extreme points of the curve from the zero lines of the chart indicates the demand in kilowatts.

A New Phosphoroscope.—In view of the recent discussion on "Fluorescence and Phosphorescence" before the Illuminating Engineering Society, it is of interest to note an apparatus, described by Mr. W. S. Andrews in the "General Electric Review" for March, by which the luminescence excited by ultra-violet rays on any material can be conveniently tested. The instrument is termed a "phosphoroscope." The material to be studied is placed in a light tight chamber and, by means of rotating shutters driven by a small electric motor, ultra-violet light is alternately admitted and shut off. The succession of stimuli occur too quickly for the eye to perceive a break, and by looking in through an eye-piece in the chamber a steady luminescence is seen. The motor can be speeded up to such a value that there is practically no time for the phosphorescence to decay ; or, by running at a lower speed the rate of decay during a short period after stimulus can be estimated.

Count Rumford as a Pioneer of Concealed Lighting.—Although it is generally known that Count Rumford holds a high place amongst pioneers in photometry, much of his work on general lighting problems is apt to be overlooked. Indirect lighting has been brought to the front by the invention of metal filament and gas-filled lamps, and people sometimes assume that this is essentially a new method of illumination. According to a recent Paper by Mr. E. Karrer, before the Illuminating Engineering Society in the United States, Rumford was a pioneer of "concealed" lighting. He regarded it as an axiom that lights should be screened from direct vision, and spent much of his time in devising methods of diffusing light without destroying it. He produced also special units for various purposes, for example a dining room light which shed direct rays on the table but provided diffused lighting for the general illumination of the room. Other special devices included lighting units for drawing rooms and tables and for use with the looking-glass.

Digitized by Google

THE LONDON AND NORTH-WESTERN AND BAKERLOO ELECTRIFICATION.

(*Concluded from p.* 146.)

There are some further points of interest in the joint rolling stock that may be mentioned.

The controller has four forward points and two reverse (series only), of which Nos. 2 and 4 are running points, where all resistance is cut out. A useful provision in the control is that if in the course of the automatic notching up the controller handle is brought back to the first or third notch, as the case may be, the automatic closing of contactors is stopped, but those already closed are kept up.

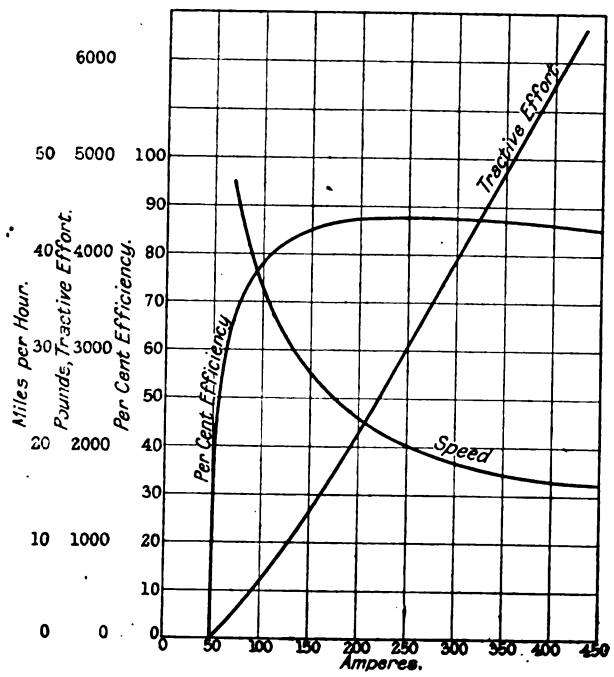


FIG. 13.—CHARACTERISTIC CURVES OF G.E. 212A RAILWAY MOTOR.
Gear ratio 64/19=3·37. 36" wheels. 550 volts. Efficiency curve includes gear and friction losses and is based on a copper temperature of 75° C.

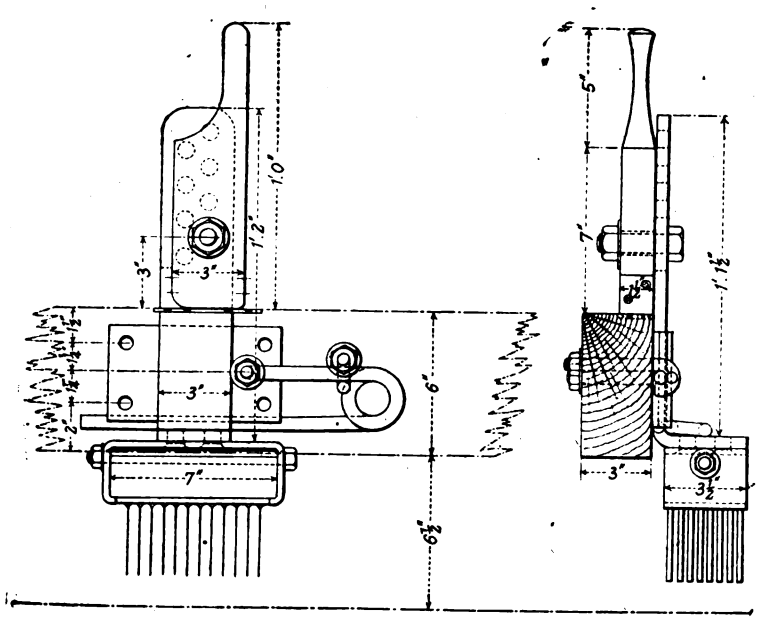


FIG. 14.—ARRANGEMENT OF SLEET BRUSH.

The working of the safety button on the controller handle differs from the L.E.R. standard in that the safety button can be released, except when the handle is at off position. If, however, the handle itself be let go, it flies back to off position when current is instantly cut off and the brakes applied throughout the train.

Another safety device, which is now part of the standard L.E R. equipment, is the control circuit governor. By interrupting the control circuits it prevents the train being driven forwards unless the train pipe of the Westinghouse brake is charged with air and the tripcock is cut in.

Each motor car is fitted with two G.E. 212 motors of 240 H.P. geared for a free running speed of 35-40 miles per hour. Characteristic curves of one of these motors are given in Fig. 13.

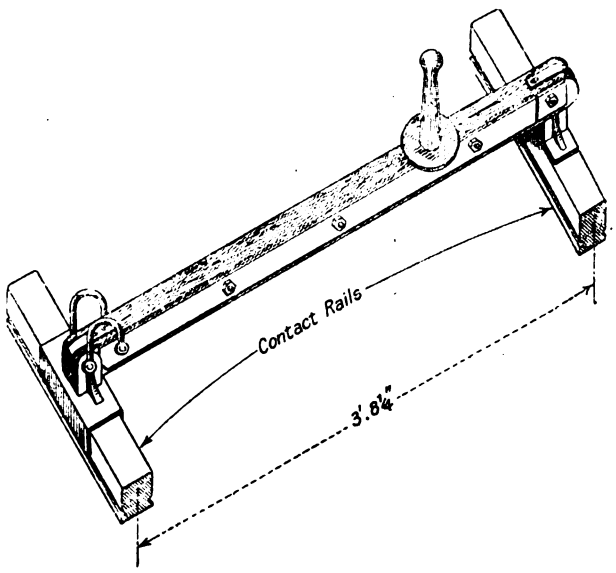


FIG. 15.—SHORT-CIRCUITING DEVICE.

The beam carrying the contact shoe also carries a sleet brush A view of this appeared in our last issue, and details of the arrangement are given in Fig. 14. Under ordinary conditions the brush is raised out of contact with the rail, but it can be lowered by pulling over the handle, which is seen in the vertical position, until this is horizontal, when the spring forces the brush down so as to clear the rail.

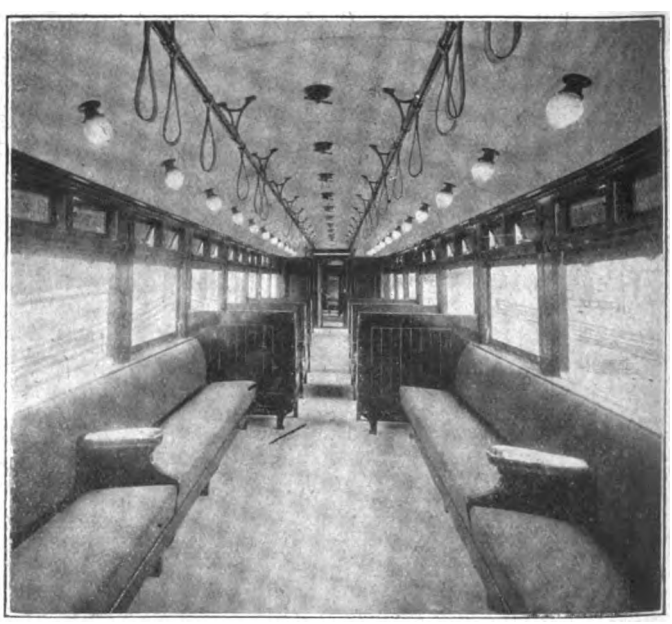


FIG. 16.—INTERIOR VIEW OF THIRD-CLASS COACH.

The brake equipment is Westinghouse with improved triple valves on the motor cars and quick acting triple valves on the

Digitized by Google

trailers, the air compressors being by the B.T.-H. Co. The brake blocks are of unchilled cast iron.

All cars are fitted with emergency electric lights, supplied from accumulators carried on the motor-car, and arranged to switch automatically on in the event of the main supply of current failing at any time.

As is well known, it is sometimes necessary in emergency to short-circuit the third rail so as to render a section dead, and various short-circuiting devices have been so used. Fig. 15 shows the device that is provided for this purpose on the present joint stock. One end of the bar is hinged to a shoe, and the other end is provided with a wooden handle. When required the shoe is placed on the negative rail, and the other end of the bar is then allowed to drop on to the positive. Owing to the hinged end being fixed, the free end drops truly on to the positive rail.

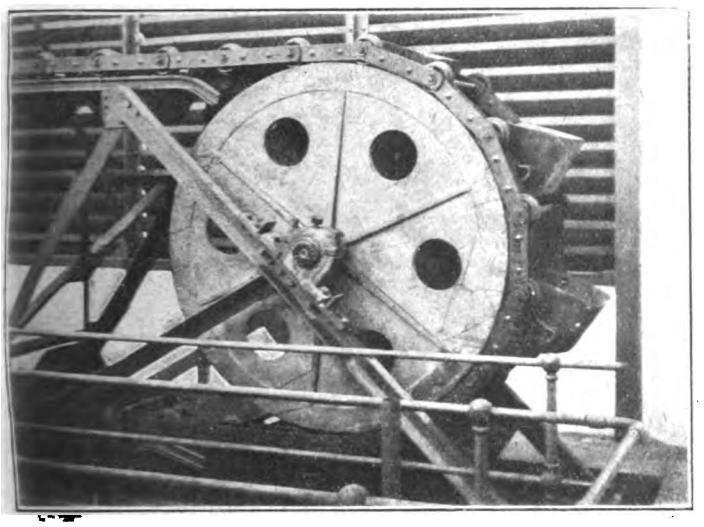


Fig. 17.—Return Wheel of one of the Gravity Bucket Conveyors over the Boiler House.

With regard to the rolling stock of the London & North-Western Railway Co. that is being used on services from Watford to Broad-street and to Richmond, this comprises three-coach trains, each of which consists of a motor coach and two trailers, control being at either end. Two of these units are coupled together making a six-coach train for times of heavier traffic. On the first four trains the equipments were made by Siemens Bros. Dynamo Works, but on all the later trains the equipments are by the Oerlikon Co. Each motor coach is provided with four motors of 260 H.P.

A view of one of the Oerlikon motor coaches appeared in our last issue (Fig. 7). These are 56 ft. 11 in. in length over headstocks. As seen in Fig. 16 both longitudinal and cross seats are used The exterior of the body is covered with steel panelling and the wooden roof is rendered non-inflammable.

Although we are unable to give full details at the present time, we may mention that the power station of the London & North-Western Railway for this electrification will include five 5,000 kw. 3-phase turbo-alternators by Westinghouse and Siemens, current being generated at 11,000 volts and a frequency of 25. Three of the sets are seen in Fig. 18. The boiler-house and turbine-room run parallel, and this lay-out allows sufficient space in the turbine-room for one end of it to be used as a sub-station. Apart from the main generating sets there is a tandem set consisting of a 500 kw. alternator giving 440 volts and a 120 kw. d.c. dynamo giving current at 220 volts. This machine supplies current for lighting purposes and for auxiliaries in the event of the main station sets being shut down, but in the ordinary course the auxiliary plant is supplied from the main 'bus-bars through step-down transformers, of which there are six, each of 353 k.v.a.

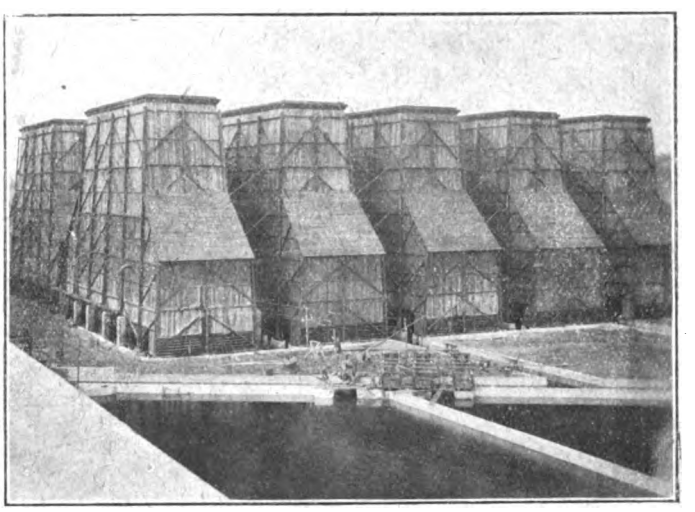


Fig. 19.—View of Five of the Eight Cooling Towers, showing the Temporary Load Tanks erected for Testing the Alternators.

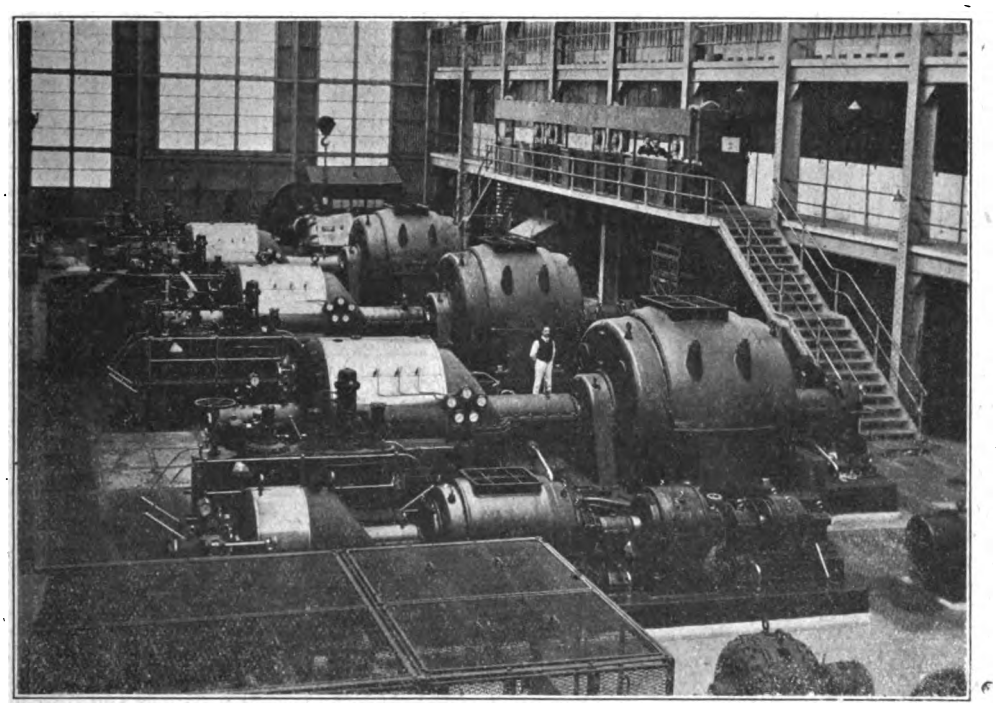


Fig. 18.—Interior of the Power House showing the Three 5,000-kw. Units at present installed and the 620-kw. Unit in the Foreground.

The boiler-house depends on natural draught and includes Babcock-Wilcox boilers, each boiler being designed to evaporate 25,000 lb. of water per hour at a pressure of 200lb. and a superheat of 200°F. There is a Greens' economiser to each pair of boilers. The boilers are arranged in two rows, but each row is divided up into two groups, the space between these groups being sufficient for a chimney shaft. Thus there are two shafts, one for each row of boilers. The lay-out is such that the power house can be easily dupli-

Digitized by Google

cated. The boilers are so arranged that four boilers across the boiler house form a unit for supplying a single turbine, and are generally so used; but inter-connection between the groups can be made by means of a 'bus steam pipe.

The coal is delivered on to two gantries above a large storage ground from which it falls by gravity on to two tray conveyors which deliver it to two bucket conveyors. The latter pass over the top of the boiler house. The driving mechanism of the bucket conveyors is seen in Fig. 17, and is situated over the coal bunkers. Each line of conveyors is driven by a 3-phase squirrel cage motor. The coal bunkers occupy the upper part of the centre of the boiler house, but sufficient space is allowed at each side to provide efficient light. The ashes are handled by two Babcock-Wilcox suction plants. Make-up water is obtained from artesian wells and is passed through softening plant before use in the boilers. The cooling towers are seen in Fig. 19. The main switchgear at the power station was provided by the British Thomson-Houston Co.

There are 11 sub-stations, including the one at the power station, equipped with rotary converters and with accumulators, and to these the electrical energy is transmitted at 11,000 volts and is there transformed down to 630 volts continuous current. One of the most difficult operations was the transformation of the old gas engine power station at Chalk Farm, this plant being replaced by three booster type rotary converters, and the space originally occupied by the gas engines is now utilised for the traction rotaries and transformers. The old gas producer house has been converted into a battery room. As the whole of the electric signalling, electric lighting and electric cooking at Euston depended upon this power station, more than usual care was required in its reconstruction, but this was effected without mishap or any interference with the supply. Fig. 20 shows the battery at the West End Lane Sub-station.

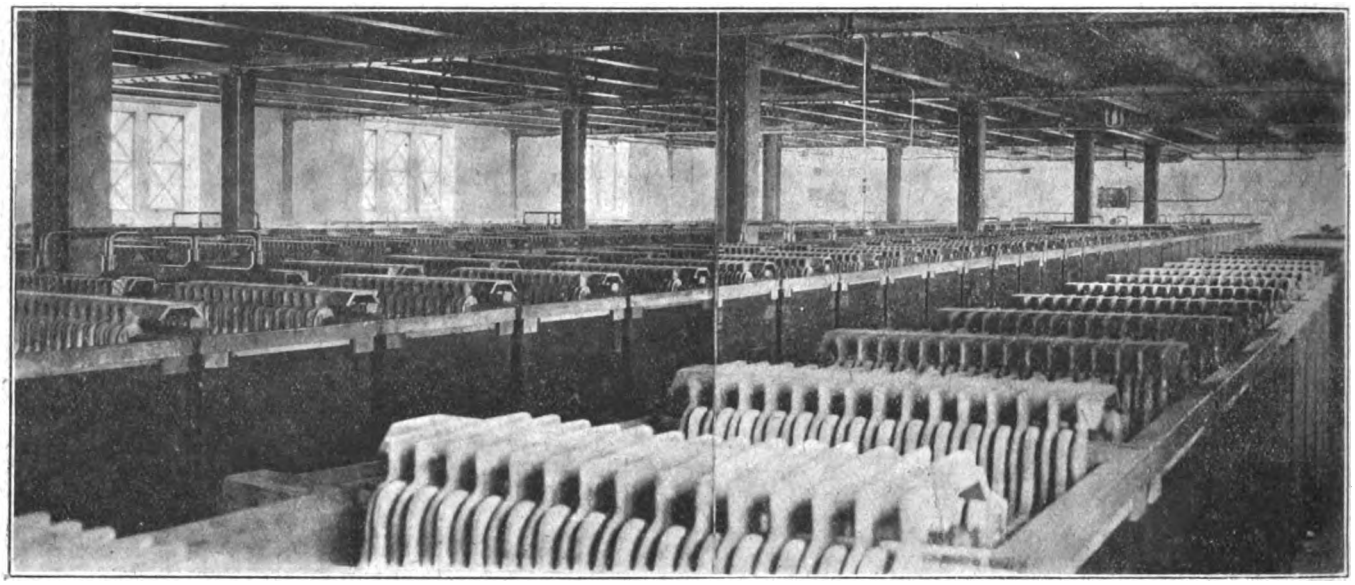


FIG. 20.—BATTERY ROOM IN THE WEST END LANE SUB-STATION. THE BATTERY CONSISTS OF 300 TUDOR CELLS, GIVING 1,500 AMPERES FOR 1 HOUR, AND MOMENTARY DISCHARGES OF 4,000 TO 4,500 AMPERES.

At some later date we hope to give complete details of the new power station and the track equipment.

We desire to express our thanks to Mr. W. A. Agnew of the London Electric Railway Co., and Mr. George Broughall, of the London & North Western Railway Co., for their courtesy in placing information at our disposal for the preparation of this article.

Electric Propulsion of Battleships.—The U.S.A. Navy Department has decided to build five battle-cruisers with electrical propulsion machinery. The "Electrical World" announces that two of these are to be built at Newport News, one by the New York Shipbuilding Co., one by the Fore River Shipbuilding Co. and the fifth by the government at the Philadelphia Navy Yard.

The vessels will cost about $76,000,000 for hulls and machinery. There has been fixed a limit of cost of $19,000,000 each for hulls and machinery, although there will be another expense of about $5,837,810 for arms and armament on each ship. The ships will have a displacement of 34,800 tons; they will be 850 ft. in length and 91 ft. beam. They will be of 180,000 H.P. and have a speed of 35 knots per hour. These will be the first battle-cruisers built by the United States and will also be the first equipped with electrical propulsion. The details of the electrical machinery have not yet been worked out, but it has been decided that the generators will be driven by steam turbines, with current on four shafts, each shaft with 45,000 H.P. Rear-Admiral Robert S. Griffin, U.S.N., engineer-in-chief, bureau of steam engineering of the Navy Department, will have general charge of the construction of the vessels.

Of the four new battleships which are to be equipped with electric drive, the contracts for the construction of two each were awarded to the New York Shipbuilding Co. and the Newport News Shipbuilding & Drydock Co. The contracts for the electrical equipment were awarded to the General Electric Co. and the Westinghouse Electric & Mfg. Co., two to each company.

Electrically-Driven Cotton Bale Press.—An account of some tests on an electrically-driven baling press was given recently in the "Electrical World." These show that the cotton is compressed into 500-lb. bales at an average cost of 4d. per bale. The motive power is supplied by a 250-H.P., 500 revs. per min., 220-volt alternating current inductive motor having a wound rotor and slip rings. This motor is geared to a duplex double-acting pump of 160 gallons per minute capacity with a working pressure of 2,000 lb. per sq. in. The water is first pumped into an accumulator, from which it is supplied directly to the hydraulic press. The maximum load noted on the motor was 182·4 kw., and the average no-load reading was 14·4 kw. During a test of 100 minutes' duration the average load was 155 kw., and the power factor on the motor ranged from 0·16 to 0·87. The energy consumed during the test was 260 kw.-hr. In 100 minutes (which includes an idle period of 20 minutes) 100 bales were pressed, which corresponds to one bale per minute over the whole period or 75 bales per hour over the net period. Of the 260 kw.-hr. used during the test, 245 kw.-hr. were used for the actual operation of the press, or 2·45 kw.-hr. per bale. With energy at 1d. per unit, the cost of energy per bale compressed is thus slightly less than 2½d.

Digitized by Google

NOTE ON THE RATING OF INTERMITTENT MOTORS OF LARGE OUTPUT.

BY H. H. BROUGHTON.

Summary.—The common methods of determining the R.M.S. value give results which are in close agreement. When the effects of the accelerating, retarding and stopping periods are taken into consideration the three methods in use lead to considerable variations in the name-plate rating.

When an intermittent motor follows a definite cycle of operations the root-mean-square (R.M.S.) method, or a modification of it, is, perhaps, the most convenient and reliable method of determining the rating to be given to the motor. The principle underlying the R.M.S. method is well known, but the application of the method varies with different firms. In consequence of this variation, motors intended for the same duty may have very different *nameplate* sizes. Consider the simple horse-power-time curve shown in Fig. 1. The three common direct R.M.S. methods in use lead to the following results :—

Method 1.—

$$\text{H.P.}=\sqrt[3]{[\{(P_1+P_2)\div 2\}^2 t_1\div(t_1+t_2)]}.$$

If $P_1=20$ and $P_2=10$, and if $t_1=t_2=10$, then H.P.$=10{\cdot}6$.

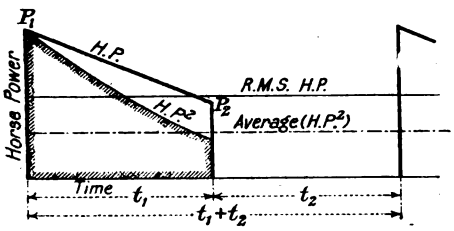


FIG. 1.

Method 2.—

$$\text{H.P.}=\sqrt[3]{[\{(P_1^2+P_2^2)\div 2\}t_1\div(t_1+t_2)]}.$$

If $P_2=20$ and $P_2=10$, and if $t_1=t_2=10$, then H.P.$=11{\cdot}18$.

Method 3.—

$$\text{H.P.}=\sqrt{[\{(P_1^2+P_1P_2+P_2^2)\div 3\}t_1\div(t_1+t_2)]}.$$

Using the same values as above for P_1, P_2, t_1 and t_2, it is found that H.P.$=10{\cdot}82$.

Of these, the third gives the correct root-mean-square value. Hence, for the simple cycle just considered the first method gives an output on the low side by 2 per cent., and the second method gives an output on the high side by 3·3 per cent.

As a rule, the errors are much smaller because in practice

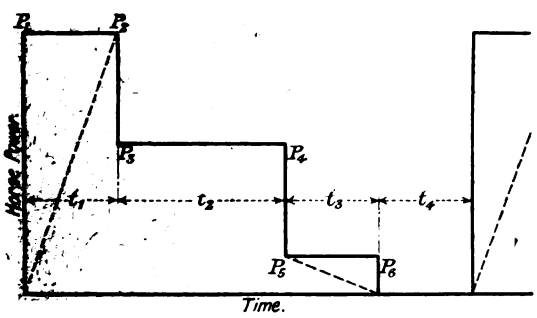


FIG. 2.

P_1 and P_2 are more nearly equal, and when the horse-power-time diagram is such that $P_1=P_2$; $P_3=P_4$, &c., as shown in Fig. 2, it will be seen that the three methods give the same result.

In the above, no attempt has been made to distinguish between heating effect and temperature rise. The heat is not carried away at the same rate all the time because at standstill, and at the reduced speeds of acceleration and retardation, the cooling surface is less efficient than at full speed. The greater the accelerating, retarding and rest periods in a given time, the greater will be the error in the rating if no correction be made.

This can be readily seen from the thermal characteristics depicted in Fig. 3. The saw-tooth curve *a, b, c, d, e* has been drawn on the assumption that the cooling surface is equally efficient during the running and standstill periods; and for the curve *a, b, f, g, h* it has been assumed that the cooling surface is less effective at standstill than it is under running conditions. If, therefore, the permissible mean temperature rise

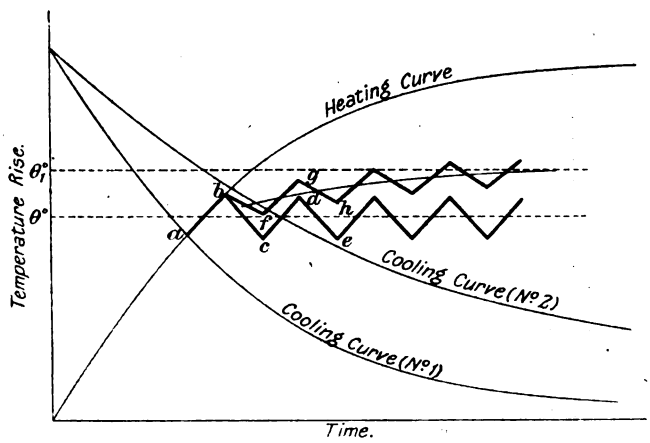


FIG. 3.—EFFECT OF REST PERIOD.

be *0* deg. it follows that the rating will have to be reduced in order to reduce the mean temperature rise from θ_1 deg. to *0* deg.

To make an allowance for the lower efficiency of the cooling surface at low speeds and at standstill it has been suggested * that the R.M.S. value of the cycle should be corrected by such a factor as shall represent the difference between the average dissipation of heat over the cycle and the dissipation at full speed. This factor depends upon the percentage of the time during which the motor is running at reduced speeds or is at

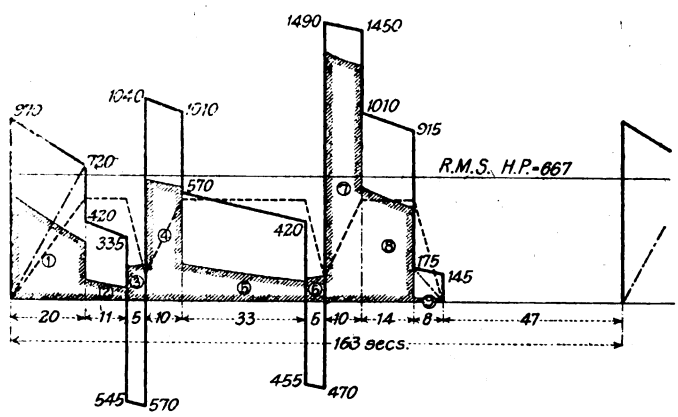


FIG. 4.—WINDER CYCLE.

rest, as well as upon the speed and design of the motor. For a general approximation it may be taken that the cooling during acceleration and retardation is 75 per cent., and during standstill is 50 per cent. of that at full-speed. Thus, if the accelerating, full-speed, retarding and standstill periods are t_1, t_2, t_3 and t_4 seconds respectively, the corresponding full-speed value of the cycle will be $t_2+0{\cdot}75(t_1+t_3)+0{\cdot}5t_4$ seconds.

The effect of the correcting factor on the rating of the motor can best be shown by means of an example. The horse-power-time diagram depicted in Fig. 4 represents the load on the

* "Transactions" Am. Inst. E.E., Vol. XXIX., p. 323, 1910.

Digitized by Google

motor of an electric winder for a compound shaft. The speed-time curve is represented by broken lines and the outline of the H.P.^{2} curve, to a reduced scale, is section lined.

Using Method 2, the expression for the R.M.S. horse-power is :—

$$\text{H.P.}=\sqrt[2]{\Big[\Big\{\Big(\frac{P_1^2+P_2^2}{2}\Big)t_1+\Big(\frac{P_3^2+P_4^2}{2}\Big)t_2+\Big(\frac{P_5^2+P_6^2}{2}\Big)t_3+\Big(\frac{P_7^2+P_8^2}{2}\Big)t_4+\Big(\frac{P_9^2+P_{10}^2}{2}\Big)t_5+\Big(\frac{P_{11}^2+P_{12}^2}{2}\Big)t_6+\Big(\frac{P_{13}^2+P_{14}^2}{2}\Big)t_7+\Big(\frac{P_{15}^2+P_{16}^2}{2}\Big)t_8+\Big(\frac{P_{17}^2+P_{18}^2}{2}\Big)t_9\Big\}\div(t_1+t_2+t_3+t_4+t_5+t_6+t_7+t_8+t_9)\Big]}$$

In substituting given values for P_1, P_2, &c., and t_1, t_2, &c., it is preferable to proceed as shown below.

P	P^2	$\frac{1}{2}(P_1^2+P_2^2)\times t=\frac{1}{2}(P_1^2+P_2^2)t$	
970 ...	$0{\cdot}941\times10^6$	$0{\cdot}730\times10^6\times20=14{\cdot}59\times10^6$	(1)
720 ...	$0{\cdot}518\times10^6$		
420 ...	$0{\cdot}176\times10^6$	$0{\cdot}144\times10^6\times11=1{\cdot}59\times10^6$	(2)
335 ...	$0{\cdot}112\times10^6$		
545 ...	$0{\cdot}297\times10^6$	$0{\cdot}311\times10^6\times5=1{\cdot}55\times10^6$	(3)
570 ...	$0{\cdot}325\times10^6$		
1,040 ...	$1{\cdot}082\times10^6$	$1{\cdot}051\times10^6\times10=10{\cdot}51\times10^6$	(4)
1,010 ...	$1{\cdot}020\times10^6$		
570 ...	$0{\cdot}325\times10^6$	$0{\cdot}251\times10^6\times33=8{\cdot}27\times10^6$	(5)
420 ...	$0{\cdot}176\times10^6$		
455 ...	$0{\cdot}207\times10^6$	$0{\cdot}214\times10^6\times5=1{\cdot}07\times10^6$	(6)
470 ...	$0{\cdot}221\times10^6$		
1,490 ...	$2{\cdot}220\times10^6$	$2{\cdot}161\times10^6\times10=21{\cdot}61\times10^6$	(7)
1,450 ...	$2{\cdot}103\times10^6$		
1,010 ...	$1{\cdot}020\times10^6$	$0{\cdot}929\times10^6\times14=13{\cdot}00\times10^6$	(8)
915 ...	$0{\cdot}837\times10^6$		
175 ...	$0{\cdot}031\times10^6$	$0{\cdot}026\times10^6\times8=0{\cdot}21\times10^6$	(9)
145 ...	$0{\cdot}021\times10^6$		
		$\Sigma\frac{1}{2}(P_1^2+P_2^2)t=72{\cdot}40\times10^6$	

Finally, R.M.S. horse-power

$$\text{H.P.}=\sqrt[2]{(72{\cdot}40\times10^6\div163)}=667.$$

If the correcting factor be applied, since there are 58 seconds for full-speed running, 58 seconds for accelerating and retarding and 47 seconds for stopping, the corresponding full-speed value of the cycle will be :—

$$58+\tfrac{3}{4}\times58+\tfrac{1}{2}\times47=125 \text{ seconds},$$

and the rating will be :—

$$\text{H.P.}=\sqrt[2]{(72{\cdot}40\times10^6\div125)}=761.$$

Another method which has been proposed is to count the accelerating and retarding periods as full speed periods as far as cooling is concerned, and to count the standstill period as equal to a full speed period of one-third the duration. According to this method the corresponding full speed value of the cycle is equal to $t_1+t_2+t_3+\frac{1}{3}t_4$. Taking the above example, the corrected value of the cycle is $58+58+(47\div3)=131{\cdot}7$ seconds, and the rating of the motor in this case is

$$\text{H.P.}=\sqrt[2]{(72{\cdot}40+10^6\div131{\cdot}7)}=741.$$

The author believes that the three methods are in use, and in view of the widely different results it would appear to be desirable for the Engineering Standards Committee to define the method of rating to be adopted in such cases of common occurrence in heavy electrical engineering.

Non-corrosive Cobalt Alloys.—A recent bulletin of the Canada Department of Mines gives an account of some tests by H. T. Kalmus and K. B. Blake on non-corrosive cobalt alloys. The addition of cobalt or nickel to iron proved beneficial as far as non-corrosive qualities are concerned. Cobalt is somewhat better than nickel in this respect. The extent of corrosion appears to be dependent on time of exposure, but is not a simple function of the cobalt content. A small addition of copper also seems to reduce the atmospheric corrosion of American spigot iron.

ON A PRECISION METHOD OF UNITING OPTICAL GLASS—THE UNION OF GLASS IN OPTICAL CONTACT BY HEAT TREATMENT.*

BY R. G. PARKER, B.SC., A.C.G.I., AND A. J. DALLADAY.

Owing to the numerous defects of the cements available for constructing glass cells for the examination of the optical properties of liquids, the following process, by which a much more perfect joint between two pieces of glass can be obtained, has been developed. Briefly, the surfaces of each of two pieces of glass are so worked and polished that they are either both plane or of the same curvature to a very high degree of accuracy. They can then be placed together in "optical contact," and if they are subjected to carefully controlled heating will unite and become one piece.

It is essential that the temperature at which union takes place shall be far below the melting-point of the glass and also below the annealing temperature—for even at this temperature very slight strain would cause sufficient deformation of worked glass surfaces to render them useless.

It is very difficult to place the windows of a cemented cell sufficiently accurately parallel for certain work depending on the phenomena of the interference of light; parallelism to ±1 (one) minute is only attained with considerable trouble, especially if the adhesive material requires baking to cause it to harden completely. The wedge shape of the enclosed liquid may be too great for interference work, even if the angle between the windows is not greater than a few seconds.

In addition, cements frequently strain the materials which they hold together to such an extent that their optical properties are considerably altered.

Glass surfaces can be polished without difficulty so nearly flat—or so nearly of the same curvature—that when carefully cleaned and freed from dust, they show less than one interference fringe per inch when placed together and examined by light reflected from the interfaces. Such surfaces can be pressed into optical contact by the application of pressure of several pounds per square inch, and the pieces of glass act as one for optical purposes. They can easily be separated by sudden warming or cooling, by force, if applied in a *peeling* manner, and by liquids; the latter gradually creep in and litt the surfaces apart. The joint is very resistant to forces tending to slide one surface over the other.

It is well known that if glass is heated it gradually becomes less viscous as the temperature rises, passing through all degrees of viscosity until at a high temperature it is quite mobile; there is thus no sharp melting-point, but only an approximate position which varies from about 1,100°–1,400°C. At temperatures very much below the melting-point the glass is still liquid enough to deform gradually under stress—hence the slow permanent bending of a glass rod supported at each end, in a horizontal position, and at ordinary temperatures. Glass behaves, in fact, as a brittle, elastic solid under sudden strain, but as a viscous liquid to severe strain applied over long periods when at ordinary or moderately elevated temperatures; with rise of temperature the elastic nature of the glass becomes more and more masked by the decrease in viscosity; and at a temperature approximating to the melting-point it becomes no longer observable.

Annealing Temperature.—If a piece of glass having two plane, parallel, and polished sides is placed in an electric furnace so that it can be heated, and examined by transmitted polarised light at the same time, the strain caused by unequal heating can be observed both as regards position and intensity by its effect on the light. This strain, which would be very evident at lower temperatures in a piece of glass in the form of a ½-in. cube, or larger, suddenly disappears over quite a short range of temperature situated very much below the melting-point. The glass has obviously reached a temperature at which it is sufficiently mobile to accommodate itself rapidly to the stresses caused by unequal heating; it is therefore deformed and the stress disappears; this is clearly the annealing-point, in that a piece of badly annealed glass would lose all internal stress at this temperature, and if sufficiently slowly cooled would be perfectly annealed.

Relation of the Temperature employed to the Annealing Temperature.—The viscosity of a glass at its annealing temperature is still very great, but it has softened sufficiently for a pointed tool, pressed against it with considerable force, to make its way slowly in. Therefore, an optically worked surface of a piece of glass would not retain its form accurately after heating to the annealing temperature, if some clamping apparatus had touched the surface.

* Abstract of Paper read before the Faraday Society, Monday Dec. 18, 1916.

Digitized by Google

The mobility of glass has been found to be an exponential function of the temperature—

$$S_T = S_{T_1} A^{\frac{T-T_1}{N}}$$

where S_T, S_{T_1} are the "mobilities" at the temperatures T, T_1, measured by the rate of deformation of glass under constant stress, and A and N are constants for the glass.

It appears that the glass becomes twice as "soft" for *every* rise of temperature of 8°C. Therefore, at 60°C. or 70°C. below the annealing temperature a glass has become sufficiently hard to withstand very great local pressure for short periods without sensible deformation.

Working at this temperature, 60°C. below the annealing-point, two pieces of glass under pressure, and in optical contact, will unite perfectly in less than 1 hour. At the same time the deformation of the outer surfaces caused by the imperfections in the plates compressing them is so very slight that a few strokes on a polishing tool are all that is necessary to restore them to the condition of optical surfaces of high accuracy; or treatment of the surfaces may be altogether unnecessary. It is perhaps well in practice to work at a temperature 10°–20° below this maximum safe temperature in order to ensure that no deformation shall occur.

Methods of Distinguishing between Optical Contact and Complete Union.—With regard to tests for distinguishing perfect union, we have already noted that the optical contact of two surfaces is easily destroyed by sudden temperature change, by the action of liquids, and by mechanical force; when the contact has changed into complete union, they cannot be separated by any of these means, and if force is used the two pieces of glass break as one—not along the interface. A crack or a diamond cut spreads through the two pieces as though one piece of glass, whereas if the pieces are merely in ordinary optical contact, it cannot be made to pass from one to the other.

EXPERIMENTAL.

The temperature selected was considerably below the annealing-point, in accordance with the facts already discussed. Two preliminary experiments were made—in one case two pieces of crown glass, in the other larger pieces of crown and heavy flint glass being used. In both cases the glasses were found to have united, but not completely. In the first case all the surfaces were optically perfect after heating.

These experiments having proved that joining would take place, more careful ones were conducted on three plates, all of a hard crown glass. These plates were put into optical contact, the centre one being about 10 mm. thick, and drilled so as to give a cell suitable for the comparison of two liquids, as in the Rayleigh interference refractometer. The outer plates were, of course, merely windows of about 3 mm. thickness. The cell was heated without pressure in the electric furnace at the rate of 2°C. per minute to 460°C., and after two hours at this temperature it was cooled at 4°C. to 5°C. per minute; the arrangement of the furnace permitted continuous inspection of the cell. During heating, at 200°C. to 300°C., minute imperfections in the contact grew rapidly, one side of the cell coming almost completely away. When cold it was found to be out of contact over parts of the surface, the rest of the surface being in contact, but covered with spots.

Rapid temperature changes, such as would easily have separated glass in ordinary contact, had no effect; water also failed to lift the surfaces apart; and when a thin knife-blade was forced in from a corner where the two surfaces were apart, that portion of the window out of contact was broken off without moving the window as a whole. The cell was then compressed in a vice in such a way as to apply large shearing stresses at the interfaces, with the result that corners of the windows out of contact broke away, while the rest, in contact, remained unchanged.

The spots referred to above were small round areas where the surfaces were just out of contact in each. It appears that these spots are due to the decomposition of minute particles of cellulose from the rag used in cleaning the surfaces; a pressure of many atmospheres can be produced in this way. By careful cleaning it is possible to eliminate them almost entirely.

The optical surfaces of this cell were found to be perfect and quite unchanged after heating, including the unsupported internal surfaces; we therefore have *optically worked* surfaces in the *interior* of a solid glass cell.

A second cell was then made of the same glass and pattern, and heated at the rate of 1°C. to 1½°C. per minute to a temperature nearer the annealing-point—523°C.—at which it was kept for two hours, then cooled at 4°C. to 5°C. per minute. Pressure was applied by means of a hand screw-clamp. Precautions were taken this time to avoid carbonisation of paper.

The union of the three components was complete except for a few small spots. They could not be separated by any of the means indicated, and when subjected to severe mechanical strain a portion of the cell broke away, showing the conchoidal fracture of a solid glass block. No bending of the fracture occurred at the interfaces, except at one small portion where a spot showed that there was no contact.

A third cell of rather different construction also showed very few imperfections of contact.

The internal surfaces of the cell windows were parallel to 1 second both before and after union. The degree of parallelism remained quite unaltered, and it therefore appears that the accuracy of parallelism is determined only by the initial accuracy of the central component.

Union of Two Different Kinds of Glass.—The components of the cells described above were all made of one kind of glass, and the joining of different glasses is complicated by at least three factors—differing expansion coefficients, differing annealing-points of the glasses, and the degree of ease with which they will fuse together in the blow-pipe flame.

A Rayleigh cell prepared of hard crown glass with plate-glass windows was heated to a low temperature—400°C.—at the rate of 2°C. to 2½°C. per minute and kept at the maximum temperature for 1½ hours. Pressure was not applied. In consequence of this, and also of the different temperature expansion coefficients, they remained in optical contact only over a very small part of the surfaces. When cold the glass was found to have united in these places in spite of the unnecessarily low temperature. The optical surfaces had not been changed by the heating. This experiment indicated that two glasses of quite widely differing annealing-points could be joined even under unfavourable conditions.

A more severe test was then carried out with an object-glass having curves of the same radius on the common faces of its components.

It appears, however, that the flint and crown glasses commonly used in object-glasses differ too widely in annealing temperatures for successful union. Owing to the large number of factors which limit the nature of the glasses to be employed, this is one of the most difficult cases to which the method has been applied.

Polarimeter Tubes.—A polarimeter tube having windows permanently fixed in position by this method was prepared without difficulty. The tube was of soda-lime glass and the windows of plate glass; maximum temperature 470°C. The joint was perfect and in spite of the fact that different glasses were employed the windows showed little strain—the amount was found not sufficient to interfere with measurements of rotation in any way. For many purposes this form of tube should be very convenient, especially in respect of ease of cleaning and freedom from corrosion. As soon as possible we intend to apply this construction to jacketed tubes; they would somewhat resemble the ordinary pattern of glass Liebig condenser, and should, with careful heating, withstand very high temperatures. The nature of the hot circulating liquid would be determined only by the temperature required, and not by the powers of resistance of the cement, as is the case at present.

Union of Fused Silica.—An experiment with component parts of this material showed that there was no essential difference between its behaviour and that of glass; the temperature required for union was naturally found to be much higher. The upper limit of temperature to which silica glass apparatus may be heated is determined by its power of devitrifying; this takes place at about 1,200°C. to 1,300°C. and is accompanied by great decrease in mechanical strength. It is obvious that a very small amount of devitrification would be sufficient to spoil silica glass for optical work, especially as it takes place more readily where there is access to the air, *i.e.*, at the surfaces. The highest temperature which we can use is therefore somewhat below 1,200°C.; fortunately, a preliminary experiment has shown that a still lower temperature (about 1,100°C.) will probably give results equal to those obtained with glass.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Preliminary Mathematics." By Prof. F. E. Austin, B.S. (London: E. & F. N. Spon, Ltd.) Pp. iv.+169. 5s.

"Electrical Laboratory Course for Junior Students." By Magnus Maclean, M.A., D.Sc. (London: Blackie & Son, Ltd.) Pp. 120. 2s. net.

"The Aviation Pocket Book, 1917." By R. Borlase Matthews. (London: Crosby Lockwood & Son.) Pp. xix.+300. 5th edition. 4s. 6d. net.

Digitized by Google

The Electrician.

FRIDAY, MAY 4th, 1917.

Editorial and Publishing Offices:—

1, 2 & 3, SALISBURY COURT, FLEET STREET, LONDON, E.C. 4.

Telephone: City 4698-9. *Telegrams:* "Electrician Newspaper London."

THE EXCESS PROFITS DUTY.

In view of the approaching Budget, when no doubt the question of Excess Profits will be discussed and may figure once more as a source of revenue, it is well to consider whether this tax has been satisfactory in its effect on industry, apart from being satisfactory as a source of revenue. In regard to the latter point it will no doubt be contended that since this duty produced a revenue of £140,000,000 during the past year the tax has more than fulfilled expectations, and that this duty may, therefore, be considered satisfactory. It is always necessary, however, to look somewhat further, and consider what is the ultimate effect of any taxation before deciding whether Parliament is justified in continuing legislation of this kind.

It will be generally admitted that the principle of preventing high profits at the expense of the nation in times of war is a good one, and should be maintained as far as possible. The only matter that concerns us at the moment is whether the present method of attempting to apply this principle is successful, or whether it introduces unsatisfactory results.

In taking up this question we must distinguish between controlled and uncontrolled establishments. In the case of uncontrolled establishments, a 6 per cent. untaxed profit is the maximum permitted unless some reason is found on appeal for allowing a larger percentage. In the event of a larger percentage being earned, then 60 per cent. of the excess must be paid to the Government. Theoretically, it may be argued that the paying of so large a proportion of the profit will prevent large profits being earned, but in practice, this is found not to be the case. The manufacturer, being limited in this way, puts up his prices as far as possible so as to increase the profit to such a figure as will secure a large net profit for himself, notwithstanding the contribution falling to the Government. Consequently, one main result has been that prices have risen abnormally, whereas the contrary was doubtless anticipated. As an example, it may be said that the raising of shipping freights to a point which has seriously crippled industry was due chiefly to the Excess Profits Duty. Paper is another case in point. Although raw materials have been cut off and every form of restriction has been placed upon it, nevertheless almost every paper mill in the country has paid Excess Profits Duty.

In the case of controlled establishments, among which the bulk of electrical manufacturers are to be found, the case is very different. Here, after a profit 20 per cent. above a pre-war average has been earned, the whole of the excess goes to the Government. But if this percentage is not earned the excess profits tax becomes operative. Of the two methods of taxation we think it will be admitted that the basis (apart from the actual figure adopted) for regulating the controlled establishments is better than that for the uncontrolled, owing to the fact that no object is attained, as far as the manufacturer is concerned, in earning a profit exceeding the 20 per cent. increase, and consequently the tendency will be to avoid any excessive prices.

As a war measure it may be contended, not without reason, that we have no right to complain of this Excess Profits Duty so long as it applies to the present time only. When, however, we come to consider the period immediately after the war the case is very different. It must be remembered that the term "profit" as defined by the Inland Revenue is very different from that which is accepted by every sound commercial concern. No allowance is permitted for depreciation, and a company which earns no dividend may nevertheless show a considerable profit for taxation. This is an uncommercial way of looking at things. Depreciation is increasingly important at the present time when factories are running day and night, and when sufficient attention cannot be given to repairs. It is short-sighted policy to neglect this important side of the question.

There is no question that the normal progress of any company depends upon the accumulation of adequate reserves. If insufficient reserves are put on one side at the present time the resulting position after the war will necessarily be one of weakness. In ordinary working t is desirable to use excess profits accruing in good years to off-set the loss of bad years and to take care of replacements and depreciation so as to keep the plant up to date. By so doing easy expansion also becomes possible. This side of the question, however, is lost sight of in the present scheme of excess profits.

The whole matter would be of little importance if the war were to result in subsequent easy commercial conditions. This, however, will be far from the case. In many instances we shall have to recover foreign markets to which attention cannot at present be given and which are falling into the hands of neutral firms with large reserves. As far as can be said at the moment, German firms are not being correspondingly taxed, and are consequently accumulating huge reserves with the express purpose of carrying on a keen commercial war as soon as this becomes possible. When our manufacturers require capital after the war to meet this competition, who will provide it? Obviously the average investor will not be in a position to meet the need, nor will the Government be so inclined. Consequently, if our manufacturers themselves have not been in a position to accumulate the necessary reserves, their position will necessarily be one of weakness.

There are two steps that appear to us to be desirable. The first is the abolition of the Excess Profits Duty before the termination of the war. This might be contingent on the use of such profits for the building up of adequate reserves. Of course, it may be objected that Trade Union rules have been relaxed largely on account of the limitation of profits, and that such limitations must therefore be maintained until the Trade Unions go back on their side of the bargain. It seems to us, however, that so long as excessive dividends are not paid there should be no great difficulty in agreeing upon a basis for the accumulation of proper reserves.

The second step, which we feel should be taken at once, is to revise the Excess Profits Duty so as no longer to endanger reserves. During the course of the war the Government has been constantly at fault through not looking sufficiently ahead. Let there be no procrastination in facing this new position. Let us realise now that the commercial war with Germany during the next few years will be no myth. Fortunately our present Chancellor of the Exchequer is acquainted with commercial matters and therefore we feel with some confidence that he will appreciate the seriousness of taxing British industry in a way that may cripple it for the coming international struggle.

Digitized by Google

REVIEWS

Electric Switch and Controlling Gear. By C. C. GARRARD, Ph.D., M.I.E.E., A.Am.I.E.E. (London: The Electrician Printing & Publishing Co.) Pp. xviii.+656. 15s. net.

The author attempts in one volume to give a useful handbook on electric switch and control gear. In doing this he is handicapped by the vastness of the ground he tries to cover. There is hardly any field of engineering offering so many difficulties to comprehensive compression. Both in switch-gear and control-gear the ways of doing things are legion, resulting in an individualistic treatment of almost every proposition. And just as the minds dealing with this class of engineering are good, bad and indifferent, so is switch-gear and control-gear. Fortunately the great importance of this gear is more and more recognised, and the bad and indifferent types, instead of prevailing as they did not long ago, are gradually making room for the good and the excellent; and the engineers, who formerly often bewailed their misfortune of being side-lined into a rather despised and subordinated auxiliary branch of electrical engineering are coming into their own. This change is only of recent growth and counts probably for the fact that relatively few text books of any note exist on the art. Any new addition is therefore to be welcomed and in Dr. Garrard's book we have a production which should be useful to a good many. We have mentioned already, however, that the author tries to cover too much ground, and as he is apparently, in the first place, a switch-gear specialist, we should recommend that in a second edition he should deal with switch-gear only. Here he is at home, has a large personal experience, and the more he cares to tell us about it, the more useful his book will be.

What the author says about control-gear only touches the fringe of this other large and important class of electrical apparatus, extending over all the innumerable industrial applications of electric power, from simple motor starters to the control of a train, from a field regulator to the automatic control of a printing press. But still, what Dr. Garrard mentions is good and to the point, and his many allusions to desirable standardisation will, we hope, bear fruit in official quarters.

The book is divided into eight chapters. The first deals with materials and manufacturing methods. The second with apparatus for making and breaking electric circuits. In the third chapter we find information on apparatus for preventing a dangerous condition of the current flowing. This is followed by apparatus for regulating the current, continued by a chapter on starting and controlling gear. In the next two chapters the author deals with low, medium, high and extra high-tension switchboards and, finally, in the last chapter, with apparatus for protection against abnormal electrical conditions. Very useful also are the appendices, giving abstracts of mining rules, factory rules, B.O.T. Regulations, I.E.E. Wiring Rules, &c.

The book is well printed, illustrations are numerous and clear, drawings and diagrams precise. To anyone interested in switchgear the book should prove useful and, at the moderate price of 15s., a good investment. R. F. BAERLOCHER.

Dynamo and Motor Attendants and their Machines. By FRANK BROADBENT. (London: S. Rentell & Co., Ltd.) 8th edition. Pp. xv.+212. Price 2s. 6d. net.

This book has reached its eighth edition, and is, therefore, probably well known to any interested parties. We doubt whether any exceptional skill has been shown in the choice of a title for this book. However, it is too late to alter this in an eighth edition. "Dynamo" includes any kind of electric generator, either of the direct-current or alternating type. This certainly conforms to German practice, but in old-fashioned days in this country the word "dynamo" had a more limited significance. "Motors," consequently—and quite legitimately—includes all types, and there is a good deal of information about alternate-current motors of various kinds, their starting arrangements, &c. But, judging from a random glance at the title, we should hardly have expected to find within the covers a discussion of such subjects as autotransformers and star-delta switches, together with a long chapter about accumulators, a seemingly extraneous matter.

That patient beast, the transformer, is, however, entirely neglected, probably because he has no "attendant," and is capable of fending for himself. Still, we admit that the choice of a title for a book like this, covering a good deal of ground, is not easy. The volume is really a sort of expanded pocket-book for engine-room attendants, though it contains nothing about engines. It postulates the existence of motive power in some form, and then proceeds to consider its application to the driving of dynamos and motors. The contents might well have been more logically subdivided into sections for purposes of reference. An early chapter on "General Principles" is said by the author in the preface to be written to meet the popular demand; but attendants are not apt to be over-worried by considerations of lines of force. A little learning of this kind is of no great value, and engineers should be encouraged to drink deeper elsewhere. Then one part of the book should be definitely set apart to direct-current machinery (and accumulators, if they are to be included), and another part to alternating-current types. These might be followed by other sections of the severely practical kind, dealing with the erection of machines, the testing for faults and breakdowns, the various methods of driving, &c. All these things are, in fact, included; but there seems to be an absence of method in the presentation of the diversified aspects of a rather comprehensive subject. The general survey of the ground is good—perhaps rather of the nature of a bird's-eye view; but nothing else is necessary under the conditions set out by the author. There is a good deal of wisdom of the practical sort in what the author says, and the book would be useful to many an engine-room attendant; but a few weeks spent on the rearrangement of its contents would be to the good. The beginner may expect to find a solution of most of his working difficulties, together with a description of the various kinds of dynamos, motors and their accessories, and the whole is spiced with the experience of a man who has seen a good deal of the working side of an engineer's life.

W. H. S.

Theoretical Elements of Electrical Engineering. By C. P. STEINMETZ, A.M., Ph.D. (London: The Hill Publishing Co., Ltd.) 4th edition. Pp. xiii.+368. 12s. 6d. net.

With the fourth edition this standard work has been radically revised and practically rewritten. Everything beyond the most fundamental principles of general and special apparatus has been withdrawn in order to make room for the adequate representation of the theoretical elements of present-day electrical engineering. The removal of everything beyond fundamental principles is a decided improvement. We understand that this has also been done in the new edition of "Alternating Current Phenomena." It is the author's intention to use the material which does not find room any more in these two books, together with such additional matters as the development of electrical engineering requires, for a third volume.

In conformity with the decision of the International Electrical Congress of Turin the crank diagram of vector representation has been adopted, although Dr. Steinmetz is of the opinion that the polar diagram is the better, and he believes that the crank diagram was adopted without sufficient consideration of the relative merits. Nevertheless, since all serious students of electrical engineering will, sooner or later, have to turn to "Steinmetz," we are glad that the author decided to use the vector representation that is common to all elementary text-books.

Although a good deal of matter has been withdrawn, and notwithstanding the fact that the present edition contains nearly 100 pages less than the third edition, so much new matter has been added that the volume is to all intents and purposes a new one. It is characterised by almost uncanny lucidity and simplicity of expression, and is indispensable to the engineering student and to those who are interested in the essentials of the range of subjects with which it deals.

Digitized by Google

THE FUTURE OF THE BRITISH X-RAY INDUSTRY.

At the meeting of the Röntgen Society on April 3rd a discussion took place on "The Future of the British X-ray Industry," to which manufacturers, medical men and physicists contributed. It was opened by Mr. Geoffrey Pearce, who said that before the war it was estimated that 50 per cent. of the electro-medical apparatus used in this country was of foreign origin. In 1913 we imported about £19,000 worth of such apparatus from Germany. Germany's geographical situation, with her clinics attracting medical men from the surrounding countries, had had no small part in advancing her electro-medical industry, with the consequence that German manufacturers were enabled to develop far larger concerns for the production of such apparatus than could be contemplated in the United Kingdom. Owing to their size, these concerns were able to employ a highly trained technical staff, not only to supervise production, but to carry out investigation and research. In this country manufacturing houses had done their best to keep pace with the developments, but in the absence of a properly trained and efficient technical staff they had in many directions—although not entirely—fallen short of their foreign competitors. In his opinion, research could not, and should not, be undertaken by individual manufacturers, but should be on a properly organised plan, the benefits of which would be enjoyed not only by the manufacturers themselves, but by the users of the apparatus. The British manufacturers had recently formed a section of an organisation which existed in the interests of the electrical trade as a whole in this country, and much useful work had already been done and would be done in the future. It was obvious, however, that it was only by a participation in a large share of the world-wide trade that a sufficiently large output could be secured to enable the industry to occupy the position it should, and to develop as the scope of the science increased.

Following on the opening Paper, Prof. A. W. Porter pointed out that research in connection with manufacture was a very difficult matter, if not almost impossible, in connection with small firms. The only solution was some sort of combination between different firms. This was being very satisfactorily carried out already in connection with optical manufacture. Facilities for the proper training of workers in such research laboratories were already available in any physical department of the universities.

Mr. R. S. Wright, speaking as a manufacturer, said that the biggest obstacle to a policy of manufacturing as against importing was not the conservatism of the British manufacturer, but the prejudice of the British medical man and user of apparatus. British medical men had a rooted idea in their minds that a thing made in England must be behindhand. The Snook interrupterless machine, for example, was first placed on the European market by his own firm, but it was not bought until, some time afterwards, it had been taken up in Germany, and then, when at last the British doctors woke up and the hospitals began to put it in, two-thirds of them went to Germany for it. On the other hand, the German doctor would refuse to buy any bit of apparatus that was not made in Germany. The German doctor was out for the prosperity of German manufactures as much as the manufacturer himself.

Sir James Mackenzie Davidson, while admitting that in many respects we had been obsessed by an idea of German superiority, which he did not think, however, would persist after the war, pointed out that, so far as the Snook apparatus was concerned, the fact that it did not come into favour until later was not entirely due to its re-introduction from the Continent. When the Snook machine first came out there were very few tubes that would stand the energy it put through them, but in the process of development of tube construction we had now arrived at a tube—the Coolidge—quite equal to the energy which the Snook machine put in, and no doubt that form of machine would come into more general employment.

Capt. G. W. C. Kaye said that while in pure research the British contribution was one of which none could be ashamed, on the applied side the work done in this country was comparatively small. He hoped that an X-ray institute, or something of the kind, might be set up whose particular province it would be to thrash out problems for the manufacturers.

Mr. Cuthbert Andrews said that there were in this country only four firms who actually manufactured X-ray tubes on a commercial scale. Prior to the outbreak of war, a large number of these instruments were imported from Germany, France and America, and those made in this country were dependent on Germany for their material. On the outbreak of war very great difficulties arose, but fortunately they had been surmounted, and now, with the exception of a satisfactory quality of tungsten, everything required for the manufacture of X-ray tubes could be produced in Great Britain. He was of opinion that the problem of highly skilled labour, such as they must employ, was the only real difficulty remaining. If they could obtain the help of the Government in conserving their present skilled staffs they had a nucleus around which they could build. But skilled men must be kept in their present employment in order to produce and to teach others to produce. That was the vital condition. Given labour, he would guarantee that within a reasonable time they would be freed from the necessity of importing into this country a single foreign X-ray tube.

MACHINE SWITCHING TELEPHONE GEAR.

The following is an account of a discussion which took place before the Birmingham Local Section of the Institution of Electrical Engineers on Mr. F. R. McBerty's Paper on the above subject. An abstract of the Paper appeared in The Electrician of March 30 and April 6 :—

Mr. T. Plummer remarked that the question of automatic telephones had received much consideration in recent years, and the Post Office, in order to test the rival claims of various systems, had had machine switching telephone gears installed by different contractors at several towns throughout the country, totalling about 16 in all. The small installation at Dudley was opened in September last. Most of the other installations had been working for some time under service conditions, and careful records were being kept of the costs of capital and maintenance, as well as of the defects of the different systems and the faults to which they gave rise. In the course, therefore, of the next year or two, full information on these most important matters would be secured by the telephone administration. It was probably safe to say that but for the present financial stringency much greater progress in the extension of automatic or semi-automatic telephone working would have been made in this country within the past year or two. Apart from the question of economy in regard to the employment of operators, the great improvement in machine switching was, in his opinion, the substitution of rigid electrical and mechanical contacts and gears for the flexible switching cords ordinarily used on manual boards. Flexible cords remained the essentially weak feature in the manual switchboard. The reduction in the employment of operators brought about by the installation of machine switching had a most important bearing on the question of building costs, as the smaller number of operators meant a very large saving in exchange buildings, not only on account of the comparatively small floor space occupied by the machine switching gear, but the saving in retiring rooms, dining rooms, &c., for the operators. This saving had not been referred to in the Paper. The automatic system had a further advantage in relieving the telephone service from the imputation, rarely deserved, of the delay in completing calls on the part of the operators. The subscriber made his own call, and knew that any following delay was entirely due to the person called not attending promptly to the telephone. The arrangements for machine switching had been worked out to give practically an identical service with the manual board, the only difference being in relation to the need for the handling of traffic by operators on the manual board in connection with certain differential rates for the use of junctions and the trunk service. Self-contained towns seemed to him to give the best results in the economy of operating staff which was brought about by the absence of junction circuits to other exchanges, unlike an area served by multi-exchanges. The case of Dudley from this point of view was not entirely satisfactory, as it was a single exchange in a large multi-exchange area with an exceedingly large number of junction circuits in comparison with the number of direct exchange lines connected, and this called for the employment of a comparatively large number of operators on the manual switchboard fitted in addition to the machine switching gear. Of course, this was working the automatic system under the greatest disadvantage from an economic aspect, and if the results proved satisfactory at Dudley they would be much better under more normal conditions. He (Mr. Plummer) agreed with Mr. McBerty in his conclusions on page 26 as to the maintenance of machine switching. His experience was that the type of skilled men employed in dealing with the maintenance of ordinary common battery exchanges of the larger type were fully capable of handling automatic exchanges, and there was no need for the special training of such men in workshops where the manufacture and assembly of the apparatus took place. The figures relating to the maintenance man-hours seemed rather low, but Mr. McBerty had explained that they referred to the moving switches only. Locally such low figures had not been reached. Another point concerning maintenance costs was that when odd automatic exchanges were installed, relatively high costs must be expected, as a certain number of men had to be trained in excess of the actual requirements so as to be available in case of emergency through sickness, &c. This factor would disappear as the type of exchange became more general and a margin of trained staff would then be available for emergencies.

Mr. R. G. Masaroon (P.O. Engineering Dept.) said that he had observed one feature in working an automatic telephone exchange to which there was no allusion in Mr. McBerty's Paper; nor, indeed, in any literature he had seen on the subject. It was the fact that the subscriber was given something to do in getting his call through. He thought that inventors in the past had been too leniently disposed towards the subscriber by relieving him of the necessity of doing anything except lift the telephone from its rest and speak. It was notorious that after a change over from the magneto system to central battery working subscribers frequently complained of the delay in answering calls, although the service under the new conditions was superior to what it had been under the old—*i.e.*, the answering time was less. This had proved to be due to the subscriber having nothing to do but wait after putting the telephone to his ear, whereas in a magnetic system there was a handle to turn, and the time passed more quickly. He would like to ask Mr. McBerty whether any means had been devised for redistributing the lines for outgoing traffic. Any redistribution which necessitated changing subscribers' numbers was out of the question, and the rigidity of the automatic system in this respect appeared likely to be the cause of difficulties in adjusting traffic to meet abnormal conditions.

Digitized by Google

Mr. W. C. BURBRIDGE referred to the re-action which the extension of the automatic telephone system was expected to have on the design of external plant, and emphasised the saving in the comparatively heavy conduit and cable cost which would ensue from the placing of small automatic units, requiring only occasional attention in suburban areas, and the connecting of such to the central automatic exchange by a limited number of "trunks." He inquired whether the United States administrations, with their longer experience of automatic plant, had experimented in this direction.

BRITISH SCIENCE GUILD.

The eleventh Annual Meeting of the British Science Guild took place at the Mansion House on Monday, April 30, at 4 p.m., the Lord Mayor being in the Chair.

The proceedings were opened by Sir William Mather, the President, who referred briefly to the work carried out by the Guild over many years in labouring to remove the neglect of science in this country, and encouraging, through its various committees, the application of science to industry.

Sir BOVERTON REDWOOD moved the adoption of the annual report, the election of Lord Sydenham as President and of the Lord Mayor as Vice-President of the Guild and the election of the Executive Committee. These items were seconded by Prof. R. A. Gregory and carried unanimously. Sir Boverton and Prof. Gregory referred to various points in the annual report, a feature being the exceptionally large number of important steps to be recorded in the development of machinery for securing co-operation in scientific matters. The report contained a summary by Sir Charles Bedford of the aims of the Committee on "The Relation of Science to Industry and Education," a proposal being the establishment of a central propaganda office in London, with local agencies in the chief provincial cities. Reference was also made to the work of the Metric System Committee, while in connection with technical optics, a synopsis was given of the report of the Board of Scientific Societies on Technical Education in Optics, recently noticed in these columns. There was also a brief account of the now considerable number of scientific committees working in conjunction with the Government. In referring to the important step taken by the Government in establishing the department for scientific and industrial research, Prof. Gregory drew attention to the corresponding efforts being made in Canada, Australia and the United States.

The CHAIRMAN then called upon Lord Sydenham to deliver his address on "National Reconstruction."

The British Science Guild, Lord SYDENHAM remarked, acted as a clearing house for scientific thought. The aims which it had advocated for many years were now being gradually realised. The war had revealed very clearly our lack of forethought and scientific preparation, although the national genius for improvisation had gone some way to neutralise this defect. Apart from direct shortcomings in the application of science, such episodes as the Dardanelles Commission's report and the difficult question of handling man-power showed a want of that grasp which sound scientific training can confer.

In the future there would be a great need for the application of scientific knowledge and method in developing the resources of the Empire. The Empire could produce all the great food staples and had almost a monopoly of many minerals and rare earths. In industrial matters the need for more scientific method was equally evident. There had been too much individual effort, too little concerted action. What was needed was a great industrial federation, on the lines of the "Central Verband," developed by the Germans from 1875 onwards. Of great importance was the development of sources of power. The British Association had indicated methods by which over 50-million tons of coal might be saved per annum, and in Scotland there was water-power sufficient to develop one million horse-power.

Turning to education, Lord Sydenham urged the need for continuation classes and technical schools enabling young people to follow up their education to a later age. Scientific and technical education did not involve divorce from the "humanistic studies." Finally, there was the need for developing the moral and civic instinct and the elimination of the mutually destructive strife of parties and individuals which hindered the application of lofty patriotism and trained intelligence to the urgent problems arising from the war.

The Rt. Hon. H. A. L. FISHER said that one of the great difficulties in the past had been to present scientific teaching in such a way as to grip the imagination of children, and induce them to make practical use of it in after-life. Throughout industry one saw evidence of the want of scientific method. Business men were apt to rely upon a certain "flair" rather than predetermined plan and proved method. Only scientific education on a great scale could remove the general indifference to the value of science in industry. Dealing with technical training as a continuation of elementary education, Mr. Fisher remarked that the war had shown how readily those with a training of this kind responded to the call of duty; scientific training, he thought, would in itself go far towards supplying the sense of duty and self-discipline which were needed to-day.

It was necessary to encourage outside experience on technical matters, to pool all available knowledge. Yet he thought there was a certain danger in uninformed criticism, of which he had had some experience in considering the charges sometimes levelled against industrial workers during the recent period of anxiety. In some cases workers had been impelled in this way towards overstrain.

There could be no question that after the war science would be urgently needed and there would be endless opportunities for its application in making good the losses which the present strife had caused.

Mr. H. G. WELLS contended that the great defect in existing education was the excessive time allotted to classical studies in the public schools and the dominance of the classical element throughout both the schools and the universities. He had no wish to limit the activities of those who felt a call towards the study of such subjects; he only protested against the undue subjection of other fields of knowledge to the classical studies.

At the present time it was obviously impossible to allot adequate time to science, modern languages and general knowledge of future industrial value in a curriculum in which Latin and Greek filled so large a space. Not only was the education in schools stultified by this predominance, but the effect was perpetuated by the greater encouragement given to classical studies through scholarships and in the public services. The result was that those in whose hands the guidance of the country's destinies rested were warped by this influence and were without a proper appreciation of scientific knowledge and method. Moreover, by insisting on the study of philosophy through the medium of the dead languages the present educational system barred the study of philosophy by the ordinary man. He felt, therefore, that before any lasting progress in education could be made this dominating influence of the classical tradition must be removed.

A vote of thanks to the Lord Mayor and to Mr. Fisher closed the proceedings.

CORRESPONDENCE.

THE NATIONAL ELECTRICAL SAFETY CODE.

TO THE EDITORS OF THE ELECTRICIAN.

The Editorial in the February 9th edition of THE ELECTRICIAN relative to the National Electrical Safety Code has been read with interest, but with some disappointment.

Apparently the magnitude of the code has deterred the writer from such a careful study of it as would enable him to appraise the code on its merits as a guide to safe electrical practice. The editor speaks first and last of the bulk of the code and what appears to him an excess of detail. It is even wondered if the conduct of the electrical industry will not be embarrassed by the constant necessary attention to the rules.

It would appear that the writer is under some misapprehensions as to the influences surrounding the electrical industry in the United States and the state of development of that industry, the extent of the electrical accident hazard and the wide variations in practice. He finds naturally, as he states, a difficulty in comparing the safety code with the wiring rules of Great Britain, or with the Home Office rules. This is not strange, since the code embraces not only the subject matter of both the sets of British rules referred to, but also of several other sets of rules in effect in Great Britain. The safety code should not be compared with any one set of rules, but with the code, which might presumably result from a unification of all existing British electrical rules, exclusive of those bearing only on the fire hazard.

Bulk.—It should be noted that the rules of the code occupy only 175 printed pages, instead of 323, the remaining matter consisting of tables and about 100 pages of notes and discussion explaining the rules. Similar and relatively much longer memoranda were issued by the British Home Office to accompany the early editions of their "Electrical Regulations." In this connection it should be recalled that the different sets of British rules usually state that certain features of the installations must be taken up with the administrator before the construction is begun. The effort in the safety code has been to leave room for as few inconsistencies in practice between different administrative jurisdictions as possible, which, of course, arise from the necessity for frequent rulings of administrators on points not made sufficiently clear in the rules themselves.

The utilisation part of the code comprises but 28 pages, while the wiring rules of the Institution of Electrical Engineers,

Digitized by Google

which in most respects parallel this part of the code, occupy some 35 pages. But the safety code covers also the subject of stations, which is not covered in the wiring rules, and is not clearly differentiated in the Home Office rules from utilisation installations, although the freedom from industrial processes and the electrical training of the operators make a less rigid safeguarding permissible for equal safety.

The code also covers overhead and underground transmission and distribution lines, which are treated in Great Britain in several more or less overlapping sets of regulations, which, however, leave many important gaps. In fact, it seems quite apparent to one endeavouring to familiarise himself with British regulations that their lack of codification is responsible for so many gaps and incongruities that only long usage, unified inspection and general respect for authority has rendered these rules measurably sufficient for British needs in the development of electrical applications. Interior wiring in this country has developed side by side with a fire code of 224 pages, which, although as specific as the National Electrical Safety Code, is without accompanying discussion. The extended study and public discussion of the code through which it was developed resulted in the addition of many details, making the rules more explicit and providing alternatives and exceptions, so as to avoid as far as possible misunderstandings between administrators and those to whom the rules apply.

It is believed that the codification of existing British rules and the expansion into readily understood terms of rules now expressed in such general terms as to require definition through precedents might well be of advantage to their users. Of course, much detail on pole wiring and climbing space may be omitted in British practice, where men do not work about live lines; but in this country such work is essential to the service, and duplication of lines to obviate necessity for work about live lines would be prohibitive in cost in most communities. Rules for reasonably safeguarding workmen on live lines are, therefore, essential.

Obviousness and Common Sense.—If the writer of the Editorial had known that 25 per cent. of all accidents in supply stations of this country are caused by slipping, tripping or falling it might have appeared to him that common sense is not so commonly applied as to warrant the omission he suggests of the specific rule on the subject included as a guide both to inspector and to building occupant. Home Office regulation 17 and its note recognise this, and include quite specific requirement for good footing, but less general in application, referring only to switchboard passage-ways. It may be stated that our careful study for several years of the Home Office regulations has increased our appreciation of them, and so far as seemed feasible, considering the great differences in practice, administrative limitations and necessities for development of electrical business in the two countries, we have made use of many of these requirements and their well-arranged memoranda.

As to the requirement in the code for periodic inspection, which you consider unnecessary, this requirement is largely paralleled in the Home Office regulation No. 1 and its long discussion, except that the code is more definite with regard to the action to be taken whenever the deterioration or changes which are bound to occur in equipment have made its use dangerous. The code simply makes clear what is "reasonably practicable" in the way of "maintaining apparatus and conductors so as to prevent danger." It is apparent that the points in Rule 1 of the Home Office regulations are largely common sense; but our experience goes to show that, far from being encumbered by explicit statement, such general rules are made clearer and more useful by a reasonable amount of detail.

We are led to ask what is the "good standard practice" to which you refer, which may be relied on and which makes specific rules unnecessary. Our experience shows that without definite guide there is no definite standard; that has certainly been the case in this country. Interior wiring under the National Electrical (Fire) Code, issued by the National Board of Fire Underwriters, has been well standardised, probably as adequately as has been the case under similar rules in Great Britain. Line construction is found to vary in strength and in clearances in this country, according to the so-called common sense of local company officials of local authorities, the strength for overhead lines of 2,300 volts above busy city streets, for instance, not being specified at all, prior to the National Electrical Safety Code and in important cities being, in absence of any guide, sometimes found to have as little as one-tenth of the maintained strength called for by the Board of Trade rules for overhead lines of medium pressure in much less congested locations.

Extent of Electrical Danger.—On account of this dependence on the unguided common sense of those concerned in the electrical industry, and of those who undertook to administer varying, incomplete and especially uncodified rules in the various administrative jurisdictions, states or cities, the electrical fatalities from overhead lines in this country amounted in 1913 to approximately 600, while those in stations, factories and other places where electricity is handled were about equal in number. It was quite evident that the companies and the administrators did not have sufficient understanding of the hazards or sufficient guide for their abatement. The non-fatal accidents, of course, were very many more. It must be remembered, too, that it is frequently the worker, not the company or administrator only, who determines from a study of the rules whether safety is assured or not, and who brings hazardous conditions to the attention of those in authority.

Possibly a less number of provisions and a less specific treatment may ultimately prove advantageous, although experience may show that the opposite course will give the best result. The whole matter is so closely concerned with the cost of the installation that a detailed and specific treatment becomes necessary to avoid the varying interpretations which would be put upon less specific requirements by unco-ordinated inspection agencies, as well as by those to whom the rules apply. It must be remembered that, besides many municipal and insurance inspection agencies, there has been a great increase recently in the number of State, public utility and industrial commissions having jurisdiction over this matter, and such newly organised administrations have naturally need for a more detailed guide than longer established and more unified administrative agencies.

Correctness, Adequacy, Reasonableness.—We would have been particularly pleased if the Editorial had instituted comparisons of the code requirements with British practice. It is believed that no set of rules has ever been based on so thorough a study and so full public and private discussion to assure correctness of the data and adequacy and reasonableness of the provisions of the rules. Their reasonableness has been constantly under comment during two years past by those to whom they apply and who are, therefore, greatly concerned in the matter of cost and difficulty of complying with the rules. A comparison will show less stringency in many respects than corresponding British rules. Overhead line construction would have been so hampered in this country by enforcement of British strength requirements that many parts of the country dependent on electrical distribution could not have been developed electrically. The growth of the electrical industry would thus have been much more restricted than in Great Britain, where so much more of the country is closely built up and greater cost per mile is justified.

We shall be very glad to have you publish the foregoing statement, and to extend our invitation to your readers for constructive criticism of the code, based upon experience and careful comparison of the requirements of the code with their own practice. It is the nearly unanimous opinion of those most competent to judge in this country that the code is not too detailed or unnecessarily bulky, and the more it is studied the better impression it makes upon American readers and users.

Bureau of Standards,
Washington, April 4.

S. W. STRATTON,
Director.

Digitized by Google

THE EDUCATION OF APPRENTICES.

TO THE EDITORS OF THE ELECTRICIAN.

In your issue of April 20th Mr. R. W. Paul criticises the proposals made in my article on "Technical Education," which you published on April 6th (but which, I may say, was written in October of last year).

Before considering Mr. Paul's letter, I wish to express appreciation of your own enthusiastic sympathy on behalf of the welfare of British boys, but to take exception to your reference to Great Britain as "this barbaric country."

I had thought of asking if you could spare me space to deal in detail with Mr. Paul's letter, but two reasons make me refrain: The first is that the letter seems to contain inconsistencies, and the second is that it enables me to form only a vague idea as to what Mr. Paul's own educational proposals are. I take it that his proposals, whatever they may be, are suggested as a cure for "our present troubles," whatever these may be. Experience has shown that a man's success in curing troubles depends greatly upon the accuracy of his diagnosis of their cause. Mr. Paul says "our present troubles result from the superabundance of soft jobbers in all walks of life, the legacy of a long peace." I regard Mr. Paul's judgment in this matter as at fault. So far does my own opinion differ from this that I believe the good things the world needs will come only as "the legacy of a long peace."

The assumption that peace brings lack of virility has led to the writing, by able men, of much that is unwise, an entertaining example of which I cannot refrain from quoting. The great Treitschke wrote: "One of the short-comings of English culture lies in the fact that the English have no universal military service. This fault is in some measure atoned for, on the one hand, by the extraordinary development of the Fleet, and on the other by the never-ending little wars in countless colonies, which occupy and keep alive the virile forces of the nation. The fact that great physical activity is still to be observed in England is greatly due to the constant wars with the colonies. But a close view will reveal a very serious want. The lack of chivalry in the English character, which presents so striking a contrast with the naive loyalty of the Germans, has some connection with the English practice of seeking physical exercise in boxing, swimming and rowing, rather than in the use of noble arms."

If Mr. Paul really believes "our present troubles" are, even indirectly, due to a long peace, I think it waste of time to listen to his proposals for their cure. Our object, who are trying to educate boys, is to help the normal ones amongst them to get the best out of life, and some of us feel that, to get this best out of his life, a boy should have from the State at least as much care and attention as the State would give to a steam engine. Low commercial efficiency and short life result from working at excessive pressure with infrequent renewals and overhauls. We demand that, so far as possible, the State shall assure to those boys whose guardians cannot do so the same efficient conditions of training for a useful life's work as are the lot of the well-to-do.

In conclusion, I should like to say that I have always regarded Mr. Paul as one of the comparatively few men who have the problem of engineering education actively and enthusiastically at heart. Mr. Paul has spared neither trouble nor expense in a practical endeavour to train his apprentices.

London, April 24. F. M. Denton.

"READING BY EAR."

TO THE EDITORS OF THE ELECTRICIAN.

In view of the conflicting reports in the non-scientific press regarding the possibilities of my type-reading optophone, please allow me to state:—

1. That the possibility of reading an ordinary newspaper correctly by ear has now been established under the most rigid test conditions.

2. That the speed attainable is still an open question, my estimate of 25 words a minute being based upon the fact that the characteristic sounds remain clear at that speed.

3. That the difficulty of learning and reading is the same as that encountered in Morse signals.

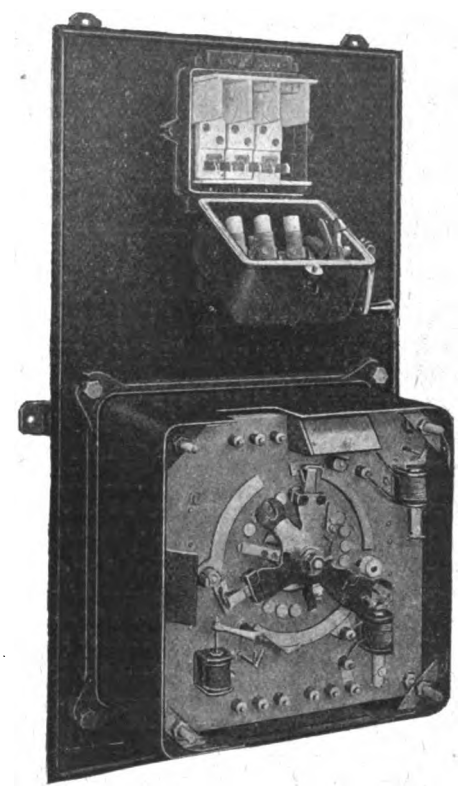
The optophone now used is substantially the same as that described in Roy. Soc. "Proc.," A. 90, p. 373.

London, April 20. E. E. Fournier d'Albe, D.Sc.

B.T.-H. MOTOR CONTROL PANELS.

List No. 3,265, issued by the British Thomson-Houston Co., Ltd., gives particulars of the latest types of motor control panels for alternating current.

The panels (as seen in the illustration) combine in a convenient form the apparatus required for starting and controlling stationary polyphase slip-ring induction motors, are specially designed to meet the Home



B.T.-H. Motor Control Panel.

Office requirements and carry no exposed live metal on any part of the equipment.

The equipment consists essentially of a base plate carrying starting rheostat and switch fuse. Standard panels are available for motors up to 550 volts, 25-60 cycles, and carrying a stator current, not exceeding 48 amperes at full load.

SPRACO PRODUCTS.

We have received from the Spray Engineering Co., of Boston, Mass., a general catalogue description of the "Spraco" products and their application in the form of sprinklers, air washers and sprayers for various purposes.

The chief feature of the various devices is the production of a very fine spray through specially designed nozzles. The liquid in passing through the nozzles is given a rotating motion by a turbine centre and is driven forth through the orifice as dense uniform spray by a central driving jet. A diagram illustrates the increase surface treated owing to the smaller sized drops.

Apart from their use for water-spraying, *e.g.* on lawns, parks, and for general irrigation, the system has many special applications. In the form of an air-washing and cooling equipment it is applied to electrical generators for cooling water in condensers, jackets, &c., and for evaporation generally. It is designed also for spraying paint and asphalt by compressed air action and has been used for such special purposes as aerating and purifying water, atomising liquids, sulphurising beet sugar juices and spraying brine for refrigeration.

Digitized by Google

PARLIAMENTARY INTELLIGENCE.

EMPLOYMENT OF DISCHARGED SOLDIERS.

In the House of Commons last week, Mr. ANDERSON asked the President of the L.G. Board whether he has received a communication from the Marylebone and District Trades and Labour Council in regard to the employment of wounded soldiers at less than a standard rate of wages by the electricity department of the Marylebone Borough Council; whether it was the view of his department when discharged soldiers were employed by a local public body that their State pension should be taken into account in deciding what wages should be paid them; and, in view of the objections to such a practice, what steps he intended to take?

The PARLIAMENTARY SECRETARY to the L.G. Board (Mr. Hayes Fisher) said he understood that a few disabled soldiers were employed by the electricity department of the St. Marylebone Borough Council on work which, notwithstanding their disability, they were able to perform, and that they were paid a fair and reasonable wage and given the benefit of the Council's scheme as to sick pay and superannuation. A Trade Advisory Committee, consisting of an equal number of representatives of associations of employers and workpeople, had been formed (jointly by the Minister of Labour and the War Pensions Statutory Committee) to give advice upon questions relating to the training and employment of disabled sailors and soldiers as electricity sub-station attendants; and he was informed that the matter had been considered by the Committee, who had reported that the rates of wages which were being paid by the Council to the men in question had been determined without regard to their pension, and were the same as the rates that were paid in pre-war times, with an additional war bonus of 2s. In reply to the latter part of the question, the matter was not one in which the Board would be empowered to take any action.

LEGAL INTELLIGENCE.

G. W. Fowler v. Midland Electric Corpn. for Power Distribution.

Last week the Court of Appeal (the Master of the Rolls and Lords Justices Banks and Warrington) dismissed defendant company's appeal against a judgment of Mr. Justice Eve in favour of plaintiff. The question was whether a company which did not appoint a particular place for payment of its debentures was under an obligation, on the death of the registered holder of debentures in the company, when the date for paying arrived, to seek out the personal representative of the deceased debenture holder and pay to him the principal moneys secured by the debentures. Plaintiff, as executor of Miss Mary Jane Fowler, claimed £1,800 for principal and £115 for premiums due on 18 debentures issued by the defendant company to Miss Fowler of the value of £100 each, together with interest at 4½ per cent. per annum from June 30, 1913, the date when the debentures were to be paid off, down to the date of actual payment.

The MASTER OF THE ROLLS, at the close of appellant's case, said they need not call upon counsel for respondent, as they were of opinion that Mr. Justice Eve's decision must be upheld. There was clearly a legal right to interest under an express warrant for payment until the capital moneys were repaid. There was no special obligation on the part of the executor to register the probate with the company at once; all he had to do was to prove his title as executor.

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Lieut.-Colonel C. B. CLAY, V.D., Commanding.

Orders for the Week.

Officer for the Week.—Second-Lieut. Bowden.

Next for Duty.—Lieut. W. J. A. Watkins.

Resignation.—Lieut. H. de P. Birkett resigns his appointment.

Monday, May 7.—Technical for No. 3 Co., right half company, at Regency-street; Drill, No. 3 Co., left half company. Signalling class.

Tuesday, May 8.—Lecture, 6.30; physical drill and bayonet fighting, 7.30 to 8.30.

Wednesday, May 9.—Drill, No. 1 Co., left half company, 6.15.

Thursday, May 10.—Drill, No. 2 Co., left half company; Ambulance class, by M.O., 6.30. Signalling class.

Friday, May 11.—Technical for No. 3 Co., left half company, Regency-street Drill, No. 3 Co., right half company; recruits' drill, 6.30 to 8.30.

Saturday, May 12.—N.C.O. Class, 2.30, examination by Adjutant and Assistant Adjutant.

Sunday, May 13.—Special work at Bombing School, parade Clapham Common Station (City & S.L. Tube Railway), 9.45 a.m. Midday rations to be carried. As this work is very important, the Commandant would like to see much larger parades.

Armlets.—Armlets must be worn at all plain clothes parades.

Musketry.—For all companies see notice at Headquarters.

Note.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street, W.).

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

3,737 RELAY AUTOMATIC TELEPHONE CO. & HERINK. Automatic and semi-automatic telephone systems. (13/3/16.) (Cognate application, 12,971/16.) 104,892.

4,049 SHEPPARD & BRITISH EVER-READY CO. Casings for electric batteries. (18/3/16.) 104,900.

4,143 LYON. Searchlights and like apparatus. (20/3/16.) 104,907.

4,184 LONGFORD, LONGFORD, CLARK & MORRIS. Electrical distributing systems depending on the use of condensers. (21/3/16.) 104,909.

The invention comprises an electrical distributing system involving a plurality of conductors, each appertaining to a spark-gap, and being connected to a system of condenser plates, the system of condenser plates appertaining to the several conductors being isolated from each other, the said system of condenser plates constituting the one element or series of elements of a compound electric condenser or a series of electric condensers, the other element or elements of said condenser or condensers comprising a system or systems of plates which are insulated from the plates of the first-mentioned systems, and which are connected with a common electric supply conductor.

4,196 STONE & CO. (Rohman.) Means for indicating the state of adjustment or output of dynamo-electric machines. (21/3/16.) 104,910.

4,275 CARPENTER. Burglar alarm systems. (22/3/16.) 104,918.

4,376 CHAMBERLAIN & HOOKHAM & JAMES. Maximum indicators for electricity speed and other registering apparatus. (24/3/16.) 104,924.

4,467 GUEDATARIAN. Interrupters or contact make-and-break mechanism for magnetos. (25/3/16.) 104,931.

6,823 MORRIS & WHITHAM & ALLISON. Automatic machine for the manufacture of stems for metallic filament electric lamps. (12/5/16.) 104,962.

8,128 B.T.-H. CO. (G.E. Co.) Electric motor control systems. (8/6/16.) 104,979.

A system of control for an electric motor having a series field, comprising a starting resistance adapted to be connected in series with said motor at starting and cutting out of circuit as the motor speeds up, means for reducing the field strength of said motor, means responsive to the current in the motor circuit for operatively connecting the field, reducing means in shunt to the motor armature when the current in the motor circuit falls to a pre-determined value, and means responsive to the current through the starting resistance for preventing the connection of the field reducing means in shunt to the motor armature until the starting resistance has been cut out of circuit.

10,142 PARSONS. Pendulum indicators for use with electric bell systems or for other purposes. (19/7/16.) 105,004.

11,125 COLE. System of electrical distribution. (12/8/15.) 101,151.

Relates to protective devices for use in electrical distribution systems having a plurality of parallel-connected conductors grouped in feeding sections subject to power flow in either direction, comprising relays for disconnecting the conductors from the system either singly or in pairs, which relays are arranged to be inoperative so long as the ratio of the currents in the conductors of any associated pair of conductors remains within a pre-determined limit, but which become operative to disconnect from the system either one or both of the conductors of said pair whenever the ratio of the currents carried in the conductors of said pair exceeds a pre-determined limit due to an increase or a decrease or a reversal in direction of the current in either conductor of said pair relative to that in the other conductor.

11,191 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electric motor control systems. (8/8/16.) 105,013.

12,999 MAYER & CROXON. Telephone appliance. (13/9/16.) 105,028.

13,585 DETRAUX. Means for carrying electric cables. (23/3/16.) (Divided application on 4,353/16.) 105,029.

14,524 HANSSEN. Apparatus for electrically sterilising foods. (12/10/15.) 101,804.

17,923 PLETSCHER. Electric pocket lamps. (18/11/16.) 105,046

1917 SPECIFICATIONS.

449 BETHENOD & GIRARDEAU. Stators of electric generators. (10/8/15.) (Divided application on 10,576/16.) 103,658.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

February 22, 1917.

2,601 PREECE. Artificial cooling of motors and generators.

2,617 MCCOLL. Protective devices for a.c. systems.

2,620 PECKHAM. Electric massage generators, &c.

2,623 REYROLLE & GREGORY. Tanks for oil-break switches.

2,624 ELECTRICAL IMPROVEMENTS (LTD.) & GREGORY. Oil-break switches.

2,639 GRAHAM. Electric signalling, &c., apparatus.

2,650 ARON & HILL. Combined electric generating and self-starting mechanism for motor vehicles.

2,656 BEAUVAIS & BRILLOUIN. Receiving apparatus for wireless telegraphy. (27/3/16, France.)

2,657 BEAUVAIS & BRILLOUIN. Wireless telephone installations. (7/11/16, France.)

February 23, 1917.

2,674 FOREMAN. Fittings or supporting combinations for electric lighting, &c.

2,691 B. T.-H. CO. (G. E. Co.) Controllers for electric circuits.

2,701 GARIN. Electrolytic treatment of copper and nickel ores. (29/2/16, France.) February 24, 1917.

2,718 ALLAUN. Pocket electric torches or flash-lamps.

2,740 MORRIS. Electrostatic machines.

2,741 MORRIS. Electrostatic generators.

February 26, 1917.

2,779 FALKIRK IRON CO. & NOBBS. Electric heaters for use with internal combustion engines, &c.

2,785 WAYGOOD-OTIS. (Otis Elevator Co.) Electric lift system.

2,788 WILSON. Apparatus producing or utilising electric oscillations.

2,802 ASSERSON & CARTER. Telephone system.

2,803 HASLAM. Contact fingers.

2,807 BOVING. Electric furnaces.

2,838 BONORA. Primary batteries.

February 27, 1917.

2,851 POPPER. Electrolytic recovery of metal from scraps.

2,865 WEBSTER. Electric water heater.

2,874 LUCAS. Receivers for wireless telegraphy.

2,878 ALEXANDER, IMBERY & VINT. Heating, melting and annealing metals by electricity.

2,890 MAZZA. System of telephony.

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Development of Foreign Trade. A special meeting of the directors of the Glasgow Chamber of Commerce was held on Monday in order to consider a communication from the Association of Chambers of Commerce with respect to the distribution of confidential information regarding trade openings for British traders in foreign countries, particulars of which are being collected by the Foreign Trade Department of the Foreign Office from British Consular officers abroad.

The President (Mr. J. W. Murray) said that they would be aware that a Foreign Trade Department of the Foreign Office was established some time ago, principally (he understood) for the collection of information regarding firms abroad with whom persons in this country were prohibited to trade. A quantity of other information had been collected by the Foreign Trade Department. Many firms in this country had had their trade channels in good markets cut off by the statutory lists, and the idea was to assist such firms and other firms who desired to extend their foreign connection to find alternative channels of trade and obtain particulars of the people who desired to purchase their goods. The Foreign Trade Department desired the co-operation of Chambers of Commerce in the dissemination of that valuable information, and each chamber had been asked to decide whether they would agree to the conditions laid down and take part in the scheme. The idea was to make each chamber individually responsible for seeing that the information supplied was given only to manufacturers and dealers in British goods who were members of the chamber and whose names were approved by the Department. If they agreed to assist in the work, and he was sure they would, they would be further required to agree to distribute the information to interested firms immediately. Our Consuls would play an important part in obtaining the information it was considered desirable to circulate, and the consular reports, oftimes dreary and always belated, which we had been accustomed to for so many years, and which were in many respects useless, would probably disappear when the new system became operative. Special machinery for the collection of information, which was extremely simple and ingenious, had been invented. He explained the object of certain forms proposed to be adopted for the work. On form C the Consul would enter certain important facts concerning the district to which he was attached; also particulars relating to weights and measures, currency, distributing centres, ports of supply, population, value of imports and exports, &c. The form also became the general cover for further information collected about individual firms in the consular district through form K. The first part of the latter form dealt with local firms who desired to enter into trade relations with the United Kingdom, and which firms were recommended by the Consul. The second part related to the principal competing firms in the district who were not recommended. The information relating to recommended firms would be given on the following lines: Names and nationalities of partners, financial standing, commercial reputation, names of local bankers, European references, general nature of the firm's business, principal goods required (important immediate requirements would be made known by cable), mode of transport and route from port to locality, &c. Similar information would be given regarding competing firms not recommended. He considered the scheme to be one of the most important steps for developing foreign trade which had been undertaken by the Government, and he thought it was clearly their duty to assist the Government, and also the traders in the city and district, by cordially agreeing to co-operate in the scheme. He moved that they inform H.M. Government that they would cordially co-operate with them in the important scheme which they had devised, and that they undertook to provide the staff and accommodation necessary for supplying their members without delay with the information when it came to hand.

The resolution was seconded, and unanimously agreed to.

* * * *

Patent Law Reform. We understand that a Departmental Committee is considering the important question of the reform of our patent law, and that certain amendments will be proposed as soon as the war is over. For an engineering and industrial country a good patent system is essential, but in view of the movement for the development of the trade and resources of the Empire we hope that the possibility of the introduction of an Imperial patent, to cover the whole of the Empire, will not be forgotten when reforms are being made. We are glad that Sir Robert Hadfield raised the subject in his recent presidential address to the Society of British Gas Industries.

Sir Robert said he attributed much of America's industrial success to the excellence of her patent system. An American, for the small fee of about £7, including the final payment, could obtain patent protection for no less than 17 years from the date of issue of the patent. That patent monopoly for a new idea which would indirectly benefit not merely the patentee but the users of the invention, held good throughout the whole of the 52 American States, and covered country representing an area of some 3,000,000 square miles, and embracing a population of not far short of 100,000,000 people. At the present time within the British Empire, to get full protection required no fewer than 40 separate patents, the total cost of which, for a much smaller term of years—only 14 in Great Britain or Ireland—was about £1,340. The total charges, what with special Government fees, agents' expenses, patentee's expenses, would probably increase the cost of one patent to something like double that amount; that was, to something over £2,000 for one patent, including Government fees, also general expenses and charges. There was unquestionably a close connection between the fact that American patents were obtainable for about £7, and for 20 per cent. longer time, as compared with the practice of this Empire, and the way in which America had gone ahead and developed her material welfare and industry. He looked forward to the time when it would be possible to obtain one patent for the whole of the Anglo-Saxon speaking race. That may be yet far off in the future, but there seemed no reason why a unification of the patent system to cover the whole Empire should not be taken in hand immediately the exigencies of public affairs permitted of it. The loss of revenue entailed in adopting a lower scale of patent fees for the larger area would be trifling, and in any case ought not to be allowed to weigh for a moment. The return which a patentee made for the monopoly accorded him was the furnishing to the public of full particulars of his invention. To charge him fees in excess of such as might be required to maintain the patent office was simply to place a tax on inventiveness—perhaps the worst of all conceivable forms of taxation in its effect upon industrial development.

We are in entire agreement with Sir Robert Hadfield in his desire to see an Empire patent system introduced. There are no insuperable difficulties in the way, for the term of a patent in India, Australia, the Union of South Africa, and the principal colonies is 14 years. In Canada, however, the term is 18 years, and in the United States 17 years. The present period in this country is held by many to be too short to allow of the patentee reaping a suitable reward for his labour and skill, and when changes are being considered it might be desirable to fix a uniform term of, say, 16 years for the whole of the Empire. An Empire patent would also involve uniform practice as to the working of patents, fees payable, &c., and with a little mutual concession these things could be arranged.

* * * *

Electric Power for Factories. Shortly after the outbreak of the war we impressed upon electric supply authorities the necessity of taking steps to provide an adequate supply of electrical energy for power and industrial purposes, and on more than one occasion we have appealed to the Government departments interested to give reasonable facilities for borrowing the money necessary for carrying out extensions of plant and mains. At the time of the outbreak of war the demand for electric power was developing at a rapid rate in many industrial areas, and the war has greatly accentuated this demand. At the outset the Treasury restrictions upon the raising of new loans so impressed certain local authorities that even urgent schemes of extension were either postponed or abandoned, with the result that as the war developed, and the demand for power exceeded all expectations many supply authorities found themselves in difficulties, and new consumers could not be connected up. Owing to this short-sighted policy some firms have been compelled to put down their own generating plant, and as these isolated plants cannot be so economical as one large supply station, the result is waste of fuel and extravagance. The position of Lincoln may be cited as typical of many electric supply undertakings. At the recent meeting of Clayton & Shuttleworth (Ltd.) the managing director (Mr. P. W. Robson) said that the Corporation were unable to give them an adequate supply of electrical energy, and they had to provide a new power station for their own requirements. They had experienced difficulty in obtaining the necessary plant. It was a matter of regret if in an important area like that every establishment had to set up a separate power station, when one could supply the whole community.

* * * *

The Metric System. It is announced that Lord Balfour of Burleigh's Committee on Trade after the War has been strengthened by the addition of Sir William Pearce, Sir Charles Henry, Sir Archibald Williamson and Sir William Priestley.

The Committee are at present investigating the question of the possible substitution of the metric and decimal systems for our existing coinage, weights and measures. Already a great deal of evidence has been taken on the working of the metric and decimal systems in various countries.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Chester.—The L.G. Board have sanctioned a loan of £4,500 for the extension of the supply cables to certain engineering works in the neighbourhood.

Hanley.—The Board of Trade have authorised a supply of electric current being given to Messrs. Bullers (Ltd.) in the Rural District of Leek and to the British Aluminium Co. in the Smallthorne Urban District.

Permission has been given to Mr. J. W. Hartley to take a supply of current from the Potteries Electric Traction Co., subject to the interests of the Corporation being protected.

Luton.—The electrical engineer (Mr. W. H. Cooke) reports that at an early date it will be necessary to lay additional mains to augment the supply to some large works.

St. Pancras (London).—Recently an application was made for sanction to borrow £5,000 for the purchase of a turbine, but the L.C.C. is questioning the necessity for the expenditure at present.

St. Pancras Finance Committee point out that it is absolutely essential to purchase the turbine, also that the Government have granted a class A priority certificate for the work.

The staffs of the generating stations and of the mains department have applied for increased wages, and a special committee is to be appointed to consider the matter.

Owing to a clerical error made by the Brush Electrical Engineering Co. the amount to be paid the firm for the conversion and purchase of the turbine at King's-road is to be increased from £5,000 to £5,840.

Salford.—Application is to be made to L.G. Board for sanction to borrow £8,065 to cover the cost of plant, &c., required to give a supply of electrical energy to the Manchester Ship Canal Co. at Irwell Park Wharf. The Board of Trade are also to be asked to sanction the supply, as the district is in Eccles.

Todmorden.—The Council have resolved to apply for sanction to borrow £10,000 for an additional generating unit for the electricity works.

In the course of the discussion on the proposal Councillor Greenwood, chairman of the Gas Committee, said some of their members were jealous; they were not afraid of competition, but they objected to the Electricity Committee being subsidised by the rates, so that they could sell current at one-third of its cost. To spend another £10,000 would be saddling them with a white elephant.

Councillor Brook (chairman of the Electricity Committee) said the present plant was five years behind the times. The Gas Committee had been allowed "to rule the whole show," but he should push the new scheme whether it meant decreasing the gas customers or not.

GENERAL.

Hanley.—Mr. B. Hudson, a charge engineer, recently resigned but the Electricity Committee refused to grant a leaving certificate.

The engineer and manager (Mr. C. H. Yeaman) has reported upon the position which would ensue upon the passing of the Military Service (Review of Exceptions) Bill, and the increasing difficulties in getting men, particularly those who had any mechanical knowledge. Experience with substitutes sent by the Labour Exchange had not been satisfactory, considerable sums having been spent in wages without adequate return. Applications received had either been from men without any knowledge or experience of mechanical or electrical matters, from over age men asking much larger salaries than those paid, or from young badged men in certified occupations elsewhere.

Mr. Yeaman also stated that the Reserved Occupations Committee had written stating it was inadvisable that women should be left in charge of electrical stations or sub-stations, and that in such cases there would be strong grounds for appealing against the taking of a man which would have this effect.

Ilford.—The L.G. Board have intimated that they cannot alter their decision refusing sanction to borrow £10,000 for the electricity undertaking, but they suggest that the Council should consider the installation of converting plant at Ley-street works.

A special committee has instructed the Electrial Engineer and the Surveyor to report on a temporary scheme for the utilisation of the steam at the refuse destructor, and also on the suggestion of the Board.

Islington (London).—The Lighting Committee has issued a long report on the public lighting, and on the proposal to substitute half-watt lamps for the present arc lamps.

Various statistics are given, including figures of the expenditure on lighting during the past three years and of the prospective expenditure for the three years ending April, 1921, but the Committee recommend that no further action be taken in the matter until the termination of the war.

Linking-up in South London.—Lambeth General Purposes Committee has reported on a proposal by the South London Electric Supply Corpn. to enter into an arrangement with the County of London Electricity Supply Co. for the purpose of interchange of electric supply.

Under the proposed arrangement the County Co. would lay and maintain the necessary cable for giving bulk supply to the South London Co.'s generating station, and would install therein and maintain the necessary converting plant for seven years and 2½ months from the date of the commencement of the bulk supply. The South London Co. would pay in respect of the year ended Dec. 31, 1918, and each subsequent year, for a minimum of 1,500,000 units. There is also a reciprocal proviso to meet the case of the County Co. taking a supply from the South London Co. The South London Co. agrees in the event of its ceasing to take a bulk supply under the agreement at the end of seven years or subsequently, to pay to the County Co. as compensation such proportion of the County Co.'s total capital expenditure for giving the bulk supply as may be settled (failing agreement) by arbitration, having regard to the remaining life of the Lambeth Electric Lighting Order. The South London Co. is to pay to the County Co. a fixed charge of £1,500 per annum, and in addition a running charge of 0·45d. per unit for the first million units, and 0·4d. per unit in excess of one million units per annum, subject to certain conditions as to minimum demand. Provision is also made for the price of current to vary in accordance with the price of coal and other fuel, and the agreement is subject to the County Co. obtaining within three months the approvals of the Board of Trade and the Borough Council.

The L.C.C. has intimated to the Board of Trade that it has no criticisms to offer upon the agreement, and the General Purposes Committee states that "having considered the matter in all its bearings, we do not, subject to one or two minor points which we have instructed the Town Clerk to raise upon the draft agreement, consider that exception should be taken to the proposals of its lessees."

Nelson.—Twenty-eight employés of the electricity and light railways department have joined H.M. Forces, and of these four have been killed, four discharged and three are prisoners of war in Germany.

New Ross (Ireland).—In view of the suggestions made concerning the necessity of introducing electric supply, the directors of the local gas company have come to the conclusion that, being in possession of suitable premises for the installation of the necessary plant, they are in a position to supply electricity with a reasonable amount of success. The Council have also agreed to give complete facilities for the erection of pillars and brackets to carry the overhead electric wiring.

Swindon.—The salary of the borough electrical engineer (Mr. A. Dimmack) has been increased from £300 to £325 per annum, and that of the tramways manager (Mr. T. Medcalf) from £225 to £250 per annum.

Women Labour in Electricity Works.—Birmingham Electric Supply Committee, which has had under consideration the question of replacing men released for military purposes by women labour in the various departments, has resolved that women should be employed in the Corporation power stations, particularly in the switch rooms, engine rooms and boiler houses.

LIGHTING AND INDUSTRIAL POWER.

Bristol.—Last week the Watch and Sanitary Committee reported that they had again considered the desirability of extinguishing the arc lamps during the summer months, with the result that they could not recommend the discontinuance of the arc and half-watt lamps.

In the course of the discussion on the report the lighting of the streets was criticised, and the increase in the number of accidents was attributed to the defective lighting. An instruction to the committee was, therefore, adopted, requesting that the lighting of the side streets be reconsidered by them.

Electric Cooking in Asylums.—The Metropolitan Asylums Board are to purchase 12 electrical cooking mincers and mixers.

It was reported at the last meeting of the Board that the machines are made in the United States, and it is hoped that in view of the saving in food they affect, and their value owing to the present shortage of labour, that special facilities will be given by the Government for their importation. The cost before the war was about £70 per machine.

Electric Furnace Development.—Barnsley Council recently decided to give a supply of electrical energy to Mr. John Gillott for an electric furnace at his works.

Digitized by Google

Local Authorities and Electric Power Supply.—West Ham Electricity Committee have passed the following resolution and copies have been forwarded to the President of the Board of Trade and to local authorities owning electric supply undertakings:—

"That we are of opinion, having regard to the important part at present played by Local Authorities in the supply of electrical energy and the extensive character of their capital commitments in relation thereto, that Local Authorities owning electricity undertakings are inadequately represented on the Committee appointed by the President of the Board of Trade to consider and report on the future supply of electrical power for all classes of consumers in the United Kingdom, and strongly urge upon the President of the Board of Trade the necessity of increased representation being given to such Authorities."

Westminster.—The Works Committee has adopted a proposal of the Westminster Electric Supply Corporation to substitute modern incandescent lamps for the arc lamps used for the public lighting in the parish of St. George, Hanover Square.

The proposal is the outcome of representations by the Board of Trade to the company on the necessity of exercising the strictest economy in the use of fuel, and the company state that the adoption of the proposal will effect a saving of at least 2,000 tons of coal and 250,000 pairs of carbons per annum and the services of 10 men. The cost of the alteration will be borne entirely by the company as also the cost of the re-instatement of the arc lamps after the war, if such reinstatement is not required within three months of the completion of the alteration. When all the lamps (962) have been altered, the rebate to the Council will be at the rate of £2,650 per annum. The "Dula" lamp, which is made in Holland, will be used. The company must undertake that none of the material or appliances to be used shall be of enemy make and origin.

ELECTRIC TRACTION.

East Ham.—The lease of the section of the Barking Council's tramways which expires on the 31st inst. is to be renewed for three years.

Edinburgh.—The Tramway Committee has received a communication from the Admiralty stating that they were in favour of the proposed construction by the Corporation of a tramway between Edinburgh and South Queensferry.

The scheme would be beneficial to Rosyth, and the Admiralty would support the Corporation in any application for a provisional order or bill, provided there was no actual construction carried out during the war.

Electric Railway Mobilisation in the U.S.A.—The Committee on National Defence of the American Electric Railway Association, acting under the direction of the National Council of Defence, has undertaken the work of mobilising the resources of this industry (representing a capital of $5,000,000,000) for service in connection with the war.

The committee is at work preparing maps and data to show the availability of all electric lines for military purposes in proximity to the entire coast-line of the country. This will later be supplemented by similar data for all of the electric roads of the United States. The committee is also making a study of the experience of the tramways of Great Britain, which have been of great assistance both in the matter of transporting men and materials and in the work of recruiting.

Electric Vehicles in Germany.—The "Motor" states that the requisitioning of practically all petrol cars for Government service in Germany has given a great impetus to the increased use of the electric vehicle.

Owing to the fact that lead for accumulators was practicably unobtainable it is reported that a new type of accumulator has been perfected embodying the old principle of the gas battery. The gases, oxygen and hydrogen are prepared by the decomposition of water and compressed into the plates forming the anode and cathode. The use of amorphous platinum as a gas absorbent is said to play an important part in the construction of the battery.

London County Council.—On Tuesday the Highways Committee reported that they had arranged for the London Electric Supply Corpn. to continue to supply power to New Cross sub-station after March 31, 1917, on the same terms as previously.

It was agreed to amend the Conciliation Board's scheme for the duration of the war and for six months after by the insertion of the following: "Except as otherwise herein provided, the decision of a board shall be final and binding on the parties, and no decision shall be re-opened within 12 months. Provided that, owing to the abnormal conditions arising out of the war (1) any decision may be re-opened after four months, if either party represents that the re-opening of the decision is a matter of emergency, (2) no conciliation board shall be called upon to meet more frequently than once in four months for the re-opening of decisions arrived at within the preceding 12 months, and (3) both parties will use every effort to secure that the conciliation boards shall not be called together more frequently than is necessary."

Sir GEORGE GOLDIE, chairman of the Finance Committee, in submitting the annual estimates for 1917-18, said that the financial results of the Council's tramway undertaking for the year just closed would clearly be more satisfactory than was anticipated 12 months ago. In place of an expected deficiency of £74,000, they might now apparently hope for a surplus of about £7,000, and if that revised estimate was borne out when the accounts were made up, there would be no need to draw further upon the general reserve fund in respect of the year 1916-17. The estimates for the current year showed a probable deficiency in the net revenue account of £89,402. On the basis of those figures, the balance standing to the credit of the general reserve fund would be insufficient to meet it, and a draft would have to be made upon the already depleted renewals fund, unless some means were devised for obviating the adverse balance. The financial position of the undertaking was engaging the careful attention of the Highways Committee, who had appointed a special sub-committee to consider tramways fares and operation. It appeared that since the outbreak of war, additions had been made to the wages of tramway employés amounting to £154,100 per annum, in addition to war service allowances to the dependents of men serving with the colours, amounting to £114,300 per annum, and it seemed manifest that the revenues of the undertaking derived from scales of fares fixed before the war were inadequate to carry the additional burdens which war conditions had entailed. Some way would have to be found for adding a substantial sum to the present revenues; for while, on the one hand, he was not aware of any desire so to expand them, by the adjustment of fares or otherwise, as to enable the undertaking to contribute to the relief of the rates, there appeared general agreement that it should involve no burden upon the ratepayers.

Manchester.—The Tramways Committee has reduced the contribution to relief of rates from £100,000 in 1916-17 to £50,000 in 1917-18.

The committee's estimates are based on an income from traffic and other sources of £978,700, and after providing for the items of estimated expenditure, including £366,500 for wages, salaries, administrative expenses, &c., £104,000 for repairs and maintenance, £142,370 for power, £103,800 for war service allowances, bonuses, &c., £53,366 for renewals and depreciation fund, interest (£46,500), sinking fund and loan instalments (£65,634).

The total revenue for the year ended March, 1917, was £978,602, against £939,469 for 1916 and £901,876 for 1915. The passengers carried totalled 219,097,258, a considerable increase on previous years, but the car miles run (18,388,302) was a decrease. The revenue per car mile was 12·606d., against 12·197d. and 11·3d. in the previous two years. During the past three years, and including the estimate for the current year, £319,475 will have been spent in respect of war service allowances. At March 31 last the approximate amount standing to credit of the renewals fund was £424,361, the shrinkage in the value of the £348,419 invested being estimated at £106,000, or about 30 per cent. The estimated balance next year, after deducting the above sum, will be £341,000.

Middlesex Tramways.—The County Council have been informed by the Metropolitan Electric Tramways (Ltd.) that the public must be called upon to pay higher fares.

The company's revised scale of charges was referred to the Light Railways Committee. It was mentioned that the company's employees were asking for a further 10s. per week war bonus.

TELEGRAPHY AND TELEPHONY.

Radio-telegraph Notes.—"The Times" reports that the Germans have put forward a proposal for the immediate erection in Argentina of a great wireless station capable of communicating with Berlin.

It is officially announced that there are 30 radio-telegraph stations in operation in the Republic of Mexico.

Telephony in India.—The Government has directed the Bengal Telephone Co. not to instal new telephones or to extend existing installations, in consequence of the necessity of economising in the use of material.

At Simla also, owing to the numerous extra official demands, telephones are not being connected for new private subscribers. The automatic system is loaded to its fullest extent and an extension of the automatic system will, it is hoped, be installed during the coming season.

EDUCATIONAL.

University of Edinburgh.—The report presented to the General Council on Wednesday submitted arrangements for founding chairs of French and of medical chemistry for instituting a degree in commerce.

The General Council remitted to its committees to take into consideration the development of the university after the war in regard to finance, research, relations to universities of the Allies, &c. The report of the sub-committee on reforms in examinations, &c., urges (inter alia) that more provision should be made for post-graduate instruction and research.

The Sub-committee on Research suggests that it would be desirable to institute a central research fund to be drawn upon to aid individual researches. On the subject of research and industry the sub-committee states that, given that research work in pure science is established on a wide and firm basis in the universities, research with industrial applications will follow as soon as co-operation between manufacturers and the universities can be secured. A beginning might be made by the university offering to attempt the solution of problems presented to it by manufacturers under conditions of confidential treatment and remuneration, which can only be determined by the circumstances of each case.

West Ham Municipal Technical Institute.—A special course of seven lectures, with practical work, will be given on "Some Industrial Applications of Electricity," on Tuesday evenings, from 7 p.m. to 9 p.m., commencing May 15. The fee for the course, a brief outline of which is given in our advertisement columns, is 2s. 6d.

Digitized by Google

MISCELLANEOUS.

Goods Traffic on Railways.—It is announced officially that until further notice goods for conveyance by goods train between certain points will only be accepted and conveyed by selected railway routes. It is stated that this will tend to quicken transit.

Liquidation of British Companies in Belgium.—It is announced that the General Electric Co. of Belgium (Ltd.) (a branch of the General Electric Co., Ltd., of London) is included in a list of British firms, whose liquidation has been ordered (under the decree of the German Government) by the administrative authorities, acting under the Governor-General of Belgium.

Paris National Fair.—It is announced that this fair will be open from May 14 to May 31 and the exhibits will all be of French or French Colonial manufacture.

There are to be special groups for (1) motors, cycles, carriages, railways, aviation, &c.; (2) education, science, and arts; (3) electrical industries; (4) mining, metallurgy, ironmongery, &c.; and (5) machine tools, measuring instruments, &c.

Problems in Electric-light Switching.—We have just received from Messrs. A. P. Lundberg & Sons, a set of 14 new problems in the above subject, the same forming an examination paper for working at home with the help of their well-known booklet, "Lektrik Lighting Connections."

A glance through the questions or problems shows that the use of special tumbler switches is by no means confined to lighting circuits, the other uses being of a most varied and unsuspected nature. As far as we are able to judge from a cursory inspection, none of the uses cited are otherwise than quite practical. And we think that many engineers and advanced students might obtain and study the problems with considerable advantage to themselves. They may obtain a copy by sending a card to the firm at 477-489, Liverpool-road, London, N.7.

Protected Occupations.—The Minister of Munitions has prepared a schedule of protected occupations for men on Admiralty work and War Office or Munitions work. It is explained that the object is to release a considerable number of fit men for military general service.

The schedule will come into force on Monday and will supersede all war service badges and badge certificates, trade cards under Army Council Instruction 2,361, and the M.M. 94 list of protected firms. A scheduled occupation certificate (Army Form 3,476 A) will be issued by the Munitions Area Recruiting Office to every man entitled to protection under the schedule.

It is not intended to call up any man engaged on Admiralty, War Office or Munition work in an industry dealt with in the schedule who attained the age of 32 on Jan. 1 last, or who has not been passed fit for general service, subject to provisos that (1) no protection shall be given to a man with a bad record for absence from work, (2) that by arrangement men otherwise protected by the schedule may be called up for artificer units, and (3) that such men may also be called up if substitutes can be provided.

The schedule includes workmen who were engaged on March 29 last on shipbuilding and marine engineering; electricians on oilshale mining works; metal workers (from the treatment of the ore to the production of ingots, billets, bars, rods, sheets, &c.): caster makers; brass finishers (if 21 years of age by Jan. 1, 1917); engine, locomotive, machine or motor chassis erectors; metal turners; magneto machinists (if 23 years of age before Jan. 1, 1917); electrical fitters; foremen electricians, armature and transformer winders (heavy work only), commutator builders, wiremen and skilled electricians on repair and maintenance of electrical plant (if 23 years of age before Jan. 1 1917); gas producer charge hands (if 25 years of age before Jan. 1, 1917); leading electric welders (if 23 years of age before Jan. 1, 1917); skilled workmen in electric lamp manufacture; and the following professional occupations and positions on administrative staffs: Works, analytical or research chemists (if 19 years of age before Jan. 1, 1917); mechanical engineers and electrical engineers (if 23 years of age before Jan. 1, 1917); working principals of firms, managing directors, works managers, assistant works managers, heads of administrative departments, incorporated or chartered accountants, and technical staff and clerks possessing high technical knowledge (if 25 years of age before Jan. 1, 1917).

In most of these cases men will be called upon to show that they were engaged in the occupation specified (not necessarily with the same employer) on or before Aug. 15, 1915.

Tribunal Case.—Before the Middlesex Appeal Tribunal last week, the Twickenham and Teddington Electric Supply Co. appealed for two single men, one 19 and the other 22, years, who had been passed for general service.

The CHAIRMAN (Mr. H. Nield, K.C.): Is it a nursery for young men?

Lieut. CARTER: This is a funk-hole. This is a place we can probably raid.

The MANAGER (Mr. Farrer) said they had 42 men of military age out of 80. All efforts to replace them had failed.

The appeal was dismissed.

Unemployment Insurance.—The Umpire has decided that contributions are payable in respect of the following:—

Workmen employed in the manufacture of electrical appliances for railway signalling and for electric control of railway signalling installation.

Workmen engaged in adapting gas and candle fittings for electric light.

TENDERS INVITED AND ACCEPTED.

Coal-Conveying Plant.

MANCHESTER Electricity Committee require tenders by 10 a.m. May 11 for the supply and erection of coal-conveying plant at Stuart-street generating station. Specification from Mr. F. E. Hughes, Town Hall, Manchester.

Hydraulic Accumulator and Electric Pump.

MANCHESTER Corporation require tenders by 10 a.m. May 11 for the supply and erection of a hydraulic accumulator and an electrically-driven ram pump. Specification from Mr. F. E. Hughes.

Electric Lamps.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. May 23 for supply of 8,250 Incandescent Electric Lamps during the year ending June 30, 1918. Specification, &c., from the Commissioner's Offices, Spencer-street, Melbourne.

WEST HAM.—The Electricity Committee received two tenders for the supply of a marine type boiler, and the lower, that of Messrs. Babcock & Wilcox, £10,734, has been accepted. The Stirling Boiler Co. also submitted a tender, but Messrs. John Thompson (Ltd.), who were invited to tender, did not quote.

HULL.—The Corporation has accepted the tender of the Davenport Engineering Co. for the supply of cooling towers at the Sculcoates-lane generating station at £5,100. The Premier Cooler & Engineering Co. and the Lancashaire Water Cooler Co. also tendered.

KETTERING.—The Council have accepted the tender of the General Vehicle Co. for the supply of a 3½-ton G.V. electric tipping wagon.

APPOINTMENTS VACANT AND FILLED.

An assistant electrical engineer is required for the Government electrical department of the Federated Malay States. Salary £360, rising to £390 by annual increments of £15, with a duty allowance of £75 per annum. Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, London, S.W. 1. *See advertisement.*

An assistant is required in the physics and electrical department of the Borough Polytechnic Institute, Borough-road, London, S.E.1. Salary £180-£200. Forms of application from the Principal.

The Walthamstow Higher Education Committee of Essex County Council require a headmaster for their engineering and trade school. Commencing salary £300. Forms from Mr. J. H. Nicholas, County Offices, Chelmsford. Applications by May 5.

A chief inspector of telephones is required by the Ceylon Government. Salary £250, rising to £300, with duty allowance £30 or quarters. Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, London, S.W.1.

Oban Lighting Committee have appointed Mr. T. Gerrard, of Keighley, an assistant electrical engineer at the municipal electricity works.

BUSINESS ITEMS.

The General Electric Co. (Ltd.) inform the trade that their new general discount sheet (dated May 1, and referring to all departments) is now ready, and copies will be supplied on application to the company at 67, Queen Victoria-street, E.C.

The head office of Messrs. E. Cleaton, Rees & Co., has been removed from 21, Mosley-street to 1, Eldon-square, Newcastle-on-Tyne.

Owing to their premises having been commandeered, the British & Overseas Engineering Synd. (Ltd.) have removed to Sardinia House, Sardinia-street, Kingsway, London, W.C. 3.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of June 14. *Further particulars are set out in an advertisement.*

Sale by Auction.—Messrs. Goddard & Smith will sell by auction on the premises at 133 & 135, Oxford-street, W., on Wednesday next at 1 p.m., the stock of up-to-date electrical appliances and fittings, electro-medical apparatus, &c. Further particulars are given in an advertisement and catalogues may be obtained of the Auctioneers, 196, Piccadilly, London, W.1.

Plant for Sale.—The Trafford Power & Light Supply (Ltd.), Trafford Park, Manchester, advertise for sale two 600-kw. Mather & Platt dynamos suitable for coupling to oil or gas engines, and two 600-kw. Brush-Mather & Platt steam dynamos.

Digitized by Google

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Direct United States Cable Co. (Ltd.)

The seventy-fourth ordinary general meeting was held on Tuesday, Sir JAMES PENDER, Bart., the chairman, presiding.

The SECRETARY (Mr. William Miles, F.C.I.S.) having read the notice convening the meeting and the report of the auditors,

The CHAIRMAN said there are few matters upon which it is necessary for me to comment. If you will turn to the revenue account, you will see that we have received our usual rent from the Western Union Co., and, in addition, the interest and dividends on investments have amounted to £13,980, which, I may remark, is a little in excess of the interest and dividends received for the previous year. As the figure shown is the net amount, after allowing for deduction of income tax at the source, I think you will agree that the interest and dividends received have given a very satisfactory return upon our investments, in view of the increase in income tax. On the other side of the account, provision is made for the consulting electrician's fee, income tax and directors' fees, and, after paying the usual dividend of 4 per cent. for the year, less tax, a balance of revenue remains of £32,611. 17s. 7d., which has been transferred to the reserve fund below. The cost of maintaining the cables for the year amounted to £17,503, as compared with £16,088 in the previous year—which, you will observe, is about £3,500 in excess of the income from our investments—and after allowing for this and a small loss on the sale of securities of £301, the balance to the credit of the reserve fund account at the 31st March last was £502,511. 13s. 10d., made up, for the most part, of investments which cost £450,751, and in respect of which £50,000 has been written off on account of market depreciation, leaving their book value at £400,751. The balance of the reserve fund is chiefly represented by the cable on hand, which appears in the balance sheet at its cost price of £76,110 and cash at the bank. I mentioned last year that our stock cable was purchased just before the war at a very low price, and we may congratulate ourselves upon the fact, not only that we have an adequate stock of cable, but that if we were able to replace it at this time it would involve us in quite double the amount of its original cost.

I have no doubt that some shareholders may think that out of a balance revenue of £32,000 the Directors might have seen their way to have paid a bonus of, say, 1 per cent. upon the share capital of the Company. I need scarcely assure you that that matter was very carefully discussed by the Board, and we were unanimous in our conclusion that in view of the very heavy depreciation in the securities and the existing condition of affairs, we should be best serving the interests of the Company by limiting the dividend to the 4 per cent. that has hitherto been paid. I can only hope that before we meet you again that the war will have terminated with complete victory for the Allies, and that I may have the pleasure of presenting an account as satisfactory as that which you now have before you, with the added pleasure of a substantial bonus to the shareholders as some recompense for their patience during the past three trying years. I now move that the report and accounts be received and adopted, and that the dividend of 2s. per share, less income tax, for the quarter ended March 31 last be approved.

Mr. JOHN VARLEY seconded the motion, which was carried unanimously.

The retiring directors (Sir James Pender, Bart., and Mr. H. C. B. Underdown) were re-elected, and the auditors, Messrs. Deloitte, Plender, Griffiths & Co., were unanimously re-appointed. A vote of thanks to the chairman, the directors and the staff terminated the proceedings.

British Westinghouse Electric & Mfg. Co. (Ltd.)

The Chairman (Mr. J. Annan Bryce, M.P.) presided over the meeting last week, and gave an analysis of the annual report and accounts. He said that the number of workpeople employed in the factory was at the outbreak of war 5,223, of whom 4,720 were men and only 513, or about 10 per cent., women. At the end of 1915 the number was 6,679, at the end of 1916 7,284, and at present the number was 8,037, of whom 5,505 were men and 2,532, or about 31½ per cent., women. The old skilled labour had almost entirely disappeared, and the present personnel, the result of continual dilution by less skilled or entirely unskilled elements, was necessarily less experienced. As a consequence accidents had unfortunately increased, though every possible safeguard that could be devised was provided against them, and the number of accidents was nearly a third greater in 1916 than in the preceding year. Though the labour was at the outset entirely unskilled and inexperienced it was anxious to learn, and did its best; it was gradually becoming experienced and acquiring skill. The women had been most willing even to tackle work requiring physical strength apparently in excess of their powers, and they were becoming proficient in many kinds of difficult work. In addition to the factory hands there was an office staff of about 2,000, of whom 600 were women. They had written off patents, &c., a further sum of £25,000, and the item now stood at half the amount of three years ago. Since 1904 the cost of new patents had been charged to revenue. The amount written off for ordinary depreciation was about £5,500 less than in 1915 because it was charged at a fixed rate on a smaller book value, and the amount would continue to diminish every year unless the cost of additions to plant reached the amount of the depreciation itself. In the case of special depreciation different considerations arose. This year the amount had been increased by £9,000 to cover additional wear and tear due to the present conditions of operating the machinery, such as the character of the labour, necessity for night shifts, &c. The item "Shares and debentures in other companies" was £177,502, compared with £175,586 last year. The principal constituent in the item was their French investment. Both the French and Italian Westinghouse companies were engaged almost entirely on war work for their respective Governments. The French company had done well, but the Italian company had made some loss, due to the rise in wages and materials since the contracts were taken In France, recent legislation had imposed taxation on excess profits, but all the principles upon which it would be applied had not yet been settled in practice, and the extent to which the company would be affected was still uncertain. The Norwegian company had made a small profit. There was reason to believe that after the war there would be a good field for those companies, and preparations were being made—reorganisation and reconstruction of buildings—in so far as was possible under war conditions, for taking advantage of an increased demand, which, at any rate in France, where destruction had been so great, was likely to be large. The gross profit for the year was £311,198, compared with £293,988 in 1915, an increase of £17,210. The net profit was £199,346, compared with £176,751, an increase of £22,595. The relative increase in net profit was mainly due to the smaller amount written off for ordinary depreciation. The tonnage output in 1916 was 22½ per cent. greater, and the value, owing to higher costs, 40 per cent. greater than in 1915; but the aggregate gross profit was in 1916 only 5·8 per cent. and the aggregate net profit only 13 per cent. greater than in 1915. There had thus been a great fall in the rate of profit. The main reason was that in 1916 they were engaged with orders connected directly or indirectly with Government war work, on which margins were cut fine, but there were other contributory causes. There had been great advances in wages and materials which could not be foreseen when the orders were estimated for, and their effect had been accentuated by the unavoidable delays in the completion of orders. A further cause of the diminution of the rate of profit had been the continual dilution of labour previously mentioned. With the still uncertain effects of the Munitions Act and excess profits taxation it was absolutely necessary to provide a large sum, and the amount of the carry-over (£89,735) was none too great, though he hoped it would prove adequate.

During the year under review their orders had been more than maintained, as, excluding the large railway contract which he mentioned last year as taken in 1915, the normal business of 1916 showed a considerable increase both in volume and value, while in the current year there was also a considerable increase in orders compared with the corresponding period of 1916. There had been a satisfactory addition to their trade with the Continent, particularly in France and Russia, while their business with Australasia and South America had considerably improved. On the whole, their exports, in view of the difficulties of transport, must must be considered satisfactory. Though at the end of the year the financial position was quite easy, it might be that before long, under the present conditions of high wages, dear materials, delay in completion of orders, with consequent longer and larger locks-up of capital and a growing business, necessitating fresh manufacturing facilities, they might have to contemplate an addition to their capital. So far they had been able to meet the position out of revenue, but in view of the immensely increased demands of the Treasury—and no one knew how much further they might go—it would probably not be possible to defer much longer a request for permission to raise fresh capital. He was not alone in thinking that the policy of the Treasury in increasing the direct taxation of industry had gone far enough, and in one respect a great deal too far. He described fully last year the highly inequitable effect upon them of the excess profits tax, and since then the injustice had been enhanced by the policy of the Treasury in the last Finance Act, in virtue of which it not only exacted an additional 10 per cent —that was 60 per cent. in all—of the profits, but it reserved to itself the right to claim either that 60 per cent. or the 80 per cent. calculated on a different system exactable from controlled establishments under the Munitions of War Act, whichever might give a better result to itself. It was not, however, so much the injustice on which he had to insist. What he was quarrelling with at the moment was the policy of "killing the goose which lays the golden egg." The policy which prevented an industrial concern from providing for expansion out of savings. How was industry going to provide after demobilisation for the employment of the vast additional mass of labour which would be thrown on the market by the return of the troops and the cessation of munition requirements? Remember that to meet the colossal taxation to be borne by the present and rising generations there must be an immense increase in production. Where was the money to finance it to come from? There was much talk of trade banks and of industrial banks. They were excellent things, but even if they were to be provided in unimaginable numbers, who was to provide their funds? Not the income-tax payer, whom the late

Digitized by Google

Secretary of the Treasury menaced with 10s., or the super-tax payer, who already paid 10s., and was threatened with an increase ; not the excess profit taxpayer, who already in many trades was being sucked dry so far as the chance of providing for expansion was concerned, and who also was being threatened with a rise to 80 per cent. He would not believe that the present Chancellor of the Exchequer, who was a business man, would fail to recognise the disastrous effects of the excessive taxation of industry. Other belligerent countries had shown more consideration for industry than we. Some of them had followed our example in imposing taxes on excess profits, but none of them were anything like so severe as ours. In some cases they were graduated up to a maximum of 50 per cent., while in others, as for instance, in France, there was the wise provision—and that was a point he wished to emphasise—that profits devoted to expansion were allowed to escape excess profits tax altogether. Germany, our principal trade as well as war enemy, had not, so far as he knew, imposed any excess profits tax, and had not even increased the income tax. As a result the great German concerns in the electrical trade had accumulated vast sums in cash—it was true it might prove to be only paper cash—for the inevitable fight after the war. He had lately seen the balance-sheets of three of these companies for the year 1915 (the Allgemeine, the Siemens-Schuckert and the Bergmann). The first had by that time accumulated a cash reserve of 7½ millions, the second 2½ millions, and the third 1½ millions—sterling, not marks—funds which were expressly mentioned as available for operations after the war ends. It seemed to be assumed by some well-meaning people that when peace was declared there would be an end of economic war also, and they deprecated any measures tending to perpetuate it. It was forgotten that the military war is only the complement of the economic war which, started half a century ago with the 200 millions indemnity robbed from France, had been waged ever since, with the purpose, as they now knew, of dominating the trade of the world. He had before him lately a striking instance. A great German firm had maintained a factory in England entailing for the last 10 years an annual loss of some £100,000, with the express object of keeping prices in this country low, and so preventing that particular industry from being able to compete abroad. The economic war Germany would renew more savagely and more unscrupulously than ever if she could, and "it must be our aim, if we are not to go under, to use every means to defeat her." As it was, they were urged by the Government to capture her trade, but bereft by it of the wherewithal. The Government were taking the savings of industry, and the manufacturers of this country would have no means to undertake the immense business which the world would offer after the war, while the vast mass of labour set free in this country would be short of employment. There must be a catastrophe unless the Government, which had taken the manufacturers' money, stepped in behind him with its credit. They had daily evidence of immense business open to them in every country where they traded, in France, Italy, Russia, Spain, and the Dominions—business demanding great extension of their works and the employment of masses of labour, but which they should be unable to undertake without large additions of capital. Meanwhile others were stepping into the breach. America, with her vast resources, had started a powerful organisation, which was securing business in every quarter. Happily they knew that she had no ulterior objects, but they could not fight friendly rivalry without money, and if they were to avail themselves of post-war opportunities they must obtain fresh capital. Their educational scheme, under the able guidance of Mr. Fleming, continued to make excellent progress. They had now 328 bound apprentices, an increase of 45 since the end of 1915, all of whom attended their schools, and lectures were given by 30 foremen, against 23 in 1915. A teachers' training class had been formed to render junior teachers more proficient in the art of imparting knowledge. Many of their students attend the Manchester School of Technology. One of them had gained a three years' scholarship of £50, and had proceeded to the full university course. A trade apprenticeship association had been formed to cater for the social side, and was flourishing. The classes for women had been extended to provide training for those engaged on technical calculations, testing and chemical laboratory work, and were proving of much benefit. Special arrangements had been made during the year for research work in connection with materials, processes and products, and for that purpose the equipments of the chemical laboratory had been considerably increased. The staff engaged on this work included graduates from many of the leading universities. The number of men who had joined the Colours up to the end of February, 1917, was 2,469, of whom ther were killed in action 168. Such labour difficulties as they had had it had been found possible to settle by tactful handling, and he was happy to say that in that respect their works manager (Mr. Mensforth) has ably continued the policy of Mr. Lang, now managing director. The future of British industry depends upon the loyal co-operation of employer and employed. The interests of the shareholder and the workmen were the same. The one could not be happy without the other.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—The report for 1916 states that large contracts are in hand, the current order list being well above the average. After providing for general charges, maintenance of plant and buildings and interest on the debenture stocks and loans, the balance is £21,635, and, with £9,321 brought forward the total available is £30,956. The directors recommend that £8,000 be applied for depreciation of property, patents and goodwill, that £2,044 be applied in payment of the further 4 per cent. interest to which the holders of the 6 per cent. prior lien participating second debenture stock are entitled out of the first net profits available for dividend in any year, that £7,055 be placed to general reserve and that the balance of £13,857 be carried forward

JOHNSON & PHILLIPS (LTD.)—Mr. R. W. Blackwell, who presided over the annual meeting last week, said that the gross profit for 1916, after making provision for bad and doubtful debts, and after charging to revenue upwards of £8,000 for maintenance of buildings, plant, &c., amounted to £56,060. With £25,300 brought forward the total with which they had to deal was £81,361, out of which they had to deduct remuneration of directors, auditors and trustees, interest on debenture stocks and loan, depreciation, &c. The board had considered it advisable, in view of the conditions prevailing at present, to carry £10,000 to general reserve, and to place a further sum of £10,000 to special reserve account. They had, furthermore, thought it best to reduce the book value of the company's patents by £2,575, inasmuch as they had not been able fully to utilise their patents under existing circumstances, and could not clearly see when normal conditions of trade would be restored. After those deductions (£62,650) there was an available balance of £18,711. The directors recommended payment of a dividend at rate of 5 per cent. per annum (tax free), leaving £9,961 to be carried forward. It was the opinion of the board that it would be unwise to make any larger distribution. In their reserves and in the carry forward it was indispensable that they should hold a considerable cash reserve. The total outstanding of both first and second debentures amounted to £154,948. During 1916 they had added £14,053 to capital account by additions to buildings and plant, and provided £12,000 for depreciation. The company had not been benefited by the war ; they had merely held their own. They had had great difficulties to meet, and had met them with fair success.

PRITCHETT & GOLD AND ELECTRICAL POWER STORAGE CO. (LTD.)—The directors' report, submitted at the general meeting on Monday, showed that the net profit for 1916, after providing for depreciation, debenture interest and reserve for leasehold redemption was £10,183, making, with £1,105 brought forward, £11,288. Deducting interim dividend at 5 per cent. per annum on the preference shares (£618), the balance was £10,670. The directors recommended a dividend of 5 per cent. per annum on the preference shares for the half-year ended Dec. 31, 1916 (£580), a dividend of 15 per cent. on the ordinary "A" shares (£2,325) and a dividend of 10 per cent. on the ordinary "B" shares (£1,446) and that £265 be written off amalgamation expenses, £3,000 placed to general reserve and £600 to reserve for depreciation of investments, leaving a balance to be carried forward (subject to income and excess profits taxes) of £2,455. The turnover for the year showed a considerable increase compared with 1915 and the net profit an increase of £2,067. The improvement in net profit would have been materially better in normal times, but the increase in the cost of materials and labour and in expenses generally resulted in a considerable reduction in the rate of profit earned. The Millwall works were closed in August last and manufacturing is now concentrated at the Dagenham works. Owing to a recent order of the Ministry of Munitions the business in the immediate future will practically be confined to work either directly or indirectly for Government departments. It is anticipated that this will result in a reduction of turnover for 1917. The Feltham property and plant was sold during the year at a small profit. A portion of the purchase price remains on mortgage until six months after the conclusion of the war.

Mr. JAMES GRAY, who presided at the meeting in the absence of Mr. G. E. B. Pritchett (the chairman of the company), said Mr. Pritchett had, in consequence of the work involved in the amalgamation and re-organisation of the business, had a temporary breakdown in his health and had been prevailed upon to take three months' rest, and Mr. C. R. D. Pritchett had been appointed by the Board to undertake the duties of managing director during his absence. Much of the Government work was obtained at pre-war prices and left only a small margin of profit, but when times were normal the Board had reason to believe that the estimates formed at the time of the amalgamation would be fulfilled. The gross profit for 1916 (£30,162) showed an increase of £7,556 and the total amount at credit of profit and loss account (£31,360) an increase of £8,233. The net profit showed an increase of £2,067, which was satisfactory, having regard to the unfavourable conditions under which they had been working. The large amount of war work on hand and the difficulty of obtaining prompt supplies of material made it necessary to carry large stocks, and they had been unable to ship batteries ordered from abroad, which caused a larger lockup of capital than they could well afford. The Germans in the past had had a large portion of the foreign and colonial trade in batteries, which it would be the business of British concerns to capture. The addition of 20 per cent. only to the pre-war standard of profits was insufficient to permit an effective effort to be made to secure further markets. The report and accounts were adopted, and the retiring directors, Mr. G. E. B. Pritchett, Major A. G. Gold, D.L., and Mr. F. C. Graham Menzies, were re-elected.

CITY NOTES.

MEMORANDA.—(May 1).—Consols, 55. Consols Pay Day, June 1. Stocks and Shares Ticket Days, May 10 and 29. Pay Days, May 11 and 30. Price of Silver, 37⅞d.

EASTERN TELEGRAPH CO. (LTD.)—The date for the payment of the additional dividend and bonus on the ordinary stock is May 15, and not May 5, as stated in our last issue.

SUBMARINE CABLES' TRUST.—The numbers of the 68 certificates which were drawn on Tuesday, the 1st inst., for payment out of surplus income are set out in an advertisement.

Digitized by Google

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—The chairman of the Todmorden Gas Committee objects to the Todmorden Electricity Committee buying a new turbo-generator, because "it would be saddling the borough with another white elephant."

* * * *

Apropos of the above, Seaton would probably say that he knows of turbo-generators that are "whited sepulchres"!

* * * *

Mr. Arthur Goodwin, general manager of C. A. Vandervell & Co., has given it as his opinion that the magneto will be replaced on all but the expensive cars by coil and battery ignition in conjunction with the lighting and starting dynamo. To all of which the Hun manufacturer of magnetos replies "Bosch!"

* * * *

"Electrically Tempered Tools" is an innocent looking headline, but it's my experience in making munitions that quite a lot of tools are very nasty tempered. [KVA. is engaged on the manufacture of munitions—EDS. *E.*]

* * * *

It is suggested by a correspondent that Mr. C. H. Merz has been "connected" with extra-high-tension power transmission for so many years that he should by now have a strongly developed "corona."

* * * *

I owe Aberdeen an apology. Under the title of "Economies of the Moment" I attributed to that city's electricity department the payment of bonuses to the staff out of the electrical engineer's army pay; of course it should have been Dundee!

* * * *

Mr. Michael Longridge laid about him in rare style in his Presidential address to the Mechanical Engineers. I hope every engineer—mechanical and electrical—will read every word of it. I have extracted one of the most poignant passages:—

The mechanical engineer must be held responsible for the maintenance and efficiency of the workshop on which the feeding of the people and the defence of the people against their enemies now depend. He became and he remains a trustee for the British Empire. How did he discharge the trust? By humbly seeking knowledge to turn the gifts of Nature to the use of man? By invoking the aid of science to develop the discoveries of the men who had prepared the road to his success? By caring for the welfare of the thousands who were spending their waking in his factories? By giving them a fair share of the profits of his business? I think we have the grace to-day to answer NO. I think we are willing to confess that our heads were turned by elation at our prosperity, that we are obsessed by admiration of our own achievements; too confident of the sufficiency of our limited knowledge; too contemptuous of the few who tried to throw the light of science on our path; too eager for wealth, and the social influence wealth could buy in the new state of society; too careless of the needs and aspirations of the "hands" who helped to make the rapid accumulation of large fortunes possible.

* * * *

OUR HOT PLATES.

No. 236 to—

Mr. Michael Longridge, for his vigorous, stimulating, and characteristically British Presidential address to the Institution of Mechanical Engineers.

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, May 1, 1880.]

REGENT STREET.—The Société Général d'Electricité recently made proposals to the St. James' Vestry (Westminster) to light Regent-street by the electric light, at a cost of 2½d. per lamp per hour. The Vestry calculated that the total cost of the light would be £18. 15s., as against £3. 1s. 4d. per annum, the present cost, so the proposal was not accepted.

ELECTRIC CLOCKS FOR PARIS.—On March 22 M. Fresca brought before the Academy of Sciences a memoir "On the Electric Regulation of the Hour in Paris." A certain number of good clocks are distributed on two telegraphic systems, their action being regulated every second from horary centres. Six of these have been in action since Jan. 3, and six others are about to be set up.

IS IT OF PRACTICAL USE?—Pierre Valcour, of Lockport, N.Y., has invented a portable cable. A metallic, cigar-shaped vessel, about 30 ft. long, contains the machinery and wire. This floats about 100 ft. in the wake of the vessel. When 200 miles have been accomplished an automatic connection releases a leaden sinker weighing 5 lb., and this as the vessel goes on finds its way to the bed of the ocean. At the point where the sinker is attached the wire is much heavier for a distance of 200 ft. Thus, at every 200 miles this shell, which is full of automatic and clockwork machinery, releases a sinker, thus fixing a telegraph wire on the bed of the ocean. The object of the shell is that the wire should not be at the mercy of the rolling and pitching of the ship.

Lift Accidents.—At a recent coroner's inquiry into a death due to a lift accident the City Coroner, Dr. F. J. Waldo said his experience of lift accidents in the past 18 years was that they were mostly preventable, and the fatalities were increasing, especially in the City. The lifts were mainly electrical and hydraulic. He had held 14 lift inquests in 1916, and for the first three months of this year investigations had been held into 10 cases.

Manufacturers' Advisory Committee to Ministry of Munitions.—In March last a deputation from manufacturing associations waited upon the Minister of Munitions in order to suggest that manufacturers and employers should be taken more into confidence and consulted in regard to the steps the Government consider it necessary to take, and thus entail the minimum of interference with output.

As a sequel to this, the Ministry have now appointed a Manufacturers' Advisory Committee to the Ministry of Munitions, composed of the following members: Messrs. G. Murc Ritchie, Douglas Vickers, Geo. Terrell, M.P., R. G. Perry and H. McGowan, and Sir Frederick H. Smith.

Argentina.—The Commercial Court of the Republic has decided that foreign companies are not required to publish their statutes in the local newspapers in order to obtain registration and permission to work in Argentina.

The only requirements are (1) proof of having been constituted in accordance with the laws of the country of origin, (2) inscription in the "Public Register of Commerce" of the articles of association and authorising documents, and (3) reciprocity by the country of origin.

Sourabaya (Java) Exhibition.—The Algemeine Nederlandsch-Indische Teutonstelling, Soerabaia, is to be held from May 1 to Nov. 1, 1919, or, alternatively, as soon as possible after the conclusion of peace.

A special section will be devoted to agricultural implements and electricity, but all branches of commerce and industry will also be represented. The exhibition is being promoted by private enterprise, but the Acting Director of Agriculture, Industry and Commerce is on the advisory board, and the Municipality of Sourabaya has voted a sum of money towards the expenses.

Switzerland.—A Government concession has been granted to a syndicate in Olten for the construction of an electric railway of metre gauge, 11·3 km. in length, from Olten to Niedererlinsbach, with a branch line, 2·7 km. in length, from Obergösgen to Lostorf. There will be three intermediate stations on the main section. The motive power will be furnished by a hydro-electric plant already established at Olten-Gösgen. The total cost of construction is placed at 2,097,000 francs (£83,880 at par rate).

TUNGSTEN FOR ELECTRICAL CONTACTS
MORE EFFICIENT AND MUCH CHEAPER THAN PLATINUM.
Recommended for use for X-Ray Targets, and as Contacts on Induction Coils and Tapping Keys. Magnetos and similar devices where there is frequent making and breaking of Electric Current. Also suitable for Gas Engines, Circuit Controllers, and like purposes.
Write for Particulars:—
THE L.P.S. ELECTRICAL COMPANY, 14, Howick Place, Westminster, S.W.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

Digitized by Google

SIEMENS

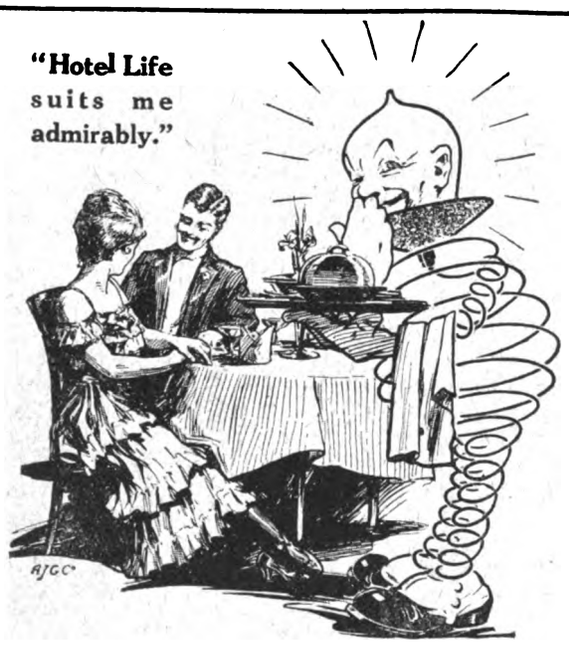
IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars
Distribution Boards
Main Switchboards

Write for particulars to —

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept. 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

"Hotel Life suits me admirably."



For Hotel Lighting
POPE
ELASTA
(British Made)
WIRE LAMPS
Strong—Brilliant—Economical

Advt. of Pope's Electric Lamp Co., Ltd., Hythe Road, Willesden, N.W. 10.

BRITISH TRADE WITH CHINA.

In our last issue we gave an abstract of the address which was delivered at the London Chamber of Commerce by Mr. Archibald Rose, H.M. Commercial Attaché at Shanghai, on our trade with China, means of developing same, &c. Mr. Rose has kindly sent us a list of 62 towns and cities in China which either have electric supply undertakings or the question of obtaining a supply is at present under consideration. There are 25 other towns, mainly in Manchuria, in which a supply of electric current is also given, but particulars of these are not yet available.

In the February issue of the Shanghai "British Chamber of Commerce Journal" some particulars (taken from the Japanese "Zaisei Keizai Jiho") are given of the electrical industry of China, which is described "as yet in its infancy," existing enterprises being confined almost entirely to large towns and open ports, and seldom extending beyond urban districts. The aggregate capacity of electric motors in China is stated to be only 70,000 kw. The number of electrical undertakings throughout China is 87, of which 62 are located in China proper and 25 in Manchuria. Eighty supply light or power services or both; four are carried on in conjunction with electric railways, while three are devoted to the manufacture of electrical apparatus and supplies. In China proper (including Hong Kong) there are only three cities (Shanghai, Hong Kong and Tientsin) where there are electric tramways. The South Manchuria Railway Co. operates street railways at Dairen and Fushun, the only towns having such services in Manchuria. According to the latest data, the electric energy supplied for power and light throughout China totals 33,000 H.P. and 1,375,000 c.p. respectively. As a prime mover, steam power is almost exclusively employed in China, water power being utilised only in Yünnan.

Out of the 87 Chinese electrical undertakings, six are Chinese Government enterprises, 53 are managed by Chinese private individuals, while the remaining 28 are foreign undertakings. Some of the Chinese private businesses, however, are run with foreign capital, so that the enterprises really under Chinese private management are only 41. Out of the 28 foreign undertakings Japanese interests number 10, seven of which are located in Manchuria. The capacity of the plants, represented by the Chinese (both Government and private), foreign (Japanese excluded) and Japanese enterprises is 22,000, 31,000 and 17,000 kw. respectively. The capitalisation of the industry amounts to about 36,000,000 yen (yen = 2s. 0½d.) of which foreign investments represent 14,000,000 yen, and Japanese investments to 5,000,000 yen. Electrical enterprise in China has not yet attained such a stage of development as to yield satisfactory returns on the capital, only 13 businesses declaring an annual dividend of 5 per cent. With the general development of industrial and economic resources in that country this branch of enterprise is bound to expand.

The first telegraphic system in China was introduced in 1882, under the direction of a Danish expert; the private telegraph business was nationalised in 1908, and now the entire service is controlled by the Ministry of Communications. At the end of 1913 telegraph lines extended over 37,403 miles, with 51,129 miles of wire. Submarine cables, with the exception of the Woosung-Canton line opened in the early part of 1915, are all under foreign control. The telephone service, inaugurated in 1903, consists of Government (both central and provincial) and private undertakings. The control of both telegraph and telephone systems is practically in the hands of foreigners, from the circumstance that these systems were constructed by the aid of foreign capital.

The electrical apparatus and supplies branch of the electrical industry is almost non-existent, with the result that there is severe competition in the Chinese market for the sale of apparatus and supplies. Before the war Germany occupied the first position, the United Kingdom the second and Japan came third in the value of goods of this class imported into China. Since then a considerable change has taken place, with consequent increase of imports from Japan and the United States. The following figures for 1913, 1914 and 1915 (given by the Board of Trade "Journal") show the early effect of the war on imports in this line from different countries:—

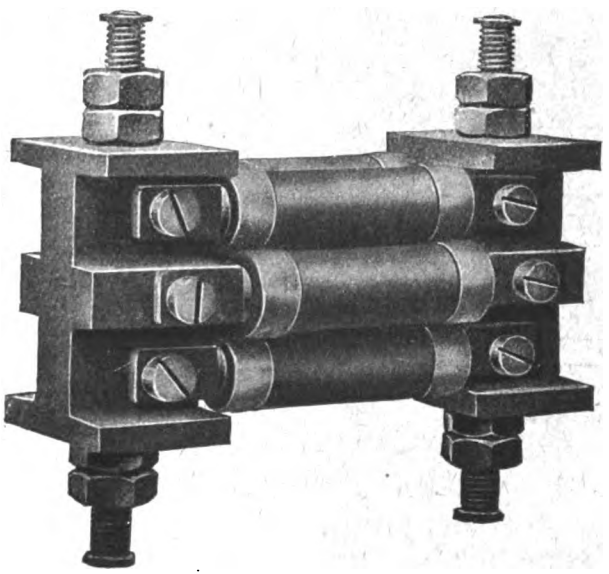
United Kingdom, 596,472, 735,870 and 403,851 Haikwan taels; Germany, 845,422, 735,884 and 1,412; Japan, 392,749, 688,140 and 845,053; Hong Kong, 173,980, 243,976 and 259,602; United States, 179,079, 134,733 and 285,010; Belgium, 70,515, 70,633 and 8,428; Other countries, 148,873, 185,181 and 281,683. The totals were 2,407,070, 2,794,417 and 2,085,039 taels respectively. The average value of the Haikwan tael was 3s. 0½d. in 1913, 2s. 8¾d. in 1914 and 2s. 7½d. in 1915. The growth of electrical industries, as well as other enterprises requiring the introduction of foreign capital, is hampered by the scarcity of funds occasioned by the war. On the return of peace, however, severe competition is expected to ensue in regard to electrical development in China. The activity of United States capitalists in China is remarkable, and they have formed a combination for exploiting the light, power and tramway services in the principal towns.

GENUINE
M & M VULCANISED FIBRE
MOSSES & MITCHELL, 122 & 124 GOLDEN LANE, LONDON, E.C.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.



Prescot Multiple Enclosed Fuses
(Patent No. 28872/11).

Built up of easily replaceable units disposed round terminal blocks, these fuses are particularly suitable for high capacity currents.

By a simple re-arrangement of the units, circuits can be protected for a current capacity of from 25 amperes to 900 amperes.

See Pamphlet P. 121.

BRITISH INSULATED & HELSBY CABLES.

LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Vicmaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.
ELECTRICAL MACHINERY
Engineers, Edinburgh.
See our Illustrated Advt. next week.

Digitized by Google

FOR

High and Low Tension

SWITCHGEAR

THE

NEW SWITCHGEAR CONSTRUCTION CO., Ltd.

SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

Manufacturers of

PHOSPHOR BRONZE,

GUN METAL, MANGANESE BRONZE

Brass & Copper

Tubes, Sheets,

Rods, Wire, and

CASTINGS.

PHOSPHOR TIN.

PHOSPHOR COPPER.

TRADE MARK.

CHARLES CLIFFORD & SON, LTD.,

BIRMINGHAM.

(Registered Trade Mark)

"FORMITE"

THE

BRITISH MADE SYNTHETIC RESIN

FOR

MOULDED & BUILT-UP INSULATION.

THE DAMARD LACQUER CO., Ltd.,

98, BRADFORD STREET, BIRMINGHAM.

LEWIS'S SCIENTIFIC CIRCULATING LIBRARY.

ELECTRICAL, MECHANICAL & GENERAL ENGINEERING TEXT BOOKS & TECHNICAL WORKS.

New Works and New Editions can be had from the Library immediately on Publication. Telephone: Museum 1072.

SUBSCRIPTION, Town or Country, from ONE GUINEA.
READING ROOM open Daily to SUBSCRIBERS.

H. K. LEWIS & Co. Ltd.,

136, GOWER STREET, and 24, GOWER PLACE, LONDON, W.C.

TRADE AND INDUSTRY AFTER THE WAR.

An interesting statement on the future of British trade was made by the President of the Board of Trade (Sir Albert Stanley) at the Aldwych Club last week. He said that an opportunity had been given to us, for which we could not be too grateful to the Germans, of reviewing all our past methods in respect of trade and industry. He had had in the last few months very exceptional opportunities of studying the business methods of this country and of our competitors of the past and of our competitors of the future. The conclusion he had definitely come to was that if our methods of the past were continued we should fail to hold our place in the front flight of business countries.

There was not (said Sir Albert) the slightest reason why the British Empire should not be the foremost industrial nation of the world. In most of the great industries which had secured enormous wealth and commanding positions to other countries this country took the initiative. It was not many years since this country produced more than one-half (nearly 60 per cent.) of all the steel produced in the world. In 1914 Germany produced 85 per cent. more pig iron and 143 per cent. more steel than this country. In spelter and copper we were entirely dependent upon Germany for our supply. Germany had established by business organisations such a hold on the non-ferrous metals of the world that we found ourselves at that time dependent on Germany not only for our supplies, but for any statistical information which would guide us in determining new sources. After a reference to the position of the dye industry, he said that those illustrations showed the extreme seriousness of allowing the system of penetration to continue. Unless industries could be carried on with an equal degree of efficiency, unless they could produce their manufactured products at a price that would compare favourably with those of their great foreign competitors, what chance had the country of succeeding in establishing its place with the other nations of the world? He thought the Governments from now on would take an infinitely greater interest in their industries and would make it their business to see that they were carried on efficiently and that we secured to the country the establishment of industrial enterprises which would make us absolutely secure against dependence on any foreign country for any essential commodity. In connection with many business undertakings he was struck by the extraordinary desire to retain what was considered important secrets of their business. Surely there was everything to be gained by an exchange of ideas. He was not an advocate of State ownership or State interference in business, but it must be borne in mind that those who had on their shoulders the responsibility for the conduct of great business enterprises and had under their charge the welfare and happiness of a great staff could not be free to determine solely for themselves exactly how those businesses should be conducted and to what extent they proposed to expand and develop them. If a duty rests upon the workmen to give the best of himself in return for a day's wage, he thought it rested upon the employer to do likewise. An employer should not be allowed to be satisfied with carrying his business to a certain point of expansion. There could be no standing still in business. You had to go forward. Every man interested in a great business had to make that business as big as conditions would permit. You had to study the methods prevailing in other countries and if you found, as was so common in this country, that small undertakings could not exist in competition with the great combinations found in other countries, then it seemed to him that you had to adapt your methods to meet the altered conditions. All that they were fighting for to-day would not seem worth while if, after it was over, they found there was no desire on the part of any of them to continue the fight for commercial supremacy in the world.

ECONOMIC POLICY OF THE EMPIRE.

An important memorial recently presented to the Imperial War Cabinet by 81 associations of producers and manufacturers (representing about £1,000,000,000 of capital) sets out certain basic principles upon which it is considered the economic policy and industrial organisation of this country and of the Empire should be framed in future. Among the associations who signed the memorial are the British Electrical & Allied Manufacturers, the Cable Makers and the British Engineers Associations, the British Empire Producers Organisation, the British Association of Trade and Technical Journals, the Electrical Contractors Association, the British Acetylene & Welding Association, the British Rubber Tyre Manufacturers Association, London Colour, Paint & Varnish Manufacturers Association, Scottish Association of Master Heating, Ventilating & Domestic

INSULATION BEADS

Asbestos Wire; also for flexible Leads, etc. AMPLE STOCKS.

HOLDER-HARRIDEN, LTD., 35/37, STREET, LONDON, E.C.

Digitized by Google

PRE-WAR STOCK

OF

MOTOR STARTERS

(as Illustrated)

½ to 2 H.P. (110-v. to 440-v.)

No-volt Release Magnetic Blowout on All Steps.
CHEAP BUT RELIABLE.

AT **PRE-WAR PRICES**

ALSO MANUFACTURERS OF FOLLOWING

SIX SPECIAL LINES

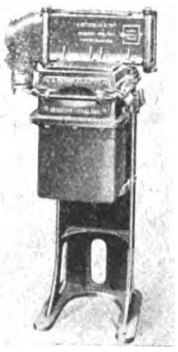
(1) **500-v. IRONCLAD SWITCH FUSES.** →

(2) **MOTOR STARTERS.**
Drum Type with Free Handle Circuit Breaker (interlocked), also Lever Type.

(3) **WALL PLUGS.** W.T., for outside use, as supplied to Admiralty, and Dustproof for Works use.

(4) **H.T. ARMOURCLAD SWITCHGEAR.**

(5) **MINING SWITCHGEAR.** ——→



(6) **PROTECTIVE DEVICES.** to isolate faulty sections on Power Supply Systems without interruption of supply through Sound Sections.

A. REYROLLE & CO., LTD.

HEBBURN-ON-TYNE.

Digitized by Google

The House for
ELECTRIC
HEATING

PETROL
PARAFFIN
GENERATING
SETS

F. Husband Ltd

Electrical Engineers and Manufacturers,
CRAVEN HOUSE, KINGSWAY,
LONDON, W.C. 2.

Telephone - - - - GERRARD 7601 (2 lines).

"The Electrician" Monographs.

Bound in limp cloth, 2s. each, post free 2s. 2d.

These **Monographs** are reprints of articles on special subjects which have appeared in *The Electrician*. They are written by well-known authorities and are published in book form and at a cheap rate (2s. each, post free 2s. 2d.) in order to make them accessible to all electrical engineering students, designers of electrical machinery, supply engineers and others who desire to consult reliable, up-to-date information on the special subjects dealt with.

Up to the present the following Monographs have been published:—

(1) The Estimation of the Dispersion Coefficient of Three-phase Induction Motor and its Application to their Design.

By E. A. BIEDERMANN, B.Sc.

(2) Notes on Design of Electromagnetic Machines. I.—Continuous-current Machines.

By S. P. SMITH, D.Sc.

(3) Notes on Commercial Transformer Design.

By F. M. DENTON, A.C.G.I.

"THE ELECTRICIAN" PRINTING & PUBLISHING COMPANY, LIMITED,
1, 2 and 3, Salisbury Court, Fleet Street, London, E.C. 4.

Engineers, Scottish Employers' Federation of Iron & Steel Founders, many Chambers of Commerce (British and Colonial) and other representative trade and industrial organisations. The principles set out in the memorial are as follows:—

1. That the deepened sense of our unity of interest in the face of national danger, as between various classes of the community, and as between the Dominions and territories of the Empire, must be recognised and maintained in all measures to be considered from the point of view of economic security and progress.

2. That the first claim on Imperial statesmanship is that remunerative employment shall be made available for all under conditions that will crown with comfort and prosperity the freedom for which we are now working and fighting.

3. That to this end the three great agencies of production, capital, labour and science, should be systematically directed towards the development of the boundless resources of the Empire so that it may become more productive, not only of the prime necessaries of life, but also of the essential materials of industry and of all departments of manufacture.

4. That the Resolutions of the Paris Economic Conference provide a sound basis for national self-development, and for maintaining mutually advantageous and privileged commercial intercourse between the Allied Powers.

5. That after the institution of such a system of reciprocal preferential arrangements as will give practical effect to the Resolutions of the Paris Conference, which can best be settled in detail by conference with representative organised associations of manufacturers and producers, our next Imperial duty is to stimulate the employment of available resources of mechanical and chemical science for enhancing productive capacity and so enriching the whole community.

6. That the system of general and technical education should be thoroughly revised to afford to all classes equality of opportunity for talent and industry.

7. That the State should, while facilitating general conditions, recognise and regularise the position of industrial organisations and give them additional responsibility for the efficient conduct of each section of industry. In conference with each other, with labour, and with the Government, they may thus found a system of industrial security and progress in true accord with the spirit of British enterprise as being capable of continuous adjustment to varying circumstances and giving opportunity for the exercise of individual energy and original endeavour.

It is in the light of these principles that we believe an Imperial Economic System can be constructed worthy of our vast natural resources and of a manufacturing capacity greatly enhanced in volume and variety as the result of war demands. Further, we believe that a consistent policy aiming at the efficient and bounteous production of the wealth of the Empire by and for our own people will not only establish all British States on a higher plane of progress and prosperity, but will confer material and social advantages on the rest of the world.

ELECTRIC POWER IN COPPER MINING.

At the meeting of the Tharsis Sulphur & Copper Co. (Ltd.) last week, the chairman (Lord Glenconner) said that at Tharsis they were erecting an electric power-station more than ample for all power requirements, including the power which would be required at the North Lode when it was fully equipped. At Corrales, their shipping centre, they were also building a power-station capable of supplying the energy required for the new ore-crushing plant, shipping piers and other smaller units at that place. The large ore-crushing plant which they had erected there so that it could deal with ore from any of the mines was nearing completion; in fact, all the new plant at Corrales would have been completed had they not unfortunately lost a consignment of machinery at sea. All their Calanas mine plant was electrified three years ago, and when the new plants which he described were completed they should have the most up-to-date installations, all with ample reserve for future developments.

CANADIAN MINERAL PRODUCTION.

The total value of the metal and mineral production of Canada in 1916 is estimated by the Mines Branch at $177,357,454, compared with $137,109,171 in 1915, or an increase of $40,248,283, or 29·3 per cent. There has been an increased production of nearly all metals with the exception of lead and silver.

Considerable progress has been made during the year in establishing and increasing the capacity of smelting and refining works, of which the installation of electrolytic zinc and copper refineries at Trail and the beginning of construction of a nickel refinery at Port Colborne, Ontario, are conspicuous examples. In addition, metallic magnesium is being produced at Shawinigan Falls, ferro-molybdenum at Orillia and Belleville, metallic arsenic at Thorold, and stellite, the cobalt alloy for high-speed tool metal, at Deloro. In addition there has been an increase in the capacity for the production of steel and particularly in the installation of electric furnaces. The mining output has been restricted and the efficiency of its operation considerably reduced by the withdrawal for war service of a large proportion of the more highly experienced labour and engineering supervision. Higher costs have tended to offset the advantages to be derived from higher prices of output.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,034. [Vol. LXXIX. No. 6] FRIDAY, MAY 11, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 215
Arrangements for the Week 217
The Standardisation of Engineering Materials and its Influence on the Prosperity of the Country. By Sir John Wolfe Barry, K.C.B., F.R.S. 218
Address by Mr. Michael Longridge to the Institution of Mechanical Engineers 220
The Choice of Voltage for Railway Electrification on the Direct-Current System. By F. Lydall 223
The Determination of the Torque of a Direct-Current Meter. By R. Alberti. Illustrated 226
MILL MOTORS 228
REVIEWS 228
High-Tension Overhead Transmission Lines. By G. V. Twiss. Illustrated.—*Continued* 232
CORRESPONDENCE 234
PARLIAMENTARY INTELLIGENCE 236
The British Westinghouse Company. Illustrated 235
Signalling Apparatus. Illustrated 235
LEGAL INTELLIGENCE 236
Patent Record 236
Volunteer Notices 236
COMMERCIAL AND INDUSTRIAL SECTION 239
Electricity Supply 240
Tenders Invited and Accepted 243
Financial Matters 244

NOTES.

The Boy in the Works.

THE present time is largely one of self-examination and of attempts to put our house in order, or at least to provide for doing so in the near future. Among the many problems to which thought is being given is the position of the boy in industry, for it is being realised that the boy presents a problem of his own. That it should be so is not by any means unnatural. Let any thoughtful person for a moment consider whether the boy in better circumstances could with advantage be turned loose to earn his living at the age of 14. The reply would undoubtedly be that it would be harmful to the boy, both physically and mentally. What is true of the boy in better circumstances is equally true of the boy who goes into the shops and suddenly finds himself transformed from a boy into something of a man at a moment's notice, and at an age when he is most receptive. It must be remembered that the average boy is a step in advance of what his parent was at the same age, and consequently the boy of to-day has very different ideas from the boy of a generation ago. In a sense, he has the disadvantages of education and of a better knowledge without the advantages of a later training which should enable him to place things in their true light. Consequently he is liable to develop fallacious ideas which lead to dissatisfaction and to the evolution of the young man who is no credit to his country.

A Suggested Remedy.

THE subject has been brought to our notice particularly by the reprint of three articles from the "Daily Telegraph" in the form of a pamphlet entitled "The Boy in Industry," which has been issued by the Ministry of Munitions. These articles form thoughtful essays dealing with the problem as a whole, and are a plea for the treatment of the problem largely on the basis that the boy is a boy and not a man. It is well that the boy should remain a boy, and there is no reason why supervision should eliminate the boyish spirit. On the other hand, a very great deal would be gained by supervision in many directions. We think it will be generally agreed that the only true solution of the difficulty is for education to be continued to a later age, as was recently recommended by the Departmental Committee on Juvenile Education in Relation to Employment after the War. Whether, however, the present system is continued, or whether the age limit for education is raised, there is room for suitable supervision in the works itself. At the end of the pamphlet above mentioned a scheme is outlined (on which further information may be obtained on application to the Welfare Department of the Ministry of Munitions, 6, Whitehall-gardens, London, S.W.). Briefly, this consists of the employment of a supervisor, who would be responsible for the engagement of boys, for looking after their progress and discipline, for their technical education, thrift, health and recreation. On the principle that the boy is more important than the man (for upon the evolution of the boy the man depends), we commend employers to peruse this pamphlet (costing 3d. at H.M. Stationery Office), and to give careful thought to the suggestions contained therein.

Mobilising the Engineers.

A WELCOME feature of the changes at the Admiralty, says the "Chronicle," will be the inclusion of highly competent civilians to deal with the provision of war material and the engineering side of the anti-submarine campaign. According to our contemporary, a whiff of fresh air from outside is badly needed at the Admiralty. Is it not remarkable that it has taken close upon three years of war to drive home to the Government the fact that there are such things in the country as highly competent civilian engineers? A large section of the lay Press appears to ignore the influence exerted during the past three years by the civilian engineers both at the Admiralty and in the War Office. By many, the Ministry of Munitions is held up as an example of what can be done by the State in the hour of need, and it is well these should know that the civilian engineer contributed very largely to this good work. But the poor use that has been, and is being, made of the civilians, and of the civilian engineers in particular, is one of the big blunders of the war, and is a blunder for which we are now paying very dearly. Although reforms are said to be under consideration, we question whether changes so late in in the day, unless they be drastic, will be of any real use, excepting as a precedent. Long before they declared war our kinsmen across the Atlantic took stock of their engineers and of their engineering resources, and set up strong boards of civilian engineers and scientists to consider and advise upon various questions which would arise in the event of war. A somewhat similar scheme proposed by the Institution of Electrical Engineers, either before or immediately after the declaration of war by this country, met with considerable support from the members, and with no support from the State. It was thought by the latter that the trimming of arc lamps and the like was work for which trained electrical engineers held the necessary qualifications. One of these days, we imagine, even the Home Government will learn that in time of war there is other work to be done which none but the trained engineer can do.

Digitized by Google

The Excess Profits Duty.

SINCE penning our comments on this subject last week the Chancellor of the Exchequer has made his statement on the Budget for the present year, and, as was generally anticipated, the question of excess profits received some attention. Unfortunately, the suggested modification is not that which we desired. Mr. BONAR LAW proposes to increase the 60 per cent. duty to 80 per cent., and it is evident that this announcement met with general approval. At the same time, the Chancellor, in noting this approval, admitted frankly that if the national needs had not made a large addition to the revenue necessary he would have been very glad to have left the tax where it was left by his predecessor. It is also interesting to note the view expressed by the Chancellor that the excess profits duty in the shipping industry had not fairly met the situation, and that merely putting on excess profits duty when there was something like a monopoly would almost unconsciously have the effect that the rates would be raised in order to increase the profits. It seems to us that this line of reasoning should have been extended somewhat further, and that this suggested increase may make the lot of the consumer still harder. We regret that no reference was made to the 20 per cent. basis on which controlled firms are taxed. The Chancellor referred to the hopes of a rapid recovery after the war due to scrapping of old ideas and of old machinery. Undoubtedly this hope will only be realised if the lesson of inefficiency has been properly learned and if co-operation between capital and labour is the keynote of a new era; but at the same time ideals are not all that are necessary, and unless taxation is adjusted so that our manufacturers have suitable reserves they will be most seriously handicapped in the international struggle which must follow the war.

Mr. Michael Longridge's Address.

IN Mr. LONGRIDGE'S address to the Institution of Mechanical Engineers there are many points of topical interest. Very naturally technical education finds a place, and also the organisation of engineering. In this part of the address it is very truly remarked that shops without definite planning for the progress of the work, where men drift about in search of tools and tackle, where machinery is obsolete and where lighting is so bad that good work could not be done even if the machinery were up to date, cannot possibly compete with the modern shop run on lines of "scientific management." In such shops the whole thing is planned from start to finish; cleanliness, light and comfort reign, and an endeavour is made to get the workman to regard his work more as a problem to be solved than as a task to be got through. The part of the address, however, which appeals to us most is that dealing with employers and employed. Mr. LONGRIDGE points out that a trade union policy which compels a workman to limit his output and his earnings, which refuses a manufacturer due return on his cost of installing up-to-date machinery and on expenditure for scientific research, is as injurious to the workman as it is to his country, and that if persisted in, it will ultimately ruin both. On the other hand, there has been short-sighted policy on the part of many employers. There has been a tendency to cut the rates in piecework, so that the earnings have been much the same as those obtained on time work. There has been mutual distrust, and a good deal of friction has been due to ignorance. In the opinion of Mr. LONGRIDGE more industrial disturbances are caused by misunderstandings than by wrongs, and there is probably a good deal of truth in this view. If that is so, the sooner organisations are formed for the proper adjustment of differences between employers and employed the better. Some of our readers may feel that this subject is becoming somewhat hackneyed, but in our opinion it is so extremely important to the future welfare of this country that too much attention cannot be given to its discussion.

Standardisation.

THE subject of standardisation is eminently a very suitable one at the present time for the James Forrest Lecture which is delivered annually before the Institution of Civil Engineers, and Sir JOHN WOLFE BARRY, as chairman of the Engineering Standards Committee, is particularly well qualified to deal with such a subject. To many people standardisation is a vague sort of subject, and they do not realise what is being done by the Committee and what large benefits are likely to accrue from these labours. The present lecture will do much to clear up the position, and to show the importance of the work which has been carried on very unostentatiously for a number of years. A few examples are sufficient to emphasise the results. Thus, in the case of tramway rails, there were some years ago 70 different sections, whereas the work of the country is now carried on with five sections of standard shapes. Similarly, in the case of railway rails, almost every railway company had its own section; now there are only nine standard sections of bull-head rail. The total annual output of rolled sections in a particular pre-war year was about 2,400,000 tons, worth about £17,500,000. Of this output 85 per cent. was rolled to standard specifications. Another important specification is that dealing with Indian locomotives, according to which 2,300 locomotives have been built. There are also many other specifications to which we need not refer, all of which mean a saving in cost to our industries. It is only right, therefore, that the Government should encourage this effort, and we are glad to note that a Government grant of £10,000 has been made towards the expenses of translating the standard specifications, which are to be issued at a fixed price of one shilling per copy, both here and abroad. The world-wide use of these specifications is highly desirable from the point of view of British trade.

Royal Society.—At the meeting held yesterday Prof. G. W. O. Howe read a Paper on "The High-Frequency Resistance of Multiple-stranded Insulated Wire."

Decimal Coinage and Foreign Trade.—A limited number of reprints of the following lectures, recently given before the Institution of Civil Engineers, are available for distribution:—Mr. H. Allcock, on "The Decimal System of Weights, Measures and Coinage"; and Mr. E. Crammond, on "Foreign Trade in its Relation to Investment of Capital." Copies can be obtained on application to the Secretary of the Institution.

Books for British Prisoners of War.—A word may be said on behalf of the thousands of our men, now in enemy hands, who are craving for solid literature with which to improve their minds and relieve the tedium of their captivity. The continued requests for books which are being constantly received from the camps furnish ample evidence of the value of the work being done in this field by the British Prisoners of War Book Scheme. From Germany, Austria, Bulgaria, Turkey and Asia Minor come insistent appeals for books on almost every subject, and there is also a demand for works of a scientific and technical character. Those of our readers who find themselves able to help in this way and who care to know something about the really great educational work which is going on among British prisoners, should communicate with Mr. Alfred T. Davies, chairman of the British Prisoners of War Book Scheme (Educational), Board of Education, Whitehall, S.W. 1. A booklet descriptive of this educational work is issued by the British Prisoners of War Book Scheme, and may be had on application to the above address.

Autographic Load-Extension Optical Indicator.—At the May lecture of the Institute of Metals last week Prof. W. E. Dalby, F.R.S., took as his subject "Researches made Possible by the Autographic Load-Extension Optical Indicator." Prof. Dalby pointed out that the shape of a curve so obtained in testing metals, more especially the plastic part of the curve, gave a great deal of information. Steel was characterised by a

Digitized by Google

drop in that part of the graphic record where the curve passes from the elastic to the plastic part. Alloyed steels, on the other hand, showed no such link between the elastic and plastic parts. The actual curve can now be obtained very rapidly in the latest form of instrument, and the time element is introduced ingeniously, in accordance with a suggestion by Prof. T. Mather, F.R.S., by using alternating current for supplying the lamp giving the illumination.

A Goods Clearing House for Docks.—In last week's issue of the "Graphic" an interesting diagram is given of the proposed application of Mr. Gattie's clearing house scheme to the handling of goods in docks so as to reduce the time of discharge of cargo to a minimum. The scheme is already familiar to our readers, so that we need not describe it. We have also received a letter from Mr. Gattie calling attention to waste of food on some railways owing to the difficulty of handling it. In reply to a question by Mr. Basil Peto, M.P., Sir Albert Stanley, President of the Board of Trade, recently replied—"At the present time an investigation into the system proposed by the New Transport Co. would not serve any useful purpose." Mr. Gattie's comment on this statement is that it is only a half-truth, and that if Sir Albert had given the whole truth he would have said that such an investigation would serve no useful purpose at the present time because he had already fully investigated the proposals and had expressed his full approval of them to Mr. Gattie.

Institution of Electrical Engineers.—In the "Journal" for April the following Military honours gained by members of the Institution are announced :—

C.B.—Le Rossignol, Lieut.-Col. A. E., Royal Engineers (Member).

D.S.O.—Cunningham, Major T. C., Royal Artillery (Associate); Dobson, Major J. H., S. African Pioneers (Member); McPherson, Capt. A., Highland Light Infantry (Assoc. Member).

Military Cross.—Curling, Capt. H. W., Army Service Corps (Graduate); Ditmas, Capt. F. I. L., Durham Light Infantry (Associate); Hartley, Sec.-Lieut. G., Lancashire Fusiliers (Assoc. Member); Tuppen, Capt. H. R., Army Service Corps (Student).

Nomination of President.—At a fully attended meeting of the Manchester Local Section of the Institution of Electrical Engineers, the following resolution was unanimously passed :—

The committee of the Manchester Local Section of the I.E.E. desires to put on record its strong endorsement of the action of the Council in nominating Mr. C. H. Wordingham as President of the Institution for the Session of 1917-18, and protests against the resulting attack which has been made on that gentleman in a section of the electrical press. Being convinced that Mr. Wordingham will uphold the highest traditions of the office, the committee wishes to assure him of its full support during his presidency.

Annual General Meeting.—At this meeting (next Thursday) a resolution will be put forward to enable members in future to vote by proxy.

The meeting will be followed by the annual meeting of contributors to the Benevolent Fund of the Institution.

OBITUARY.

Rankin Kennedy.—The death recently occurred of Mr. Rankin Kennedy, who was well known in electrical circles, and carried out many pioneer electric lighting and power installations.

Mr. Kennedy, who was 63 years of age, served his apprenticeship with Messrs. A. Barclay, Sons & Co. He took out a number of patents for dynamos, motors, &c., and was a frequent contributor to the technical Press, more particularly to our contemporary the "Electrical Review." He was the author of several books, including "Modern Engines and Power Generators" and "Electrical Installations." In later years he devoted himself mainly to consulting work, but he also carried out various experiments in aeroplane work, marine engineering, &c.

Sir Henry A. Wiggin.—We regret to record the death of Sir Henry Arthur Wiggin, Bart., a director, and at one time managing director, of Henry Wiggin & Co.

The deceased baronet was educated at King's College School and in Switzerland. Subsequently he went to the Royal Mining Academy of Freiberg (Saxony), but on the outbreak of the Franco-Prussian War he became a student at the Royal School of Mines, London. In 1871 he entered his father's firm of Henry Wiggin & Co. He took considerable interest in public and philanthropic affairs, and he was a director of several companies. The deceased baronet was an acknowledged authority in metallurgy and a member of the Iron and Steel Institute.

V. M. Dunford.—We regret to record the death of Mr. Valentine M. Dunford, of the Central Telegraph Office, London. Mr. Dunford, who was in his 53rd year, entered the Post Office service at the age of 16, and gradually rose to the position of deputy-controller, from which position he retired recently on account of ill-health.

I. Frankenburg.—We regret to record the death of Mr. Isidor Frankenburg, J.P., chairman of I. Frankenburg & Sons (Ltd.) Deceased was in his 72nd year.

PERSONAL.

Congratulations to Sir James Pender, Bart., and Lady Pender, on the occasion of their golden wedding. Sir James Pender, who is a son of the late Sir John Pender, G.C.M.G., is chairman of the Direct United States Cable Co., and a director of the Telegraph Construction & Maintenance Co., the Globe Telegraph & Trust, the Electric Construction, Metropolitan Electric Supply and other electrical companies.

The marriage of Second-Lieut. Harold H. Hirst (Manchester Regt., attached to Army Signalling Service), son of Mr. Hugo Hirst, chairman of the General Electric Co., to Miss Carol Lindon, took place on Wednesday.

Glasgow Electricity Committee recommends the following increases of salaries: Mr. W. W. Lackie (chief engineer and manager) from £1,100 to £1,400 by annual increments of £100, W. T. Calderwood (constructional engineer) from £350 to £400, and Mr. R. B. Maccall (chief clerk and accountant) from 400 to £500, by annual increments of £50.

Mr. C. Elliott recently retired from his position of district manager of the Post Office telephone service at Gloucester.

Mr. Kenzo Nakagawa has been appointed director-general of Japanese posts and telegraphs in succession to Mr. Jiro Tanaka.

M. Ramon G. Saldana has been appointed director-general of posts, telegraphs and telephones in Uruguay.

Lieut.-Col. E. W. Allen, A.S.C., has been appointed director of machinery and implements in the Food Production Department of the Board of Agriculture, in the place of Mr. P. D. D. Perry, who is transferred to the Ministry of Munitions to supervise the manufacture of agricultural machinery.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 11th (to-day).

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, S.W. Paper on "Works Records," by Mr. F. D. Napier.

SATURDAY, May 12th.

Royal Institution.

3 p.m. At Albemarle-street, Piccadilly, W. Lecture on "The Electrical Properties of Gases," by Prof. Sir J. J. Thomson, O.M. (Lecture II.)

Birmingham and District Electric Club.

7 p.m. At the Swan Hotel, New-street, Birmingham. Paper on "Electric Furnaces for Nitrates from Air," by Mr. E. K. Scott, M.I.E.E.

MONDAY, May 14th.

Newcastle Local Section, Institution of Electrical Engineers.

6.45 p.m. At the Mining Institute, Newcastle. Annual General Meeting. A short account of the early days of the Telephone, Phonograph and Electric Light, illustrated by lantern slides and old specimens of instruments, lamps and apparatus, will be given by Mr. J. H. Holmes.

TUESDAY, May 15th.

Illuminating Engineering Society.

5 p.m. At the Royal Society of Arts, John-street, Adelphi, W.C. Discussion on "Economies in Lighting in Relation to Fuel Saving."

THURSDAY, May 17th.

Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, S.W. Annual General Meeting.

FRIDAY, May 18th.

Royal Institution.

5.30 p.m. At Albemarle-street, Piccadilly, W. Discourse on "The Complexity of the Chemical Elements," by Prof. F. Soddy, M.A.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, S.W. Paper on "Metric Weights and Measures and Decimal Coinage," by Mr. E. C. Barton, M.I.E.E.

Physical Society.—The meeting announced for to-day (May 11) has been postponed until Friday, the 25th inst., at 5 p.m.

Digitized by Google

THE STANDARDISATION OF ENGINEERING MATERIALS AND ITS INFLUENCE ON THE PROSPERITY OF THE COUNTRY.*

BY SIR JOHN WOLFE BARRY, K.C.B., F.R.S.

Before approaching the subject of this the 25th James Forrest Lecture I ask leave to refer to the Founder of the series of discourses, and especially in view of his recent decease in March last at the ripe old age of 91 years.

He became Secretary of the Institution as long ago as 1859, and thus held the post for nearly 40 years, and during that long period of service devoted himself heart and soul to the interests of the Institution. These were nearest his heart, and he gave of his best not only to the welfare of the body, but also to every individual member and associate, whether young or old, who sought his advice and guidance.

I will now, with your permission, pass to the consideration of the work, past, present and future, of the Engineering Standards Committee, and to the general subject which is nowadays embraced under the word "Standardisation."

Dr. Johnson in his great dictionary of 1785 defined a standard as "that which is of undoubted authority; that which is the test of other things of the same kind."

Similarly, Webster in 1853 described a standard as "that which is established as a rule or model by the authority of public opinion, or by respectable opinions, or by custom or general consent."

And again Richardson in 1855 defined it as "that by which quantity or quality is fixed or regulated, rated, estimated."

This afternoon we shall not discuss standards or standardisation in general, but only their application to our British engineering industries. With this subject the Engineering Standards Committee have been concerned for the past 16 years.

Before entering on the history of this movement I should like to give some statistics in pre-war years of the British engineering trade.

The total number of occupied persons in this country in 1914 was given as follows:—

15,389,000 (12,134,000 male and 3,254,000 female).

These are distributed as follows:—12·66 per cent. agriculture; 11·39 per cent. commerce; 8·2 per cent. conveyance; 5·0 per cent. mining; 7·89 per cent. metals and machinery; 6·77 per cent. building and construction; 6·92 per cent textiles; 7·23 per cent. dress.

In 1912 it appears from Whitaker that 1,359,000 males and 74,000 females were engaged in the engineering industries. These figures and their relative proportions must be, of course, in this time of war considerably modified.

It is not easy to arrive at the annual value of the total production of the engineering trades, but it was in 1912 estimated in a general way at some £241,000,000, which was much less than for the same trades in Germany. The values of the total British output exported in 1913 are given in the Board of Trade returns as follows:—Iron and steel, £54,292,000; other metals, £13,279,000; cutlery and hardware, £7,972,000; electrical goods, £5,386,000; machinery, £37,013,000; ships (new), £11,027,000; railway carriages, trucks, motor cars, &c., £11,366,000.

It will be seen that in 1913 approximately about £140,000,000 represented our engineering export trade.

I propose now to enter on the main subject of my lecture, viz., British Engineering Standardisation.

The first notable step taken in the direction was taken by Sir Joseph Whitworth about 1841 when he urged and obtained the adoption of the Whitworth Screw Threads which came to be adopted here and in all countries. They remain as standards to this day, though extensions and modifications of the Whitworth original series have been found to be desirable and have been made.

Generally speaking, it appears that industrial standardisation abroad is to a considerable extent in the hands of a comparatively small number of national societies. There is so far no organisation similar to that of the Engineering Standards Committee, although, it is true, a concerted movement is being made in America to co-ordinate under one head the work of industrial standardisation, which hitherto has been carried out by numerous engineering and trade associations with considerable overlapping of effort.

In 1864 a committee of the Franklin Institute recommended the adoption of the Sellars Screw Thread, which is now known as the U.S. Standard. Also in 1898 the American Institute of Electrical Engineers appointed a committee, under the chairmanship of Prof. F. B. Crocker, of Columbia University, to consider the standardisation rules for electrical machinery. The chairman of this committee at the present time, which has now 34 sub-committees, is Prof. Comfort Adams, of Harvard University.

The Bureau of Standards of America was established in 1901, and although there had been previously a Bureau of Weights and Measures, it was merely a receptacle for Standards of Weights and Measures, &c., and not an active institution. The work of the present Bureau of Standards has greatly extended since that date, and its total Government Grant during 1916, including that for buildings, was nearly two-million dollars.

I would add that in France the Société d'Encouragement pour l'Industrie Nationale has since 1891 given much study and attention to the standardisation of metric screw threads, and now has a very complete series ranging from 0·4 mm. to 100 mm., which includes the entire series known as the Système International.

The extension of the principles of standardisation, however, slumbered in our country, and I do not think that anything of a general nature was here set on foot till January, 1901, when I brought the matter before the Council of the Institution of Civil Engineers. It was shown that many engineers designed work with special, though unnecessary, rolled sections, that consequently purposely made rolls had often to be cut for small quantitites of steel in order to meet these demands, causing unnecessary cost and delay, that each manufacture had its own sheet of sections without any community with other rolling mills, and that manufacturers could not with prudence roll for stock, as there was no certainty that their product would be wanted.

The same was true of tramway and railway rails, for everyone designed his own type for the same or similar duties, and each type had some quite unimportant difference of shape. Thus there were 70 different sections of tramway rails, and now the work of the country is better done by 5 sections of standard shapes. In the case of railway rails almost every railway company had its own section for each description and weight of rails used on its system. Now there are only nine standard sections of Bull Head railway rails in use on our railways, from a weight of 60 lb. per yard, increasing by 5 lb. per yard up to 100 lb. per yard. There are 17 standard sections of flat bottom rails ranging from 20 lb. to 100 lb. per yard, which are very largely, though not exclusively, used in export trade.

In the case of Portland cement there were almost innumerable specifications of the constituent ingredients and of tests prescribed, the difference being quite unnecessary. Now we have one standard specification for cement combining all that was good of former requirements. In 1902 there were in many industries variations in manufacture without any real value, which added to expense and delay without increase of efficiency.

The original Committee appointed by the Institution of Civil Engineers consisted of Sir Benjamin Baker, Sir Frederick Bramwell, Sir Douglas Fox, Mr. James Mansergh, the President of the Institution, Prof. Unwin, Mr. J. A. McDonald and myself—all of whom were members of the Council. We recommended after a careful study that a commencement should be made by drawing up standards for rolled sections of iron and steel for structural work and shipbuilding, and suggested that the Institution of Mechanical Engineers, the Institution of Naval Architects and the Iron and Steel Institute should be invited to co-operate. These bodies cordially accepted the invitation, and at a later date the Institution of Electrical Engineers were on invitation added. The above bodies, with, of course, the Institution of Civil Engineers, which initiated the movement, became known as the five Supporting Institutions.

When it was first decided to take up seriously the subject in 1901 and to form the Engineering Standards Committee, certain fundamental principles were recognised as indispensable:—

1. That the different interests of producers and purchasers should be thoroughly represented.

2. That the movement was a voluntary effort to introduce order into a condition of things which had become more or less chaotic, or at any rate which urgently required intelligent regulation.

3. That the movement being voluntary and in the interests of producers and consumers, all should be asked to give their services gratuitously.

4. That it should be recognised that, though a commencement would be made in two or three important matters, there would probably be many other subjects of engineering trade which also stood in need of systematic regulation, and that these would emerge as time went on.

5. That the Committee should only undertake to deal with any subject when a demand for their services came from important representatives.

6. That the Committee should not be merely an academical body, but one in the closest touch with the practical requirements.

* Abstract of the James Forrest Lecture delivered before the Institution of Civil Engineers, May 2, 1917.

Digitized by Google

7. That the Committee should not become a Testing Authority, but that their work should be to set up the standards.

8. Most important perhaps of all—that the work of the Committee should at all times be subject to revision, so that improvements could be incorporated, and that the various trades should not become hide-bound, nor their methods stereotyped.

Thus out of small beginnings the Engineering Standards Committee, a great voluntary effort, and one in which public spirit has been lavishly shown, was founded. The original Committee consisting of only seven members has now grown to the present far-reaching organisation with a main committee of 22 members, with 64 sectional committees and sub-committees, as well as numerous panels, dealing with standards relating to practically speaking the whole of engineering practice. There are now well over 500 members of the various committees.

The administration of the work is vested in the Main Committee composed of 19 representatives of the five Institutions who originally nominated the Committee, together with three members elected not as representing any particular Institution or Association, but on account of their eminence in the profession.

The first publication—viz., the "Lists of British Standard Sections"—was issued in 1903, and further specifications to the number of 77 have year by year been added up to the present year, while several others are under consideration. Revisions of publications in order to follow advances in the subjects dealt with have been from time to time undertaken.

The National Physical Laboratory acts as the Committee's official testing bureau and, generally speaking, is the ultimate scientific authority in matters concerning mechanical, metallurgical and electrical tests.

Soon after the first Sectional Committee was formed for dealing with rolled sections, demands arose in connection with other subjects and three other sectional committees were nominated for introducing standards in other important manufactures.

Thus the project of standardisation became launched in 1901-2 by the nomination of four sectional committees: (1) On bridges and building construction, (2) on materials for shipbuilding, (3) on locomotives and railway rolling stock, and (4) on railway and tramway rails.

The funds necessary for the carrying out of the work of the Committee were at the outset supplied by the five Institutions which originally nominated the Committee, and it was recognised at quite an early stage, not only that the support and countenance of H.M. Government would be invaluable to the movement, but also that the various Government departments who were large users of the materials for which Standards were being drawn up, were deeply concerned and should be asked to help, apart from financial aid, (1) by nominating representatives to assist in its deliberations, and (2) by the adoption of the Committee's standards when issued.

With this object in view the Committee appointed a deputation to wait upon the Rt. Hon. A. J. Balfour, at that time First Lord of the Treasury. Mr. Balfour, who was accompanied by the Rt. Hon. H. O. Arnold-Forster, then Parliamentary Secretary to the Admiralty, who took great interest in the movement, received the deputation in his private room in the House of Commons on May 30, 1902.

Mr. Mansergh, chairman of the committee, the late secretary and myself were subsequently requested to wait upon the President of the Board of Trade, Mr. Gerald Balfour, in regard to the financial support from H.M. Government, and as the result of this interview the Treasury expressed their willingness to include a sum of £3,000 in the estimates for 1903-4 as a contribution to the funds of the Committee for that year.

This financial support was subsequently extended over the years 1904-5-6 by a grant-in-aid equal to the amount contributed by the supporting Institutions, manufacturers and others, and was continued on a smaller scale down to 1916.

The Indian Government has made various grants towards the general expenses of the Committee in recognition of work done in the interests of that country, and especially in regard to the first report on the standardisation of Indian locomotives which received the approval of the Secretary of State for India in December 1904, and the Governments of New South Wales, Queensland, South Australia and Victoria have recently become subscribers to the Committee's funds.

The total expenditure of the Committee since its formation in 1901 to March 31, 1916, has been approximately £51,000, an average of about £3,400 per annum—not a large sum in view of the work accomplished, and contrasting somewhat strangely with the very liberal contributions to the Bureau of Standards in the United States.

The contributions towards the expenses received since the inception of the work in 1901 may be divided as follows:—

From His Majesty's Treasury £10,397, or an average of about £694 per annum.

From the Indian Government £1,800, or an average of about £120 per annum.

From the engineering profession and industry by direct contributions, neglecting the very large amount of time and money devoted gratuitously by members of the Committee to the work, £20,000, or an average of about £1,334 per annum.

It will have been observed that among the four Sectional Committees first formed in 1901 was one for arriving at standards for locomotives. It is much to be regretted that, as far as locomotives for service in this country are concerned, very little has been effected. In India it has been otherwise.

Demands have recently arisen for the standardisation of cargo ships and of agricultural machinery. In neither case have these demands assumed as yet an official character, but, if such takes place, the Standards Committee will no doubt be prepared to act.

It is, of course, impossible to trace the full effects produced in trade of the Committee's recommendations, and we may be confident that what has been the acknowledged effect in these, has been, and is year by year, being realised in all. In the matter of rolled sections for construction and shipbuilding, the total annual output in a pre-war year was about 2,400,000 tons, worth probably about £17,500,000. Of this quantity at least 85 per cent. was rolled to standard sections and specifications, and in some cases the proportion rises to 95 per cent. upwards. Of rails for railways and tramways amounting to 991,000 tons annually, of a value of about £6,100,000 approximately 75 per cent. of tramway rails were rolled to British standard, and in the case of bullhead railway rails, which are almost exclusively used in this country, although it is more difficult to give a definite figure, it is no exaggeration to say that rails now rolled to standard are rapidly approaching a figure of 90 per cent., as practically all the railway companies since the war have agreed to adopt the standard.

It is more difficult to arrive at the proportion of electrical products made in accordance with the British standards, owing largely to the state of flux of the industry due to the rapid advance of knowledge in this science. Most of the telegraph material employed by the British Post Office, the whole of the tramway poles now used throughout the country, and at least 90 per cent. of the cables and wires for electric light, telegraph and power purposes are made to British standard. According to the last census of production, the cables and wires alone are given at about £4,000,000 per annum.

In 1905 the Standard Specification, dealing with Indian locomotives, was issued and by 1908 a thousand engines had been built or were under construction, and this number has now increased to 2,300 locomotives, representing roughly 7½ millions of pounds sterling. Ten years of practical experience has shown the advantages of the policy which has been pursued in India both from a public point of view and from that of the trade.

From whatever point of view the subject is considered, whether from economy of money in such very large annual figures, or from the aspect of the saving of time and of the certainty that if the purchasers see that they are supplied with the standard articles they will get the articles they require and of the best kind, it will be recognised that the work already performed and still in progress by the Standards Committee assumes a position of great national importance.

Having thus endeavoured in the time at my disposal to give some idea of the history and work during the past 16 years of the Standards Committee in this country as affecting the home trade and portions of our export trade, I desire to draw attention to what it will be agreed is now an important matter as affecting our foreign commerce.

I was invited as Chairman of the Standards Committee to attend last summer a Government Committee on engineering industries under the chairmanship of Sir Clarendon Hyde, and to explain what had been done by the Standards Committee's efforts, and I was asked by the Committee several questions on the future of foreign competition, especially in countries of Latin origin and in Russia.

The conclusion at which the Standards Committee arrived was that there is urgent need for steps which will assist our engineering manufacturers in competing successfully in foreign markets.

We recommend:—

(*a*) That the specifications of the British Engineering Standards Committee, or at least the more important of them, should be at once translated into French, Spanish and Russian, with metrical equivalents for the British measurements and formulæ.

(*b*) That local committees of engineers and traders in close touch with the main Committee in London should be formed at about 12 important trading centres—for example, in the Argentine, Brazil,

Digitized by Google

Canada, Chili, China, India, Peru, Portugal, Russia, S. Africa, Spain, Uruguay.

(*c*) That the price of all our publications whether in English or the other languages should be largely reduced—viz., to about 1s. a copy, or its equivalent in foreign moneys.

(*d*) That the local committees should have as Chairman the British Consul or other representative of the Government.

The Government decided to give their assistance in carrying these investigations into effect. The Foreign Office and the Board of Trade will support the new venture through their officials, and the Treasury have given valuable financial assistance.

In alluding to these recommendations, I should like to say that in recognising that metrical equivalents are necessary for countries which have adopted and possess them, we do not enter on the thorny subject of a compulsory general change of British standards. In the case of our foreign trade, it is no doubt our business to use the standard measurements of the countries which are our customers, and we are adopting that principle, quoting also alongside the British measurements. It seems in many quarters to be forgotten that under the laws of the British Empire the British and metrical measurements are equally legalised.

All these developments abroad, including the reduction in the price of our Standard specifications, will cost money both in the first place and annually. Our Committee have accordingly asked for, and have obtained, substantial assistance from the trades concerned, amounting, so far, to close on £13,000, and His Majesty's Government have made a grant of £10,000 towards the expenses of the new departure. The funds at our disposal have thus enabled the translations to be set on foot and the cost of our publications to be reduced to a flat rate of 1s., following in that respect the example of the United States, who sell their specifications generally for a quarter of a dollar or less.

ADDRESS BY MR. MICHAEL LONGRIDGE TO THE INSTITUTION OF MECHANICAL ENGINEERS.*

In the circumstances of to-day a review of developments and inventions of the last 50 years would hardly be a suitable subject for a Presidential Address. Its scope would be too narrow. Our minds are occupied with matters of far greater moment than the developments of power plants for driving mills and works. They are fixed upon the war, and the evolution that must follow it. I shall ask you, therefore, to look back for a moment on the past, to view it from the standpoint of to-day—the retrospect may give some clue to the causes of our failures—and then I want to mention some of the things which we have done to repair our losses and some of the many we have yet to do.

When our Institution was founded in 1847, mechanical engineering, together with the other industries it served, was rapidly acquiring that pre-eminence which was soon to earn for England the title of the Workshop of the World. The mechanical engineer was favoured by circumstances of time and place. The country's natural wealth in coal and iron stone had supplied him with the raw material of his trade. The improvement of the steam engine by James Watt had given him power to drive his works. The evolution of the locomotive and the railway by George and Robert Stephenson had provided cheaper and more rapid means of internal communication than were available elsewhere. The application of steam power to navigation initiated earlier in the century by Robert Fulton and Henry Bell, the numerous harbours on our coast, and the protection of a Navy supreme upon the seas, facilitated and safeguarded trade abroad. Finally, the abolition of the corn laws, if it devastated agriculture and hazarded the safety of the nation, undoubtedly assisted the mechanical engineer, first, by driving the rural population to the towns and thus providing labour for the workshop, and, secondly, by enabling foreigners to become his customers by paying for his productions with their corn. The extraordinary expansion of the cotton trade following the inventions of Hargreaves and his fellows, and the substitution of iron for wood in shipbuilding, also brought no small prosperity to the mechanical engineer. With such advantages it is not surprising that before our Institution came of age England had won the title she has now for a long time lost.

In winning this title she was transformed from an agricultural and practically self-supporting nation into a manufacturing community dependent for its existence as we realise too well to-day, upon imported food.†

And as the mechanical engineer was responsible in no small measure for the transformation, so he must be held responsible for the maintenance and efficiency of the workshop on which the feeding of the people and the defence of the people against their enemies now depend. He became and he remains a trustee for the British Empire. How did he discharge the trust ?

Let me unfold the story of the engine-building trade of Lancashire. There was a time when shops were many and full, when Lancashire steam engines were sent wherever steam engines were used, when Lancashire's supremacy in this branch of engineering was beyond dispute. In 1900 I went to the Paris Exhibition. I went there primarily to see the stationary engines, whose claims in the matter of steam consumption were beginning to attract attention here. In elegance of form, in completeness of finish, in careful arrangement of details, the engines exhibited by some of the Continental makers excelled any I had seen before. The British stationary engines, small in size and number, slovenly in finish, makeshift in the fitting of accessories, proclaimed to seeing eyes the dangerous excellence, not to say superiority, of the foreign work.

Ominous as the exhibition was, it failed so far as I could see, to produce any important changes in the practice of British engine-building firms. Nor is this very surprising. Those in authority in the drawing offices and works were still men trained exclusively in the shops. The "produce of the technical school" was still widely held to be a useless, if not a noxious product, and perhaps in the early days of technical education his training did not make for easy correspondence with his new environment.

In the nineteenth century few British engineers were able to guarantee the steam consumption of their own steam engines. To-day most contracts contain consumption guarantees. If these guarantees are not so low as those obtainable abroad, I think their fulfilment sometimes falls less short of promise.

Most other branches of mechanical engineering have suffered more or less from foreign or American competition. Some of the causes of our relative retrogression are beyond the control of engineers, others they can remove in part or altogether, and of these I think inefficient technical education, lack of trade organisation, and the policy of the trade unions claim special attention.

TECHNICAL EDUCATION.

In the early days of our Institution most engineers were trained entirely in the shops. Theoretical knowledge was uncalled for and even held to be antagonistic to practical success. There was no supply of scientific engineers, partly because there was no demand, and partly because the places where a man could study the theoretical side of his profession were few and far between.

It was not till 1877 that the Livery Companies in London, belying the popular idea of their activities, appointed a committee to consider the possibility of initiating a National scheme of technical education. The City and Guilds Central College was the result. Its foundation in 1880 marked the first public recognition of the need of something more than office or workshop training for the engineer. Then came the appointment of the Royal Commission, which reported in 1884, the formation of the National Association for the Promotion of Technical Education in 1887, and the Technical Education Act of 1889, which refused to the schools it governed the means of teaching the practice of any trade. In 1890 only was a real foundation laid by the transfer of the control of technical education from the School Boards to the local authorities, and the appropriation of half the "whisky money" for its support.

The result has been a vast expenditure on technical schools. Nearly every local authority has built one. These schools range from the technical school of the small borough, where engineering instruction is limited to evening classes, to institutions of university rank like the Municipal School of Technology in Manchester.

Besides these we have provided engineering courses in most of our older universities, and endowed new ones, where science enjoys more prestige than Greek. To Oxford, Cambridge, St. Andrews, Glasgow, Aberdeen, Edinburgh, Dublin, Durham, London, we have added since the foundation of this institution, Manchester, Wales,

* Abstract of Presidential Address before the Institution of Mech. Engineers, April 20, 1917.

† Wheat consumption of the United Kingdom :—

Year.	Home grown.		Imported.
1842	22,000,000 quarters	...	2,970,000 quarters
1914	7,300,000 „	...	29,220,000 „

Digitized by Google

Birmingham, Liverpool, Leeds, Sheffield, Bristol, Belfast, and the National University of Ireland.

With all these schools and colleges it might be thought that the problem of educating engineers and engineering workmen had been completely solved. Unfortunately it has not. Our innate conservatism ties us too much to the traditions of the past. Many still fail to understand that the manual training which enabled an apprentice to become a master craftsman in times gone by, does not suffice to turn a schoolboy into an engineer to-day. The functions of the engineer and craftsman are entirely different, and their training must be different also. Moreover, differentiation is needed in the training of the various classes of engineers and workmen. This lack of differentiation seems to be one cause of the inefficiency of our technical education relatively to its cost. Another certainly is insufficient preparation of those entering the technical schools.

There are many Englishmen of the best type with initiative, ability to organise, and power to lead and manage men, yet really incapable of assimilating much book learning, especially higher mathematics. Do not let us make the mistake of forcing these men through the same collegiate course as men of different mentality, and then passing them on examination with a low percentage of full marks. It would be infinitely better for everybody to keep them to more elementary work and require a high standard in examination. We must not underrate these men in our new-born zeal for scientific formulæ. Many of them are of our very best. The Institution recognises their value by admitting them without examination at 30 years of age. I hope the rule will not be changed.

My chief complaint is against the obstinacy of our two most famous universities in retaining Greek as a compulsory subject in their examinations. This reacts upon our public schools, and is a serious handicap on those who, intending to deal with the concrete rather than the abstract in their future lives, yet wish to find their level in the social life and moral discipline of these two universities.

The education provided for the workmen, on the other hand, both general and technical, is most unsatisfactory. Trade apprentices who enter the shops at 14 years of age, and sometimes earlier, seldom have subsequent opportunities for learning other than, at evening classes. Some are resolute enough to attempt brain work at the end of a day beginning between 5 a.m. and 6 a.m., and some are strong enough to profit by their attempt. The majority are not. I have seen in some paper that technical education in England and Wales is provided in 6,876 evening and similar schools, but that the average attendance is about one hour per week.

In parts of Scotland continuation schools are provided in connection with the industries of the districts, and parents and employers are compelled to send young people to them during working hours between the ages of 14 and 17 years. In England, the difficulty is overcome in some large works by allowing promising boys to spend some of their working hours at technical schools without loss of time or pay. In others, technical instruction is given in the works. Unfortunately British engineering works are generally too small, and the managers too unwilling, to co-operate with each other to allow such arrangements to become general. Either the age for leaving school will have to be raised or some scheme devised for combining technical instruction (not mere craftsmanship) in the works, but with general instruction in the schools in working hours—unless engineering employers refuse to take lads into the works till they are 15 or 16 years of age. Apprentices entering works from the junior technical schools at 15 or 16 will be better workmen at 21 than those entering at 12 or 14 from the elementary schools.

I think, also, that a clear distinction should be made between technical colleges of university rank on the one hand and senior technical schools, whose entrance standard is lower than university matriculation, on the other. The interests of engineers require two classes of institutions giving technical instruction, each with its definite purpose :—

1. Technical "Colleges."
2. Technical "Schools" (senior and junior).

The Technical "Colleges" should be of university rank, and should be departments or faculties of universities, like the Municipal School of Technology in Manchester, not independent of them, as in Germany. They should provide two courses, one for the scientific advisers and designers, the other for the managers and business organisers.

The reason for making these schools departments of the universities is that the connection would prevent overlapping of teaching, and would ensure that uniformity in examination standards which some of the universities are trying to bring about. By uniformity of examination standards I do not mean uniformity of technological teaching. In this respect some diversity, and some degree of specialisation would be desirable.

The Technical "Schools," both the senior and the junior which are frequently housed with them, should also have two courses, one suitable for men likely to become foremen or supervisors, the other for those likely to remain manual workers. These courses should not be purely technical. The schools would receive their students from the elementary and lower secondary schools. They should remain under the local authorities, so that the technical teaching might be varied in accordance with the local trades.

Another desideratum is co-ordination, of the work, especially between the higher secondary schools and what I have called the technical colleges, and between the elementary and lower secondary schools and what I have called the technical schools, so that pupils passing from the one to the other would be properly prepared for the change. We also need a uniform system of adequate scholarships, to enable the best intellects among the poor to go up the whole educational ladder and mix on equal terms on each rung with those better endowed with this world's goods. The number and values of the scholarships available depend at present too much upon the ideas of the various local authorities.

Organisation of Engineering.

And now I must pass on to my second point—organisation, or, rather, lack of it. Mechanical engineers are broadly divided into two classes—manufacturers and consultants.

There was a time when the consulting mechanical engineer sent out his own drawings, and the manufacturer had to work to them. Now the engineer sends out his specification, but the manufacturer makes his own drawings and works to them, or offers some standard article complying more or less with the specification of the engineer. To-morrow the engineer will merely describe the work the machinery he requires will have to do, and witness the tests of its performance. Some day he will become a mere inspector, the manufacturer supplying the scheme and the machinery required for its working from his own designs.

But if manufacturers wish to be freed from interference of consulting engineers with their designs and processes, they must give their customers full information about the machinery they tender for. Their specifications are often extremely vague. The specifications of engine builders, for instance, are filled with such phrases as "great strength," "ample bearing surface," "best materials," "highest class of workmanship"—none of which convey the slightest meaning to the customer or his engineer. *They* want to know the stresses and pressures per square inch allowed, the materials to be used for the various parts, which surfaces are to be machined, and what tolerances are allowed. It would be better if all engine builders built their own standard engines, as some do now, and refused to alter them, but gave each customer a complete set of blue prints—as very few do now—marked (not necessarily with dimensions), but with stresses, loads, materials and machining. If the engines were built on a proportional system, one set of prints, though necessarily not to scale, would serve for a whole series. The customer would then see what he was going to buy and the engineer could "manufacture" instead of building each engine to a special design. Thereby much trouble and expense would be avoided.

The objection has been raised that if A sent out his drawings B could copy them. Well, what if he did ? A could copy B and both would be gainers by exchanging their ideas. Else why does the Institution of Mechanical Engineers exist ?

Except in a few cases, workshop organisation here has not received the attention given to it in America and Germany. There are still shops without definite planning of the progress of the work, without adequate equipment of jigs and gauges, and without standard shapes of tools or a tool room, where men drift about in search of tools and tackle or wait in idleness for drawings or materials, where machinery is obsolete, and light so bad that good work could not be done even if the machinery were up to date.

Such shops will have to go. They cannot compete in price or quality of work with those where, what is known as "scientific management," or anything approaching it, prevails ; where the progress of every job is planned to the last detail before it is sent into the works ; where machinery is so arranged that each piece passes through the whole series of operations to be performed upon it in predetermined order and without pause, and is immediately succeeded by another piece to undergo the same cycle of operations ; where labourers and tackle for fixing the work in the machines are ready the moment they are wanted ; where drawings, gauges, tools properly ground to standard shapes come with the work ; where cleanliness, light and comfort reign, and where endeavour is made to get the workman to regard his work more as a problem to be solved than as a task to be got through.

And if the industry is insufficiently organised in machinery and shop management, it is still more so in the equally important busi-

Digitized by Google

ness of obtaining orders to keep the shops at work. There are no central selling agencies like that of the great thread "Combine." Each firm has its own agents. Some kind of combination or co-operation among engineering firms, especially the smaller firms, seems very desirable, if not indeed essential.

Combinations have been arranged in other trades. The Fine Spinners and Doubles Association, Associated Portland Cement (Ltd.), Wall-paper Manufacturer (Ltd.), United Alkali (Ltd.), the North British Locomotive Co., are examples. In Germany, I understand, the dye trade, and all the trades ancillary thereto, have just been combined into one vast concern, with a capital of 800,000,000 marks. The great and powerful combinations in the steel trade in America and Germany cannot be ignored. The industrial world does not stand still. Similar combinations among engineers will have to be seriously considered.

Such associations as the Federation of British Industries and the British Engineering Association (the B.E.A.), with which is now amalgamated the Council for the Organisation of British Engineering Industries, the British Electrical and Allied Manufacturers' Association, &c., might serve as the components of a practical and effective scheme for the organisation of the British engineering industry.

At the one end of the chain there might be the individual employer responsible to the district executive of the British Engineering Association for the management of his own works, the corresponding trade union authority being the shop stewards or the men's shop committee.

The next link would be the district executive of the British Engineering Association with which might be amalgamated the district committee of the existing Engineering Trades Employers' Federation. This district executive would be charged with the oversight of the district employers, works and trade. In co-operation with the district officers of the trade unions they would arrange rates of wages and piece-work, terms of co-partnery, the number of apprentices for whom places could be found and the means of continuing their education. The district executive would receive reports from employers as to the state of their order books, their difficulties with labour, supply of materials, and transport; also as to experiments and research required to overcome local manufacturing difficulties, and would report to the Executive Council of the B.E.A.—*i.e.*, the executive council of the entire engineering industry.

The next link—the supreme body in the engineering trade—might be the executive council of the British Engineering Association. With it might be amalgamated the existing Engineering Trades Employers' Federation. Its proposed activities would include transport, intelligence, production, patents, publicity, finance, education, research and legislation in the broadest sense. The council would act through standing committees.

Last of all would come the federation of (all) British industries and the federation of trade unions, if that body be brought to birth. These would deal directly with a Minister of Industry and Commerce. The chain would then stand thus:—

The Manufacturer.	=	The Shop Stewards.
The District Executive of the B.E.A.	=	The District Officers of the Engineering Trades Unions.
The supreme Executive Council of the B.E.A.	=	The Executives of the Engineering Trade Unions.
The Federation of (all) British Industries.	=	The Federation of Trade Unions.

The Ministry of Industry and Commerce.

As yet there is no Minister of Industry and Commerce, but there is a Minister of Labour. Labour is a very essential element in industry. Both have the same interests. Let us not have two Government departments to squabble with each other and accentuate the difficulties which we hope to smooth away. Let the Ministry of Labour absorb all interests and become the Minister of Industry and Commerce, acting for the interests of employers and employed alike.

EMPLOYERS AND EMPLOYED.

Now I come to a problem of far greater difficulty, the negotiation of a treaty to secure a lasting peace between employers and employed. Without this peace the victory over Germany, for which we have sacrificed so much, will be in vain. The future of the British Empire depends on its attainment.

I hope the trade unions will have learnt, before the war is over, that a policy which compels a workman to limit his output and his earnings, which refuses a manufacturer a due return on the cost of installing up-to-date machinery, and on expenditure for scientific research, is as injurious to the workman as to his country, and that if persisted in it will ultimately ruin both, even if it bring particular unions some temporary gain. If we are to compete successfully with nations in whose industrial vocabulary "ca' canny" finds no place, limitation of output and restrictions on working machinery will have to be given up. But if the unions be wise enough to give up voluntarily what we have undertaken to restore, we are in honour bound to give them some acceptable equivalent.

For 100 years employers and employed have been at war, and war leaves bitter memories. The war began when the tools of his trade were transferred from the workman to his master and he became dependent for permission to use them on his master's will. The law forbade him to improve his lot. With the exception of a few men like Robert Owen and Michael Sadler, employers as a class for many years consistently opposed all legislation making for the health and safety of the workers. The workers know, too, that some employers refuse to recognise the unions even now.

Employers also should consider how far limitation of output, and objections to piece-work, profit-sharing and co-partnership, two of the most serious causes of difference with the unions, are due to their own short-sighted policy in cutting piece-work rates. The case has been very plainly put by Mr. Barnes, M.P. "The system," he says, "has been a failure because, in the stress of competition, piece-work earnings have tended to slide downwards to what previously had been a time-work wage." Indeed, it would almost seem to have been an article of economic religion that a workman's earnings should be limited by precedent. And thus we go on in a vicious circle, the master unable to increase wages because the workman will not give the necessary output, the workman limiting the output because the master does not raise the pay.

But that is not the only reason why the workman limits output and refuses piece-work. Deeply in his mind is rooted the belief that increased output causes glutted markets, short time, and unemployment, a terror which casts its shadow over his whole life. This delusion can only be removed by education.

We have to convince the workers by experience, and teach them by education, that piece-work, co-partnery and large output are to their advantage, and that only by putting the best machinery to the best use can high wages, relatively to the cost of living, be maintained.

And here I venture to interject a timely caution. Directly the war is over the engineering trade will have a period of activity without precedent; wages will, if possible, rise, and enormous profits will be made. These profits must not be distributed in inflated dividends, as in the "boom" after the Franco-Prussian war, first, because large dividends will encourage speculative enterprises whose failure will hasten and accentuate the financial stringency and bad trade which must come when the first great boom has to be liquidated; and, secondly, because the money must be saved to keep up wages and employment when the bad times come and the employers' theory of piece-work is put to the test.

To-day piece-work prices are fixed in some places by associations of employers and employed, but generally, I think, the former have had and still have the business practically in their own hands. In the future I hope that not only piece-work rates, but wages, demarcation, and other disputes will be settled jointly by one or other of the associations I have mentioned.

Then there is another matter which will have to be considered soon—the length of the working day. We ask for better education of the workers. We mean to try to give it them. But to enjoy its fruits they will demand more leisure, and I think public opinion will uphold them. It is, perhaps, worth while mentioning that the three great disputes in the engineering trade were concerned with one or other of the subjects I have mentioned, qualification of men to work machines, hours of work and limitation of output. The object and results of these disputes are worth consideration. The lock-out of 1852 was brought about by a demand for the abolition of piece-work and the removal of labourers from machines. The masters were victorious. The strike of 1871 was caused by the refusal of the employers to grant a 54 hours week. The men won. The lock-out of 1897-1898, though it began with a strike on the question of an eight-hours day, was really brought about by interference of the unions with the management of the works, the selection and training of machine workers, objections to the employment of non-unionists; but, above all, by limitation of output.

I plead for understanding and forbearance from employers. You cannot drive 2,000,000 trade unionists, but you can educate and persuade them. "In a national crisis men should think more of what they could give than of what they were likely to get," said a great labour leader to the Manchester Trade Union Congress only three months ago. Can *we* not act upon his words—the time is ripe.

Digitized by Google

THE CHOICE OF VOLTAGE FOR RAILWAY ELECTRIFICATION ON THE DIRECT-CURRENT SYSTEM.

BY F. LYDALL.

Summary.—The author considers first the conditions which apply to the problems of main line electrification in this country, and assuming that the high voltage direct-current system is adopted, gives reason for supposing that the voltage selected for a general electrification scheme would not be especially high. The number of different classes of locomotive is discussed, and designs for each class are worked out on the basis of four different line voltages—viz., 1,500, 2,000, 3,000 and 4,000. Details relating to these designs are given, and it is shown that even for the highest voltage considered there are no technical difficulties in the construction of suitable locomotives of all classes. Finally, a rough estimate is given of the extent to which the cost of a locomotive of any of the classes proposed is affected by the voltage selected.

A good deal has been written or said about the high voltage direct-current system as applied to railway electrification, its advantages and its drawbacks from one point of view or another. The literature consists mostly of published descriptions of locomotives or motor-car trains built for lines in the United States or on the Continent, and for one or two short stretches of line in this country. These descriptions are in some cases fully detailed, and are sufficient to prove that under certain conditions voltages as high as 5,000 can be employed. The information provided by these descriptions, however, and the views of various speakers in the discussions on this subject at meetings of technical institutions are not such as to lead to any definite conclusion as to what voltage is the most suitable for a general railway electrification in this country.

It will be remembered that Mr. Storer in his recent Paper before the Institution of Electrical Engineers on this subject, dealt with the matter mainly from the point of view of the desirability that rolling stock on one railway designed for one voltage should be arranged so that it could, if necessary, run over another railway equipped for a different voltage. Apart from urban and suburban electrifications, the length of line operated electrically in this country is still so small, that one may fairly say that the railways as a whole have not committed themselves to any particular voltage. On the North Eastern Railway between Shildon and Newport a distance of about 18 miles, a voltage of 1,500 has been adopted; but so far as the line equipment is concerned there would be very little difficulty in raising the pressure to 3,000 or even 4,000. On the London, Brighton & South Coast Railway, where the single-phase system at 6,000 volts has been adopted, a change to the high voltage direct-current system could, if desired, be made with very little alteration to the line equipment, although there would have to be a very extensive scrapping of rolling stock and sub-station equipments, which could not be contemplated until the existing electric stock has been in service for many years.

It may be said, therefore, that there is still an open field for adopting any direct-current system common to practically all the railways, and the question as to what would be the most suitable voltage is still unanswered, and very little attempt has been made to answer it. The difficulties are three, and can be put in the form of three questions, viz.:—

(*a*) Are there any engineering or technical obstacles to the use of a comparatively high voltage, say, 3,000 or 4,000, for all purposes in a general railway electrification?

(*b*) How does the cost of the rolling-stock equipments vary with the voltage adopted?

(*c*) On what basis of traffic requirements should the calculation of the most suitable voltage be based?

I propose in what follows to make an attempt to deal with the first two of these three difficulties. The technical questions are more susceptible of precise treatment than the matter of price, the basis of which is at present continually changing. It should be possible, however, to arrive at some results, however approximate, which may be of value if based on carefully worked out designs. The third difficulty is essentially one to be dealt with by railway engineers and traffic managers, and does not come within the province of the electrical engineer.

I have heard it said by a competent electrical engineer that there is no serious difficulty in the use of high-voltage direct current for railway purposes, provided that ample space is available for the motors, and his intention was to imply that the raising of the voltage above the figure of, say, 1,500 would necessitate raising the motors in a locomotive above the side frames into a position where they would not be limited by the space between the frames or the wheel flanges. For many engineers this would put a ban on the high-voltage system, as it would involve the use of diagonal or vertical coupling rods and jackshafts. This condition does not seem to me necessary, and in support of this view I have worked out designs given in some detail below in which vertical or diagonal rods are not required in locomotives of any class.

I should say that the conditions I propose to deal with are those which obtain on the main railways in this country. In other countries where the rail gauge and the minimum structure gauge are different from those we are hampered with here, the problems which arise in considering an extensive electrification scheme may be easier or more difficult of solution according to circumstances. But any detailed study of the case so far as it applies to this country will certainly throw some light on the best methods of meeting a different set of conditions—for example, in South America, Australia or South Africa.

I propose to deal with the subject in the following order:—

1. The limitations that apply to electric locomotives of all classes.

2. The consideration of the most suitable number of classes to meet the general requirements of a railway, and the operating characteristics of each class.

3. The consideration of the limits of voltage to which the discussion may be usefully confined.

4. An examination of designs for locomotives of each class, with a view to determining whether the raising of the voltage introduces any objectionable features or serious difficulties.

5. A rough attempt based on these designs at an estimate of the increased cost of the different locomotives due to an increase in the voltage.

1. *Limitations.*—These are pretty well known, but it will be as well to recapitulate them quite briefly. They are as follows:

(*a*) *Rail Gauge, 4 ft. 8½ in.*—This determines the distance between the wheel flanges, and between the side frames. The former may be taken as 4 ft. 5½ in., or 4 ft. 5⅝ in., the latter as 4 ft. 1½ in., or 4 ft. 2 in. for inside bearings.

(*b*) *Loading Gauge.*—Maximum width about 9 ft.; maximum height above rail level about 13 ft. 6 in.; minimum clearance above the rails (except at the wheels) about 6 in. to 7 in.

(*c*) *Strength of the Permanent Way.*—This introduces a limitation to the weight of the rolling stock, so that the load per axle seldom exceeds 18 tons.

(*d*) *Traders' Wagons.*—These wagons owned by private traders, have to conform to certain structural regulations, the most important of which are that they must be fitted with mechanical brakes (and, therefore, not with air brakes), and that the drawbar must have sufficient strength to withstand a pull of 28,000 lb., with an adequate margin of safety. The existence of these wagons which pervade the railways of this country determines the operating characteristics of freight locomotives.

2. *The Number of Classes of Locomotives and their Characteristics.*—I have previously * put forward tentative suggestions on this point, and in a general way I do not see any reason for modifying the opinion expressed at that time in regard to the number of different classes. The suggestion then made was that there might be four classes as follows:—

A. Shunting locomotive.

B. Goods locomotive.

* "Journal" I.E.E., Vol. LI., Part 222.

Digitized by Google

C. Passenger locomotive for light trains, running comparatively short distances.

D. Passenger locomotive for the heaviest long-distance trains.

Since putting forward these proposals I have had some opportunity of considering the matter in greater detail, and I would now modify this classification and the operating characteristics suggested. The alteration in the classification is very slight, and consists in combining the two classes C and D by adopting an articulated design for the locomotive intended for long distance heavy trains, using half a locomotive for the light short-distance traffic. The list would then be :—

A. Shunting locomotive,
B. Goods locomotive.
C. Passenger locomotive.

It might be thought unnecessary to discriminate between shunting and goods locomotives, but there is a very definite distinction between the duties to be performed by each class. The former is constantly stopping and starting, and very seldom runs at any speed above 15 miles per hour. The latter should be able to maintain a speed of 30 to 35 miles per hour with a full weight train on the level for considerable distances without stopping. Of course, the goods locomotive will at times have to do a certain amount of shunting, particularly at wayside stations, where the goods traffic is not sufficient to keep a shunting locomotive always on the spot. But to use a goods locomotive continually for shunting service in a goods yard would be to employ an expensive instrument where one of probably not much more than half the cost would be sufficient.

In specifying the operating characteristics of these three classes, it is best to concentrate attention on the principal feature of the service each has to perform. Thus, the duty of the shunting locomotive is essentially intermittent, whereas both the goods and the passenger locomotive have to maintain a steady output for considerable periods. It is advisable accordingly to attempt to fix the capacity of the first class on an intermittent basis, say, for convenience, on the basis of the standard one-hour rating, and the capacities of the second and third classes on a long period basis, leaving the one-hour ratings of the motors to take care of themselves.

A. Shunting Locomotive.

For this class I suggest that the motor equipment should have a capacity of 560 H.P. on the one-hour rating, and should be designed and geared so as to exert a tractive effort, corresponding to this output, of about 17,000 lb. at 12 miles per hour. The total weight of the locomotive, entirely on the driving wheels, should be 56 tons, and the motors should be able to skid the wheels under any conditions of track.

This equipment would be able to exert a tractive effort of 28,000 lb. for starting heavy trains from rest, and the tractive effort at 15 miles per hour would be about 8,000 lb. For shunting work it would most probably never be necessary to run at any speed above 20 miles per hour ; but shunting yards are not likely to be provided with locomotive sheds or repair shops, and at intervals each locomotive would have to travel from its own yard to the nearest depot. It would be a serious disadvantage if during this journey the speed of the general traffic on the line had to be limited to 20 miles per hour. For this reason it would be advisable to design the motors with the same limit of safety against bursting as are imposed on the motors for the freight locomotives, which, I suggest below, should be 45 miles per hour.

B. Goods Locomotive.

The weights of goods trains at the present time are usually limited by two factors—viz., (1) the ruling gradient and the hauling and holding power of the steam locomotive on this gradient ; (2) the length of the train as determined by the lengths of goods sidings, and the positions of signals and catch points. In some sections of line the second factor is not important, and the train weight is then really determined by the capacity of the locomotive.

The limitations of the steam locomotive are, of course, well known, and the question to be decided is, What advantage can be taken of the removal of these limitations by the substitution of electricity for steam ?

In the first place, the capabilities of an electric locomotive must be kept within limits on account of the strength of the standard drawbar. It would, of course, be perfectly possible to construct an engine that could exert a tractive effort of 50,000 lb. ; but such an engine would be of little use in this country, as the traders' wagons are not fitted with drawbars for a greater pull than 28,000 lb. Now the steam locomotive is limited partly by its boiler and partly by the difficulty of getting enough steam into and out of the cylinders. In other words, the steam engine is limited in horse-power. A modern goods engine can at low speeds exert a drawbar pull of 28,000 lb. and in this respect is equal to an electric locomotive. But the latter, being able to take power from an outside source, can exert the full tractive effort at a much higher speed, and can, if designed to do so, exert a much greater pull than a steam engine at ordinary running speed.

The aim of the designer should, therefore, be to produce an equipment which will deal with the heaviest freight trains at the maximum permissible speeds. Now, this question of speed is a difficult one, for the simple reason that ordinary goods trains are not fitted with continuous brakes, and, therefore, cannot be rapidly and easily brought to a standstill at an opposing signal if running at full speed. This is especially the case when the train is on a falling gradient. As a matter of practice, goods trains seldom travel at more than 35 miles per hour, and the train weight is limited by the capacity of the locomotive to start with its load on the steepest rising gradient, to haul the load at the desired speed up this gradient, and to stop at any signal on the maximum falling gradient.

In considering this matter the electrical engineer should carefully separate these factors which determine the train weight. It is essentially his duty to consider the drawbar pull and the speed, but it is not primarily his business to say how the train should be controlled by brakes. He can only point out that if the railway is electrified, trains of the maximum weight can be hauled by single locomotives at higher speeds on the condition that the necessary steps are taken to equip the trains with adequate braking power. Whether this brake equipment should be provided by the addition of a sufficient number of ordinary brake wagons at the back or of fitted goods wagons next to the locomotive, or by designing the locomotive itself with a sufficient weight irrespective of the weight required to enable the motor equipment to exert its full power, is for the railway engineer to decide. I would only say that it seems preferable to me to keep the starting and accelerating properties of the locomotive distinct from its braking capacity. For many trains the locomotive alone with the usual brake van at the back would have all the braking capacity needed, and it would be wasteful to have to haul about a lot of dead weight in all cases when it might only be necessary occasionally.

Whether this be so or not, however, the locomotive equipment is not much affected ; but for the sake of the discussion I propose to assume that for the standard goods locomotive all the wheels are driving wheels. If the locomotive has to exert a drawbar pull of 28,000 lb. as an average during the starting period, the weight on the driving wheels should be about 72 tons, divided equally between the four axles at 18 tons per axle. The motors should be able to skid the wheels under any conditions of weather, and they must, therefore, be strong enough mechanically to exert a tractive effort of 20 to 24 tons. In order to ensure a margin of safety, the motors should be able to run at a speed corresponding to, say, 45 miles per hour without bursting. A train weight of 1,000 tons is not excessive for an easy road, and the electric engine should be able to haul this train at 35 miles per hour on the level for a considerable distance. The tractive resistance of a train of this weight at this speed will depend on the composition of the train—viz., on how many wagons it contains, and also on the temperature and the wind. As an average figure I suggest 10 lb. per ton for the whole train, including the

Digitized by Google

locomotive. On this basis the duty of the equipment would be to exert a tractive effort of 10,720 lb. at 35 miles per hour, which is equivalent to 1,000 H.P. We may suppose that this average output would have to be maintained for about two hours, after which a lie over, with, perhaps, a little shunting, extending over at least half an hour, might be allowed before the performance is repeated. The continuous rating of the equipment would, therefore, be about 900 H.P.

C. PASSENGER LOCOMOTIVE.

As already mentioned, I propose to deal with the passenger locomotive on the basis of what may be called a double unit; that is to say, a complete locomotive consisting of two halves articulated or coupled together, which should be capable of hauling the heaviest trains at the highest speeds, single units being used as required for lighter trains.

The weights of passenger trains are determined as much as anything by their lengths in relation to the lengths of the platforms at the principal stations. At the present time a full-sized train seldom exceeds 400 tons in weight, exclusive of the locomotive and the passengers, and probably contains 12 or 13 60 ft. coaches. Such a train can easily be started and accelerated on the level by a pull well below the 28,000 lb. limit of the drawbar. Given an engine capable of giving this pull, there would be no difficulty in dealing with a train of 18 or 20 coaches weighing 600 tons, even on a rising gradient of 1 in 100. But for the present there is little probability of the use of such heavy trains as a regular thing, and I propose to consider the motor equipment as being intended to deal with a total trailing load of 425 tons.

As regards the other factor which determines the power of the motors—viz., the speed—it is on record that trains have travelled at about 85 miles per hour. I suggest, therefore, that in the motor design provision should be made for running at 90 miles per hour without danger of the armatures bursting. I suggest also, bearing in mind that trains often run at 75 miles per hour on slight down grades, which implies that there is no objection to such a speed from a general point of view, that the standard passenger locomotive should be able to haul the 425-ton trailing load at from 75 to 80 miles per hour on the level, and at somewhat lower speeds on rising gradients according to the motor characteristics. On falling gradients it will be for the driver to control the speed of the train as he thinks fit.

The tractive resistance of a train at this speed is somewhat difficult to determine, depending upon the length of the train and the direction and force of the wind. In order to have sufficient power under adverse conditions, I suggest that the tractive resistance of the whole train, including the locomotive, should be taken as 18 lb. per ton. Assuming as a preliminary figure that the locomotive itself weighs 100 tons, the tractive resistance amounts to about 9,500 lb., and the duty of the equipment is, therefore, to exert a tractive effort equal to this at from 75 to 80 miles per hour.

It is hardly necessary to assume that the equipment would have to do this continuously. If it be supposed that as a general rule the locomotive has to travel 150 miles without stopping or with only one or two intermediate stops, and has then a period of about half an hour for lie over before taking another train back, we have allowed for probably as severe a duty as is ever likely to be necessary under existing conditions. For example, the distance from London to Crewe is 158 miles, from London to Sheffield 158½ miles, from London to Doncaster 156 miles and from York to Berwick 146½ miles. It may be interesting to see later when a suitable design has been worked out, at what average speed this distance can be covered, and what is gained in time by employing an electric instead of a steam locomotive.

Summing up, therefore, the operating characteristics of the three classes are :—

A. *Shunting Locomotive.*—Weight 56 tons, all on the driving wheels; tractive effort and speed corresponding to the one-hour rating of the motors, 18,000 lb. at about 12 miles per hour; maximum permissible speed 45 miles per hour.

B. *Goods Locomotive.*—Weight 72 tons, all on the driving wheels; tractive effort and speed corresponding to about 110 per cent. of the continuous rating, 10,720 lb. at 35 miles per hour; maximum permissible speed 45 miles per hour.

C. *Passenger Locomotive.*—Articulated type; tractive effort and speed corresponding to about 110 per cent. of the contimnuous rating, 9,500 lb. at 75 to 80 miles per hour; maximum permissible speed 90 miles per hour.

3. *The Limits of Voltage to be Considered.*—It is difficult before having inquired into the matter to know what limits should be set to the voltage that may be usefully employed for a comprehensive scheme of railway electrification. If the choice of voltage is to depend only on the balance of increased expenditure on rolling stock as against reduction in the cost of the distribution system or track equipment, without taking into account antecedent probabilities as to the extent of these increments or reductions, there is no *a priori* reason for limiting the choice to any definite range.

But when one descends from pure theory which sometimes ignores concrete facts and general conditions, there are several considerations which make it very improbable that what may be called really high voltages will ever be adopted for a general scheme in this country. By really high voltages I mean in the present instance anything from, say, 6,000 volts upwards. I admit that this figure is chosen quite arbitrarily, and is, of course, subject to correction if further investigation should require it; but without knowing the results of such an investigation my impression is that a suitable voltage would be well below this figure.

In a general way, and speaking quite broadly, the choice of voltage will depend to a certain extent on the price of coal. It is well understood that having regard to fuel only, an electric locomotive is much more economical than a steam locomotive. The latter works almost always non-condensing and usually with single expansion and without superheat. If we assume for steam working a consumption of 30 lb. to 35 lb. of steam per brake-horse-power hour as an average for all classes of locomotives throughout the day, we shall hardly be going beyond the mark. As against this, the steam consumption in a modern electric power station may be put at 15 lb. per kilowatt hour as a maximum.

Bearing in mind that a cheaper quality of coal can be used in a power station, it is obvious that the electric locomotive costs far less in fuel than the steam engine.

Against this saving in fuel must be put the capital charges involved in the provision of the power station, the transmission and distribution systems, and the working expenses connected with this plant. To justify the electrification, the saving in fuel alone (and any other incidental economies that can be effected, such as a reduction in the maintenance and repairs of locomotives and reduction in general traffic expenses due to a re-arrangement of the time table, all of which are independent of the price of coal) must be more than sufficient to outweigh the capital charges and working expenses mentioned above. So far as the saving in fuel is concerned, this will depend on the prices of coal delivered to the steam locomotive and into the bunkers of the power station.

The price of coal is, however, only one factor. An equally important factor is the quantity of coal used or saved in any particular service. In other words, to justify the electrification, the traffic must be sufficient to permit of the total saving in fuel cost overbalancing the net increase due to capital charges and working expenses involved in the electrification.

Now the thinner the traffic the less opportunity there is of economising in fuel, and the more important it is to reduce capital outlay on substations and the distribution system. The whole object aimed at in adopting a high voltage is to enable the substations to be spaced farther apart and thus reduced in number or to keep down the cost of the distribution system from the substations to the trains or to effect economies in both. On the other hand, the fewer the trains the less important is the increased cost of the locomotive equipments caused by raising the voltage.

Now in any extensive railway system the density of traffic

Digitized by Google

varies from a maximum on some portions such as the main lines, to a minimum on some of the branch lines. If fuel costs are low it is difficult to find any justification for electrifying the branch lines; but if the cost of fuel is high, lines carrying comparatively little traffic will come within the scope of an electrification scheme to a definite extent depending on the economy that can be effected thereby. It follows, therefore, that the average density of the traffic in all the electrified sections taken together will depend a good deal on the price of fuel, and since this average density is one of the principal determining factors in deciding what line voltage should be adopted, it is clear that this voltage is dependent to a certain extent on the price of fuel.

Applying this line of argument to the conditions prevailing in this country, it may be said at once that the cost of fuel is comparatively low, and very little water power is available, and therefore the traffic will have to be fairly dense before a good claim can be made out for electrification. In other words, the average density in any comprehensive scheme is bound to be fairly high. It is, therefore, reasonable to expect that, apart from any engineering difficulties which may possibly become important with higher voltages, the most suitable voltage for this country will not be especially high.

I propose, therefore, to limit the present consideration to 4,000 volts, and to take the following pressures as convenient values for purposes of comparison, viz., 1,500, 2,000, 3,000 and 4,000.

(To be continued.)

THE DETERMINATION OF THE TORQUE OF A DIRECT-CURRENT METER.*

BY E. ALBERTI.

There are two types of apparatus used for the determination of the driving torque of meters—viz., the spring dynamometer and Schmiedel's dynamometer—which depend on the principle of the parallelogram of forces. Both of these methods determine the static torque, *i.e.*, the pull on the fixed armature. If the torque remains constant during a revolution of the armature, then a single measurement is sufficient; but if it is variable, then a curve must be constructed showing the amount of the torque in each position of the armature. This curve is a laborious affair, if it is constructed with the above apparatus without any special facilities. It may, indeed, happen that if the armature is slightly displaced the torque of the meter may vary more than the pull of the dynamometer with a corresponding displacement. Independently of this the procedure is very tedious. The obvious solution of the difficulty is to construct an apparatus that shall adjust itself and be of the registering type. An arrangement of this kind is described in the following lines, and a photograph of the original apparatus, constructed by the author at the Reichsanstalt, is given in the article from which the present abstract is made.

An ordinary spring dynamometer is used, in which the adjustment is made by turning a lever, which increases or decreases the tension of a spring to such an extent that the pointer is brought back to the zero mark. The tension of the spring is then a measure of the amount of the torque. Let us suppose the movements of the lever to be limited on both sides by two stops, which serve as contacts for the passage of current. Each time the lever comes in contact with a stop we can pass current. If this current is passed through a motor, which can revolve in both directions, we can in this way effect the automatic adjustment of the dynamometer. The process is as follows:—

As soon as the meter starts there is a torque, which moves the lever of the dynamometer out of the zero position, causing it to touch one of the contacts. The motor then starts, and increases the tension of the spring to such an extent that the two pulls balance one another, and the lever ceases to make contact with the stop. If the torque decreases, the lever makes contact with the other stop, the motor revolves in the other direction and the tension of the spring is decreased. If the two contacts are near enough to one another, the pointer vibrates between them; the torque curve then becomes a kind of zig-zag. The amount of these vibratory movements depends on the length of the lever and the distance between the contacts. These can be so adjusted that the vibrations almost disappear, and the curve becomes fairly smooth. The use of a motor for the automatic adjustment of measuring instruments has been described by Arcioni, and has been used by the firm of Olivetti for constructing registering wattmeters, voltmeters and ammeters. It does not seem, however, that a dynamometer for the measurement of the torque of meters has yet been constructed on these principles. The only essential difference between the apparatus constructed by the author and that described by Arcioni lies in the use of mercury contacts instead of silver contacts. Mercury contacts have been used in electric clocks. In the present case, in which the torque of meters is very small, they have the advantage over silver and platinum contacts in requiring no pressure to make a good contact. Condensers are used to weaken the sparks at the mercury contacts. A toothed wheel and rack are used to translate the tension of the spring—*i.e.*, the amount of the torque—to the paper roll for registration. The torque is transmitted, as in ordinary dynamometers, through a silk fibre, the other end of which is fastened to the lever of the dynamometer.

Let us now determine how the torque varies with the position of the armature. For this purpose, the meter is gradually displaced

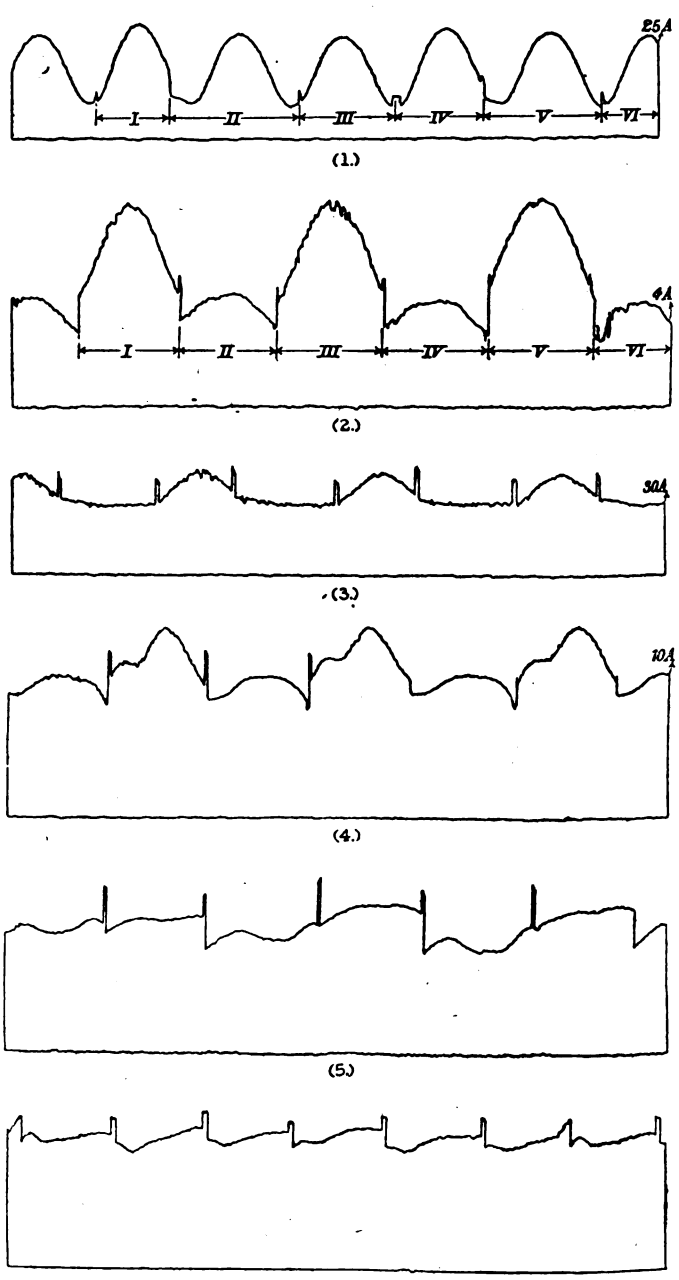
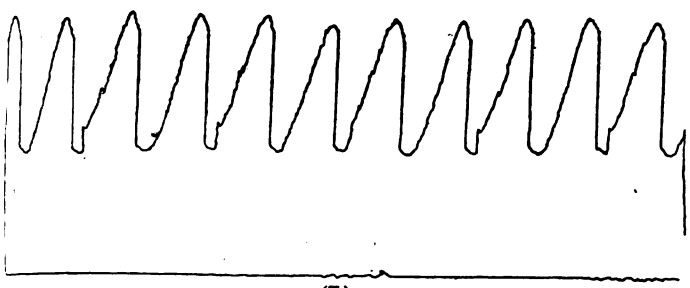


FIG. 1 (CURVES 1 TO 6).—CURVES OF TORQUE FOR DIFFERENT MAGNETO-MOTOR METERS WITH DISC ARMATURES.

* Abstract of an article in the "Elektrotechnische Zeitschrift," Heft 22, 1916.

Digitized by Google

in the direction of the silk fibre towards the dynamometer. As the distance decreases the silk fibre, which is always kept tight by the torque of the meter, is gradually wrapped round the armature or disc of the meter. For the purpose of this displacement the meter slides along a guide rod. As the meter is moved the armature is turned on its axis, and the registering paper is moved at the same time. When the movement has taken place through a distance corresponding to the circumference of the armature, then the latter has made one complete revolution. The abscissæ of the curves, therefore, denote the position of the armature and the ordinates give the amount of the torque. The armature disc or the brake disc consists



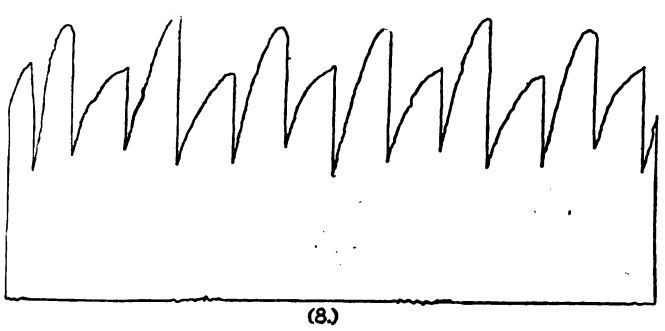


FIG. 2 (CURVES 7 AND 8).—TORQUES FOR MAGNETO-MOTOR METERS WITH DRUM ARMATURES.

usually of aluminium, about 1 mm. in thickness. If the edge is rounded it is not easy to roll the silk fibre on the disc; it is, therefore well to coat the edge with a little mucilage. The dynamometer is easily calibrated by the use of weights, or it may be calibrated by reference to another dynamometer, the curve of which is known.

We now propose to discuss some curves which have been taken by the instrument in order to show the results which can be obtained. We are only concerned with that type of meter which has a variable torque depending on the position of the armature. This limits the inquiry largely to motor meters with commutators. There are two types to be differentiated—viz., the watt-hour meters, which are built on the dynamometric principle, and the magneto-motor meters. The curves 1 to 6 (Fig. 1) refer to magneto-motor meters, with disc armatures; the curves 7 and 8 (Fig. 2) to magneto-motor meters with drum armatures; and curves 9 and 10 (Figs. 3 and 4) to watt-hour meters on the dynamometric principle. The absolute values

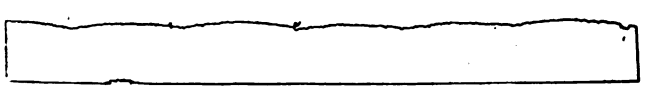


FIG. 3 (CURVE 9).—CURVE OF TORQUE OF A MOTOR METER, CONSTRUCTED ON THE DYNAMOMETER PRINCIPLE, WITH A COMMUTATOR HAVING THREE SEGMENTS.

of the torque in the different cases must not be compared, since the conditions were not in all cases the same. It is desirable to clean the commutator before making the test.

It is evident from these curves that the torque varies greatly in the different types; it may indeed vary by 200 per cent. That means that the amount of the starting current depends on the position of the armature. The small variations of the torque, which are seen to spread almost uniformly over all the curves, are obviously due to the vibrations of the lever of the dynamometer. It is also easy to see what a number of readings have to be taken, even if the ordinary procedure is adopted, before we have a clear idea of the variations of the torque. From the torque-curve it is possible to see whether the commutator is fixed in the most favourable position with regard to the commutator. The commutator is actually fixed by the makers in the position shown by the portion of the curve, marked A; but it is doubtful whether this is the best that can be chosen.

Let us analyse the curve of a magneto-motor meter with a commutator, having three sections, and a disc armature with three flat coils (Fig. 1, curves 1 to 6). On grounds of symmetry we might expect the complete curve to be divided into three symmetrical parts, which differ only slightly. And in a complete revolution a coil will be short-circuited, six times in all, by one of the brushes. These instants of short-circuit can be seen on the curves, mostly in the shape of a double vibration in the curve. If two permanent magnets

FIG. 4 (CURVE 10).—CURVE OF TORQUE OF A MOTOR METER, CONSTRUCTED ON THE DYNAMOMETER PRINCIPLE, WITH A COMMUTATOR HAVING SEVEN SEGMENTS.

are used, and if the two magnets were of exactly the same strength, we should again note certain symmetries in the curves. If the six instants of short-circuit are taken as dividing the curve into six parts, numbered 1 to 6, then 1 and 4 should be similar. But this is not usually so. If the commutator has n segments and a corresponding number of coils, then the curve should be divided into n similar sections for a complete revolution of the armature, and if there are two brushes, there would be $2n$ moments of short-circuiting a coil. Curve 10 is taken with a watt-hour meter with seven commutator segments, and for a complete revolution of the armature, one or other of the coils is short-circuited 14 times.

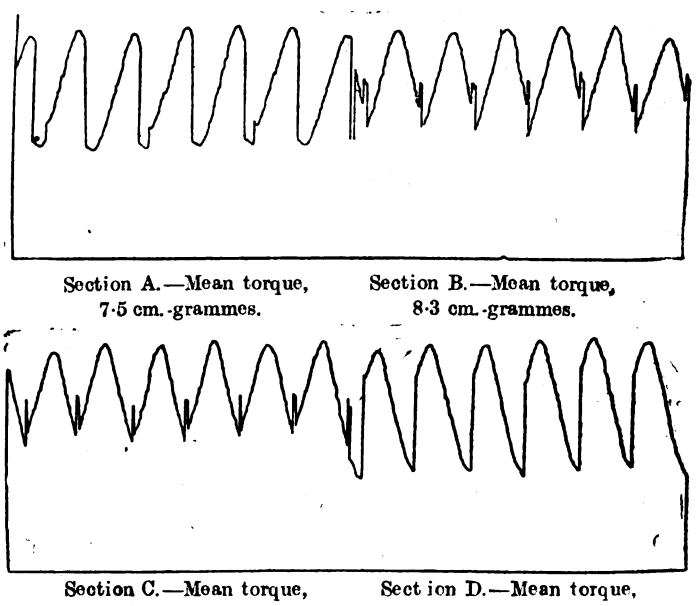

Section A.—Mean torque, 7·5 cm.-grammes.
Section B.—Mean torque, 8·3 cm.-grammes.
Section C.—Mean torque, 8·3 cm.-grammes.
Section D.—Mean torque, 7·6 cm.-grammes.

FIG. 5 (CURVE 11).—TORQUE CURVES FOR DIFFERENT POSITIONS OF THE COMMUTATOR IN RELATION TO THE ARMATURE COILS.

The author concludes with a brief mathematical investigation, which is intended to show how far the results, given by the curves, can be deduced from the known design of the meter. The peculiarities of watt-hour meters and the magneto-motor meter with drum armatures, can be regarded as sufficiently explained by the known theoretical investigations into dynamometric instruments and direct-current machines with drum armatures. He therefore confines his remarks to the study of the magneto-motor meter with disc armature, and those who are interested in the mathematics of this question will do well to study the original Paper. Curves are constructed on the basis of the author's theoretical formulæ, and are found to agree well with the results obtained by the experimental method.

Digitized by Google

The Electrician.

FRIDAY, MAY 11th, 1917.

Editorial and Publishing Offices:—

8, BOUVERIE STREET, LONDON, E.C. 4.

Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

MILL MOTORS.

From particulars recently issued by a number of manufacturers it is evident that good progress is being made, both in this country and in the United States, in the design and construction of robust electrical machinery and apparatus for use in steel works. At one time it was thought that a modification of the traction type of motor would be suitable for most of the auxiliary drives, but although many such motors have given good service in the past, experience has shown that by making radical alterations in the design greatly improved performance can be secured.

In a Paper read about five years ago before the American Institute of Electrical Engineers, Mr. BRENT WILEY told how some years previously a careful review of the requirements had been made in consultation with a majority of the steel-works electrical engineers in order to ascertain the features which should be included in a motor intended for steel-works service, and remarked that by combining the skill and experience of the manufacture and the steel-works engineer they had been able to design a satisfactory type of motor.

From a record kept by a large firm of manufacturers of the armature repairs required for the motors in steel works, using 1,410 of the modified traction-type motors and 232 of the mill-type motors, it appears that the first-named type required 706 sets of new armature coils, 436 new commutators and 101 new shafts; whereas for the whole of the mill-type motors only 10 new sets of armature coils had to be provided, none of the motors requiring either new commutators or new shafts over the period during which the record was kept. Although the average time in service of the modified traction-type motors was considerably longer than that of the mill-type motors, the makers, nevertheless, state with confidence that the average life of the armatures of the older motors is 2½ years and of the mill-type motors 10 years. At a time like the present there is no need to dwell upon the importance of reliability, but even in normal times reliability of all machinery is one of the prime essentials in the steel trade. The fact that motors have been and are being standardised specially for steel works service leads to the conclusion that there is a steady demand for such motors, and that the requirements are now generally recognised.

Of the several recommendations, in the review mentioned by Mr. WILEY, regarding the mechanical side of the subject, the principal dealt with strength and with sound design. In connection with the former may be mentioned the frame, the shaft and pinion; and in connection with what we have called sound design the most noticeable improvements are the bearings, the armature and brush gear. The bearings in the motors of Westinghouse manufacture are provided with eye-bolts to facilitate the handling of the armature. When one remembers the awkward situation of many motors, the advantage of the eye-bolt construction is immediately obvious, and this type of construction is one which could profitably be employed in many industrial motors. The commutator is carried on an extension of the armature spider, so that the shaft may be removed without interfering with the electrical arrangement of the armature. This construction, also, is one which has been embodied in the industrial motor by many of our leading manufacturers, and is in every way superior to the method in which the armature core and commutator are mounted independently on the shaft.

On the electrical side the chief improvements are fireproof windings and sparkless commutation under the most severe operating conditions. The latter makes the output of a given frame practically independent of commutation, and is secured by the use of commutating poles and by the careful design of the commutator, brush gear and windings. By the use of fireproof windings it has been found possible for motors to give satisfactory performance under working conditions. These are in the main of much greater severity than those of the test bed; but, no matter whether the motor has passed the test or not, it is a very poor advertisement for the maker if his motor should fail in service. Here, again, are features which could well be embodied in the design of all industrial motors, and which would bring in to the user a good return on the higher first cost.

In the past the user got the idea into his head that reliability could be secured at low cost, with the result that the market was flooded with motors and control gear of very inferior design and construction. Such motors and gear have not yet been entirely eliminated, and it would pay the manufacturer to endeavour to educate the user into giving a somewhat higher price for a vastly superior article. In the long run this would mean the elimination of the bulk of the so-called "special" motors, and would greatly simplify manufacturing operations.

REVIEWS

The Emission of Electricity from Hot Bodies. By O. W. RICHARDSON, F.R.S. (London: Longmans, Green & Co.) Pp. vii.+304. Price 9s. net.

This volume is a recent and welcome addition to the well-known series of "Monographs on Physics," issued under the joint editorship of Sir J. J. Thomson and Prof. F. Horton. The subject matter can be described by the one word "thermionics," except that the electrical properties of flames and all connected therewith, are excluded, these having already been dealt with, though not in this series, by Prof. H. A. Wilson. On the historical side the subject is extremely interesting. It was known in the middle of the 18th century that incandescent bodies showed peculiar electrical effects, but it was not until the middle of the next century that the phenomena attracted much attention. Thus it came about that the earliest known instances of conduction in gases were the last to receive systematic investigation, although the physicist had here ions ready to hand before the invention of vacuum tubes or the discovery of X-rays. In 1887 Blondlot showed that a white-hot body could not retain a charge even under a P.D. of 0·001 volt, and that the leakage current did not obey Ohm's law. Guthrie some years before had found similar effects, and had noticed that they were greatly influenced by the sign of the charge—probably the first recorded instance of unipolar conduction. In spite of more or less systematic researches by Elster & Geitel (1880 and onwards) and Fleming's researches on the Edison effect in electric lamps, no real progress was made until the modern ionic theory was developed. Thomson in 1899 showed that the negative discharge was electronic in character, but that the positive ions were of atomic dimensions. The most fundamental advance was made by the author himself (1901–3), when he effected a necessary simplification of the experimental conditions by putting his hot filaments in a high vacuum and by measuring both the temperature of emission

Digitized by Google

and the saturation currents. This work was accompanied by a deduction of the well-known Richardson formula $i=a\theta^{\frac{1}{2}}e^{-b/\theta}$ and its experimental verification.

The book opens with a brief account of the experimental methods usually employed. Some workers in this field will perhaps wish that this had been more detailed in character. The present writer, for example, would have been glad to learn more than is given about the technique of welding tungsten filaments to platinum leads in a neutral atmosphere. A useful form of vacuum furnace is described, by means of which a tube can be exhausted while at a temperature of 530 deg. without collapsing. This treatment ensures the removal of the last traces of gas. Only those who have tried it know how difficult it is to secure such a condition, yet it is absolutely necessary in certain X-ray tubes and recent forms of vacuum valves when used for transmission in wireless telegraphy. Chapter 2 is mainly mathematical. The general reader will find this a rather weighty course in a liberal repast, but the importance of the results atones for its character. A simple relation is found between the negative emissions from two metals and their contact P.D.'s. It is shown that the fact that thermionic currents satisfy the formula quoted above affords no evidence either for or against the view that they originate from chemical action; a result which must be kept in mind when reading the later chapter on the emission from heated salts. Although his formula applies over a range of temperature such that the current varies by a factor 10^{11}, the author is not satisfied with its theoretical basis, and here derives a slightly different result based on thermodynamics. In later chapters the vexed question of the positive emission is treated in detail, together with the effect of gases on both the positive and negative currents. In the discussion of the latter, two points emerge which are of interest to makers of valves. Two methods are in general use for increasing the current from a hot filament at a given temperature. One is to admit to the tube a small quantity of hydrogen; but Langmuir has shown that this brings about a *decrease* when a tungsten filament is used. (How it behaves in mercury vapour is not stated.) Another is to coat the filament with lime, but unfortunately these cathodes are extremely erratic in their behaviour. Gemershausen has, however, shown that by removing all the gas the emission becomes both larger and steadier. Whether the vacuum is maintained is not clear.

The author is to be congratulated on the lucidity of his exposition, the completeness with which he has covered the ground, and his arrangement and choice of material from a very considerable literature. His work presents a large mass of detail connected, as far as is possible at present, by a coherent theory. In addition, his criticism of other people's work is marked by most judicial fairness. Readers of THE ELECTRICIAN would doubtless have liked to see some of the theory applied to vacuum tube relays, the arc and current rectifiers. As we are at war it is perhaps just as well they are omitted from the present edition; before the next is due I hope the author will invent some better term than "specific charge on the ion" for the quantity e/m. "Specific" is greatly overworked in these days.

R. S. WILLOWS.

Engineering Applications of Higher Mathematics. Part V. Problems on Electrical Engineering. By V. KARAPETOFF. (London: Chapman & Hall.) Pp. vii.+65. 3s. net.

It is fortunate for Prof. Karapetoff that his reputation as an author was established before he wrote this book. From the title we infer that it is the fifth part of a work intended to show how higher mathematics are applied to engineering problems, and that it deals with electrical engineering. In some respects it is to be regretted that we have not seen the other parts which are devoted to machine design, hydraulics, thermodynamics and mechanics of materials. Such being the case we have to judge Part V. on its merits.

A careful examination of the contents convinces us that the merits, if there be any, are completely obscured by the deficiencies. Were electrical engineering as narrow a subject as the book under review would lead one to believe, then any subject the reader cares to name would be less barren of ideas than would electrical engineering.

Of the six chapters, the first deals with resistance of non-cylindrical conductors and magnetic paths; the second, third and fourth deal with minimum weight of metal in a combination of conductors, most economical size of conductors and leaky direct-current lines respectively. In the fifth chapter average and effective values of voltages and currents are considered, and in the sixth chapter examples are set out on efficiency and losses in electrical machinery. In an appendix four theorems in mathematics are given and a very incomplete list of books on electrical engineering and theory of electricity brings the work to a close.

In seeking for some explanation as to why such a book should ever have been written we turned to the Preface and found it stated that originally Part V. was planned to be much larger, but in the meanwhile the author has published two other books of a mathematical character, "The Electric Circuit" and "The Magnetic Circuit," and rather than duplicate the text he limited himself to electrical problems of a somewhat different type. We know these books from cover to cover and the author might have done worse than duplicate the text. Had he done so his book of problems would have been better than it is.

Electrical Engineering: Advanced Course. By E. J. BERG, Sc.D. (London: The Hill Publishing Co., Ltd.) Pp. viii.+332, 15s. net.

Some years ago it was our experience to meet an engineer who made a practice of attending lectures on the higher branches of applied mathematics when he needed recreation and when the worries of business were beginning to tell on him. We can imagine men in search of mental refreshment turning to Prof. Berg's book.

This volume, written by the Professor of Electrical Engineering at Union College, Schenectady, contains abstracts of a series of lectures intended to prepare the student to understand and to deal mathematically with phenomena which are incidental to abnormal or transient conditions in electric circuits.

The first part, which is practically a reprint of a series of articles published some years ago in the "General Electric Review," covers the simple transients in circuits containing concentrated inductance, capacity and resistance. In the second part the more difficult problems of transients in circuits having distributed L, C and R are considered. The third part deals with problems in electrostatics, and in the last part of the book is given an outline of the theory of electric radiation.

Unlike many authors, Prof. Berg mentions those who not only laid the foundations of electrical theory, but also raised elaborate structures thereon. He gives credit to Heaviside for the mathematical solution of difficult problems in transients and to Steinmetz for his book on "Transient Phenomena," which he rightly calls the first really advanced book on practical electrical engineering problems.

In electrostatics he mentions amongst others, Maxwell, Heaviside, Kelvin and Gray. Credit is given to Dr. W. S. Franklin for the demonstration that advanced problems can be solved "in a beautifully simple way" with simple mathematics. Under electric radiation are to be found the names of Maxwell, Hertz, Marconi, Lodge, Fleming, Pierce, Zenneck, Cohen and Austin.

Those interested in electromagnetic radiation will be grateful to the author for building up the theory in a single chapter from the fundamental laws. This chapter forms an excellent introduction to the several treatises on radio-telegraphy.

To many students in the past the works of the great masters have been sealed, and in this book 50-year old discoveries are presented in such a way as to be within the grasp of engineering students of average intelligence. For this reason we recommend the book, and we hope that other books will be written on and about Maxwell, Heaviside and the rest.

Digitized by Google

HIGH-TENSION OVERHEAD TRANSMISSION LINES.*

BY G. V. TWISS.

(*Continued from p.* 180.)

Summary.—The author discusses the subject comprehensively. Dealing first with the general design of transmission lines, a comparison is drawn between the factors of safety required in this country and those in Canada and the U.S.A. Curves are given for facilitating calculations of cost. In dealing with line materials, a comparison is drawn between the pin-type of insulator and the suspension type. The Hewlett and metal hooded insulators are discussed at some length. Finally, the mechanical design and the testing of insulators are considered.

Mechanical Design of Suspension Insulators.—In suspension insulators porcelain and metal are in very close relationship, and the insulators are also required to work under heavy loads, so that it is necessary to give very careful attention to the details of the design.

Metal-hooded insulators are sometimes considered to be in tension, and as porcelain is notoriously weak in tension the design is considered to be inferior to interlinked insulators in which the porcelain is in compression. The following test is therefore interesting:—

Insulators A and B, Fig. 8, are identical as regards section of material, shaping, shear area of cement, &c., but the pin in A is inserted deeper than that in B.

A gives an average strength of 4 tons and the porcelain is crushed without the cement being sheared; B gives an average strength of 2 tons and the spindle pulls out, shearing the cement.

It would appear that A transmits a large component of stress to the hood through the porcelain in compression, and the shape of the break as marked on the diagram and the stratified character of the porcelain at the break substantiates this.

Combined electrical and mechanical tests show that some designs fail electrically long before they appear to break mechanically, whilst others develop very nearly the full mechanical strength before electrical failure takes place. The former always appeared to be those where the shaping of parts indicated the possibility of severe and localised expansion stresses, and the latter where such stresses were likely to be the least and not localised. This shows that the design which gives the highest mechanical test is not necessarily the best design from the point of view of inside stresses.

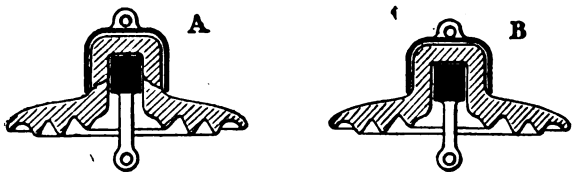


FIG. 8.—METAL-HOODED INSULATORS.

Transmission line conductors rarely have a breaking strength much in excess of 2½ to 3 tons, and for such cases there would appear to be no object in requiring the suspension insulator to stand much more than this. For a load of 3 tons or so the insulator can embody the most desirable characteristics from every point of view, but for loads very much beyond this something has to be sacrificed.

TESTING OF INSULATORS.

The objects in view in testing high-tension insulators may be broadly classified as follows: (1) "Routine tests" to detect faulty material. (2) "Design tests." To these might advantageously be added (3) "Deterioration tests."

The requirements of these different classes of tests need several different kinds of testing and combinations thereof. Routine tests consist of the application of high voltages, and possibly a high-frequency test. Mechanical routine tests should not be excessive, and should be limited to about 25 per cent. above the maximum working load.

The voltage on the high-tension side of the transformer used to be measured by means of a needle spark-gap. Needle points are, however, subject to variation due to brush discharge, &c., as mentioned by Mr. Lustgarten. The sphere gap is not subject to such variation when the spheres are of sufficient diameter in respect to the width of the gap to prevent corona preceding the spark. With a width of gap up to three times the diameter of the spheres there is very little corona, but for the most accurate work the width of the gap should not be greater than the diameter of the spheres.

The resistance of the water used for spray tests is important, and very different results are obtained with different qualities of water. Water with a resistance approximating to that of actual rain—*i.e.*, distilled water—should therefore be used when especially accurate figures are required.

The author then discusses high-frequency tests. Electrical tests should be combined with mechanical tests to ensure against the latter causing electrical failures.

* Abstract of a Paper read before the Institution of Electrical Engineers,

It is important to recognise that even a test by high-frequency oscillations is not necessarily an infallible test of either the soundness of the material or the design. For instance, an insulator might be quite sound at the works and withstand high-frequency tests, but under working conditions of changing temperature stresses will occur which, if the insulator be not properly designed, may set up small cracks, and thereby eventually cause failure. Moreover, an insulator slightly porous from under-firing might withstand these tests when in a new and dry condition.

CLAMPS OR OTHER MEANS OF ATTACHING CONDUCTORS TO INSULATORS.

The means of attachment of conductors to insulators should be such that (*a*) crystallisation of the conductor must not be set up, (*b*) the conductor should be held to the required load without bruising or injury to its surface, (*c*) the attachment should be capable of being erected with ease.

The clamp or other means of attachment for fixing a conductor to a pin insulator must necessarily be different from that for fixing the conductor to a suspension insulator. Similarly, attachments to carry the dead end load must be different from those to carry the load in an intermediate position; but there is no reason why similar principles should not be reasonably embodied in all designs.

Strain-insulator clamps have flexibility to an eminent degree owing to all the motion being taken by the link attachment of the insulator, and they are, therefore, ideal from the point of view of the prevention of crystallisation. A strain clamp necessarily requires a grip sufficient to develop the ultimate strength of the conductor before slipping. The best grip can be obtained by means of roughened gripping surfaces, but these injure the conductor, and it is preferable that the gripping surface of the clamp should be smooth and rounded, which requires a greater length of surface than when roughened.

Suspension clamps have also a considerable degree of flexibility by virtue of being suspended from a link. In the event of a conductor breaking, the suspension clamp swings out into the line of the sag, thus reducing the stress, so that there is no necessity for the suspension clamp to grip the conductor to its breaking point. In any case, the intermediate pole upon which the suspension insulator is fixed is not designed to carry the stringing tension of the conductor. A light grip which will permit the conductor to slip at a load of 500 lb. to 1,000 lb. is sufficient, and such a grip can be easily obtained in a manner which will not damage the surface of the cable.

The binder method of attaching conductors to pin insulators is largely favoured, particularly because of the amount of flexibility which it gives. To attach the conductor to a pin insulator by a rigid mechanical clamp is bad practice, as deterioration of the conductor by crystallisation is likely to occur.

Owing to the fact that a pin insulator is only capable of carrying loads of the order of the transverse load, there is no point in making the attachment grip to a greater load. The author gives results of tests on various binders.

The flexible clamp has mechanical characteristics in both the line and longitudinal direction of the same order as a good binder, and has a flexibility greater than any binder. In regard to ease of erection, a binder is probably always more difficult, and requires greater skill to erect than a mechanical clamp.

The matter, data and illustrations that have been referred to in the foregoing are almost exclusively concerned with transmission lines which have been engineered from this country, and the material for which has been designed and manufactured in this country. The author's best thanks are due to Messrs. Bullers (Ltd.) for facilities afforded in connection with the preparation of the Paper.

DISCUSSION.

Mr. A. P. TROTTER said it was expected that the linking-up of power supplies from large stations would lead to important developments in overhead work. We had not more than 30,000 volts in this country at present, and he hoped we should not have more. The increase of voltage would save copper in the line, but would add to the charges for the transformers and switchboard, and the saving of the copper of the line would be practically absorbed. For the lines we had it would not be worth while to go to anything like the voltages the author men-

Digitized by Google

tioned. As the author pointed out, the maintenance of the equilateral triangle of wires was not of great importance in this country. Where was the advantage of the three wires (C2). The author said the advantages were that the pole was the shortest possible and there was no possibility of the conductors fouling owing to snow. It seemed to him that those were the only ones likely to foul owing to snow in consequence of that arrangement. We rarely got snow here which froze on to the wires. He could only remember two or three cases in 10 years where the snow on the wire had a serious effect on the electric lighting wires. At Middlesbrough the wire sagged down so much that when the snow was knocked off the bottom wire it rose higher than the upper wire. That was due to having the wires one above the other. The author mentioned a ratio of 5 to 2 as the ratio of the factors of safety in this country and abroad. Was not that about the ratio of the quality of engineering work in this country and abroad? He thought 5 to 2 about the ratio both of the factor of safety and of the quality compared with American work and that the ratio of failings was higher than the square of that. In America they put a duplicate line alongside the first. That would hardly be done here. With regard to the author's reference to the Board of Trade regulations, it should be remembered how these arose. The first overhead wires were in Bond-street many years ago. People got frightened, thinking they would have them all over the place. Legislation was passed, and the Board of Trade was set to look after the matter. The electrical adviser, who had all the responsibility, had no one to consult. Was it to be wondered at, therefore, that the factors of safety were rather high? Mr. Starr said, in the discussion on Mr. Vernier's Paper, he was satisfied with the conditions of the regulations, and in other Papers it had been shown that alterations in the factors of safety were not wanted. But they were not so tied as was assumed in the Paper. The Board of Trade standard of 50 lb. per sq. ft. wind pressure was brought down to 35 lb. after the Tay Bridge was blown away, and subsequently to 25 lb., but that was a maximum; where a case was made out for a sheltered locality a lower pressure was permitted. With regard to the assumption of ice loading, in the United States and Canada the factor of safety was based on an accumulation of ice of about 2 in. diameter, but we had had no occasion to make regulations for snow and ice, and the regulations distinctly stated that no allowance had been made for them. Factors of safety were a question of responsibility. If he were a consulting engineer creating a line over which he would have some real control he would adopt measures outside the Board of Trade regulations. The question of density of population came in largely. The Paper said there were in this country span lengths of the order of 150 ft. There was no limitation of the span for high pressure wires in the Board of Trade regulations. In the low pressure regulations there was a limit of 200 ft. with ordinary poles, but in those it was stated that 200 ft. should not be exceeded "without the consent of the Board of Trade." The Paper stated that under no circumstances could it be possible to have an economical span of 150 ft. 120 ft. was the standard in Canada for low-pressure wires. The average here for high pressure was 240 ft. Mr. Merz and Mr. Woodhouse both had used 240 ft. It was controlled, no doubt by the factors of safety. There was a span of 1,420 ft. in South Wales and another of about the same length in North Wales. He challenged the author to show that there was any restriction as to spans for high pressure. He had discussed with an engineer, who had spans of 600 ft. with the top of the poles, 54 ft. from the ground and a clearance of 20 ft. from the ground, the advisability of not having such long spans. The Board of Trade regulation required 22 ft. clearance for towns and 18 ft. for the country. If the 600 ft. span were reduced to 400 ft. the sag would be 9·8 ft. In 300 ft. the sag would be 5 ft., and by reducing the height of the pole the saving of expenditure was at the base—the most expensive part. Of course, the saving of wayleaves was enormous if you had fewer poles. The author's diagrams were rather confusing, because of the comparison between the U.S.A. and the Board of Trade poles. He did not admit its accuracy. If they had been separated it would have been easier to define. In regard to the factors of safety with which the author said "presumably the Board of Trade were satisfied." If the engineers were not satisfied let them meet him and discuss it. It was important not to shut down and not to have fatal accidents. These two things ought to go together. He had known kite-tail insulators in which a pocket was left pointing upwards and full of water or a weak solution of nitric acid. Either on that account or through the wires grinding their way through the porcelain the wires broke off into needle points and thus failed. Care should be taken to guard against this.

Mr. A. D CKINSON said with a high-tension line there must be transformers. The difference in cost of transformers for 6,000 volts and 100,000 volts was not a serious matter for moderate powers. Dealing with small powers was another thing. The Board of Trade high-tension regulations were intended to protect the public. What difference did it make whether you were killed by 3,000 volts or 100,000 volts? It would help very much if the Board of Trade permitted higher voltages. (Mr. TROTTER: There is no limit whatever. 30,000 volts happens to be the highest. I would willingly see it ten times higher.) He suggested that the rules should not be framed by Mr. Trotter alone for the Board of Trade, but that the Institution should be allowed to share in the responsibility. Under those conditions the rules might be relaxed. Work abroad was not more slipshod than in this country, at any rate in the British Colonies and India. The various electrical authorities in the countries abroad under the British Crown took the Board of Trade regulations and would not vary them. People for whom he had worked had been put to very great expense to no purpose from that cause. If some note were attached to the regulations intimating that modifications would be considered it would help people doing work in other countries. He agreed that over testing of high-tension insulators was a mistake. Whenever the mechanical efficiency was improved the electrical efficiency was decreased. He would test about 10 per cent. above the working voltage. High-tension insulators were only in their infancy. Even in this country he believed that shortly 100,000 volts or more would not frighten us. What factor of safety should be given in the transmission line at Creek Crossing on the Tata hydro-electric system? The wind carried the salt spray up on the insulators and more discs were wanted in those cases than on the inland part of the line. The factor of safety must be taken in sections. In Canada he knew a case where for 125 miles they had five discs, on the coast they had seven and sometimes eight. In a line he had just finished a vulture flew against a slack telephone wire and carried it over the line. The telephone wire broke and its ends swung and short-circuited every time they touched the earth. The surges in the line were enormous. It would be difficult to put on extra insulator discs to meet those conditions. If possible telephone lines should be right outside the transmission line if a second right of way can be obtained.

Sir W LLIAM SLINGO said the author was a little out in thinking a 150 ft. span was a relic of telegraph experience. Their heavy spans were now 180 ft., carrying 40, 50 or 60 wires of weights of 150 lb. to 600 lb. to the mile. Ten or 20 years ago spans were longer. There were still many about the country 70, 80, 90 and 100 yards in length. It was only in exceptional cases they used the shorter spans. In the great storm of March 27-28 of last year, as the result of which he had something like £300,000 worth of damage done by snow and wind, not a single wire weighing 600 lb. to the mile (call it 5½ gauge) was broken down by the weight of snow or ice or the pressure of the wind. Where wires exceeding 400 lb. in weight went down it was because the poles or the arms failed. That information ought to be of use to power engineers, who never worked with wires of a smaller gauge than that. Sometimes ice would form round the wire in a cylindrical form, but on the occasion of the storm of March last year it formed in many cases a flat band lying horizontally, so that the wind pressure was comparatively small. A thin wire would get as thick with snow as a thick wire. The Post Office started work with copper conductors of 100 lb. and every small storm broke them down. Then it went to 150 lb. minimum and that stood up under all ordinary conditions, 200 lb. stood well and 400 lb. and over would stand almost anything. He would like to know what success engineers had met with in the use of ferro-concrete poles.

Mr. A. JACOB said the fact that a Government committee was considering the economical distribution of power made the Paper of special importance. Their labours would be simplified if they could give the supply engineers facilities for wayleaves and the other important question was that of safety factors. He quite understood the method of framing the Board of Trade regulations. The matter had more or less grown up during years and at the outset the electrical adviser had not very much to guide him. On the other hand, he did not agree that American and other foreign practices for long distance power transmission was altogether bad. If analysis were made of the leading modern transmission systems throughout the world he thought it would be found that breakdowns on American transmissions were not appreciably greater than had taken place in this country. Mr. Vernier said there were 2,000 miles of transmission in this country. That was very small compared to the length in countries like Scandinavia, Italy, France and so on, and the power transmitted there was greater than here. About 1,000 volts per mile was usually taken as a fair average figure for transmission systems. When we got power transmission from coal fields and absolute right of way over railways and so forth, no doubt we should come to longer distance transmissions and we should have to tackle the problem on a different basis from what we had at the present moment. The commercial as well as the engineering side would have to be considered. The capital cost was an important matter and it went up very quickly in ratio with the factors of safety. If a factor of safety of 3 was considered sufficient in countries where conditions were more extreme, was it necessary to have a factor of safety of 5 here? The standards adopted should be adopted after very careful consideration and analysis of the practice that existed and they should be international standards, not dealing with Great Britain alone. It was as much the business of the Institution as of the Board of Trade to frame such regulations. Mr. Twiss had had to ignore to a large extent the existence of any other conductor than copper. The whole of the output of aluminium was absorbed for Government purposes. The Germans had gone about finding substitutes in their own manner. They had standardised conductors such as iron, zinc alloys, aluminium alloys and so on. He did not think any of these were going to stay after the war, except perhaps in house to house wiring. Nevertheless it was worth while to consider these in connection with the whole question of standardising line material. The latest development in the use of aluminium was in the utilisation of steel core strand. Aluminium had a greater sag than a copper strand. The system that transmitted most power in California was employing such a strand at present. It was 404 miles in length and the average pole spacing was about 650 ft. With reagrd to the re-drafting of regulations he called attention to those adopted by Mr. Evans Airey, electrical engineer to the Government of New Zealand. He had gone about the matter in a thoroughly practical way, and his regulations were well worth consideration. He (Mr. Jacob) showed on the screen a method of supporting an aluminium conductor by means of a pressed steel catenary hanger, which had been adopted on the Canadian Northern Railway at Montreal. What Mr. Dickinson had done on the Tata hydro-electric scheme compared very favourably with what had been done in other countries.

(To be concluded.)

Digitized by Google

CORRESPONDENCE.

THE RANGE OF WIRELESS STATIONS.

TO THE EDITORS OF THE ELECTRICIAN.

In your issue of April 20th you publish an interesting article on the "Range of Wireless Stations," by Capt. Trench. After enumerating the various assumptions which he proposes to make and the symbols to be employed, the author states that: "For a vertical aerial l is about $0{\cdot}8h$, or the effective height $0{\cdot}4h$ . . . where $\frac{1}{2}l$ is the height above ground at which the distributed capacity of the aerial may be considered (for our purposes) to act as a concentrated capacity." A number of formulæ, which are subsequently employed in the Paper, are then based on this statement. The author does not explain how or where he obtains this value of the effective height. To show the need of a careful definition of terms, it is only necessary to compare this effective height of $0{\cdot}4h$ with page 126 of Dr. Eccles' handbook, where the effective height of a simple vertical aerial without turning coil is given as $0{\cdot}9h$. Although Dr. Eccles calls this the effective height, he uses the expression in a sense quite different to that in which it is employed by Capt. Trench; what Dr. Eccles calls the effective height is really the effective length of the dipole or Hertzian oscillator, which would radiate the same power in the whole sphere as the actual aerial radiates in the upper hemisphere for the same current. It would not produce the same magnetic or electric fields, and, in the writer's opinion, this definition of the effective height of an aerial is very undesirable. With Capt. Trench's definition and use of the term the writer is in complete agreement—it is the same sense in which it is employed by Zenneck and others—but where does the 0·4 come from? At the moment of maximum P.D. the charge on a plain vertical aerial, oscillating at its fundamental frequency, is distributed approximately according to a sine law, being zero at the base and a maximum at the apex. The height above the ground at which the distributed capacity of the aerial may be considered to act as a concentrated capacity is obviously $2h/\pi$, which is, therefore, the effective height. With a tuning coil of very large inductance it will be lowered to $0{\cdot}5h$, or even less, if one take into account the greater capacity of the lower part of the wire. The figure 0·4 is equal to $(2/\pi)^2$, which may have been taken in error instead of $2/\pi$; but, whether so or not, the value of the Paper will be increased by clearing up this point, and, if necessary, modifying the formulæ accordingly. The effect on the numerical examples will be very small.

Since writing the above (May 1) I have read the remainder of the article, which has now appeared, and am surprised to find that the author, in an apparent attempt to combine his conception of effective height—with which, as I stated, I quite agree—with that of Dr. Eccles, has made a serious error in comparing the Austin-Cohen formula with the simple dipole formula. After equation (25) he says: "We may consider the earthed aerial as the upper half of a Hertzian oscillator of length $l=1{\cdot}8h$, and since only the top half radiates energy the value of F [electric force at distance x] is only $1/\sqrt{2}$ of what it would be if the whole oscillator radiated."

Now the electric and magnetic fields of a Hertzian oscillator are unchanged if a conducting plane is placed normal to its axis, through its mid-point; hence, the field due to an earthed aerial (assuming a perfectly conducting plane earth) is identical in the upper hemisphere with that of the aerial and its image considered as a complete oscillator in free space. The radiated energy is halved by the suppression of the radiation in the lower hemisphere, and not by any modification of the electric field strength in the upper hemisphere.

The ordinary formula for the electric and magnetic forces in the equatorial plane of an aerial, considered as the upper half of a Hertzian oscillator or dipole is:—

$$E=H=\frac{4\pi}{10}\cdot\frac{h'}{\lambda x}\cdot I_1 \text{ absolute units.}$$

$$\therefore\ E=\frac{300\cdot 4\pi}{10}\cdot\frac{h'}{\lambda x}I_1 \text{ volts per centimetre,}$$

where E, H and I_1 are all R.M.S. values, I_1 is in amperes,

h' = effective height of aerial (from ground to centre of capacity),

λ = wave-length,

x = distance, all in centimetres

The E.M.F. induced in a receiving aerial of effective height h''

$$=120\pi\frac{h'h''}{\lambda x}I_1 \text{ volts.}$$

If R_2 is the total equivalent resistance of the receiving aerial, including that due to radiation, the current set up in it will be

$$I_2=120\pi\cdot\frac{h'h''}{\lambda x R_2}I_1 \text{ amperes.}$$

If $R_2=25$ ohms, as given by Austin for some of his tests, this becomes

$$I_2=15\frac{h'h''}{\lambda x}\cdot I_1.$$

These formulæ are only strictly applicable to undamped oscillations; with spark systems, if δ_1 and δ_2 are the logarithmic decrements of the wave-train and receiving aerial respectively, the formula becomes

$$I_2=\frac{120\pi}{\sqrt{\left(1+\frac{\delta_1}{\delta_2}\right)}}\cdot\frac{h'h''}{\lambda x R_2}\cdot I_1.$$

It appears from Austin's later work ("Bull." Bur. Stand. Vol. XI., p. 69) that this theoretical formula, with the addition of the empirical exponential factor, gives values in close agreement with experimental results obtained in tests between ships. In determining the effective height of a ship's aerial there is some uncertainty as to the datum level from which the height should be measured.

Capt. Trench's suggestion that the receiving aerial abstracts so much energy from the field that the latter is locally drained and therefore unable to induce the calculated E.M.F., is more ingenious than convincing. The oscillation in the receiving aerial certainly modifies the field in its neighbourhood in such a way that the current is reduced, but this reduction is probably identical with that calculated by the inclusion of the radiation resistance in R_2.

Both of these statements which I have criticised are made by Capt. Trench with the object of explaining the apparent want of agreement between calculated and observed received currents, but the weight of evidence goes to prove that with good "earths" and accurately determined effective heights the theoretical formula gives correct results for short distances between the stations.

In tests made by Austin between various land stations the received current was only 0·4 to 0·5 of the calculated value. This he ascribed to a decrease of the effective height due to the earth being an imperfect conductor and consequently giving an ill-defined image of the aerial.

South Kensington, May 5. G. W. O. HOWE.

RATING OF INTERMITTENT MOTORS.

TO THE EDITORS OF THE ELECTRICIAN.

With regard to Mr. H. H. Broughton's article in your issue of May 4th, on the rating of intermittent motors, there is a further factor having a considerable bearing on the rating of these motors.

The aim of engineers is to give the motor a rating of such a value that when run on this rating until a steady temperature is reached the temperature rise will be the same as when run on the intermittent load. The point I wish to bring out is that this rating does not only depend on the load curve, but may be altered considerably by using motors with different proportions of copper losses subject to the load current and iron losses. By applying these principles in the design of motors installed for crane work, the size of motor was in many instances reduced.

The R.M.S. methods analysed will apply to direct-current series-brake solenoids, where the losses are all copper.

Summarising the above, it is not possible to specify an equivalent rating for a motor working on an intermittent load, without knowing the full motor design.

Loughborough, May 8. B. ADAIR M. BOYCE.

Digitized by Google

CITY AND GUILDS EXAMINATIONS IN ELECTRICAL ENGINEERING.

TO THE EDITORS OF THE ELECTRICIAN.

I am sure that you will agree with me that examiners who make grave blunders in setting Papers are doing the students who take the examinations a great injustice. This is especially the case where evening students are concerned, who, after making great sacrifices to attend during the session, have their efforts discounted by the gross carelessness of their examiners.

The Grade II. A.C. Paper for 1916 contained a numerical question on power factor correction of three-phase circuits by means of condensers. From the data necessary for working the question the frequency was omitted. In the recent examination the corresponding Paper contained a similar question, but in this case the power taken by the circuit was omitted, thus making a numerical solution impossible.

To my personal knowledge candidates who could work these questions satisfactorily if the proper data had been supplied, had to give the question up after wasting valuable time. In justice to students the examiners should supply worked answers of all the questions to some independent assessor, who would criticise the Papers and prevent such mistakes occurring.

London, May 8. A. W. ASHTON.

DECIMAL COINAGE.

TO THE EDITORS OF THE ELECTRICIAN.

To a foreigner, as I am, the discussion on decimal coinage in your columns seems much too academic and lacking in common sense. It appears to us that the change from your present complicated system to the decimal system can be made quite easily by taking the shilling as the unit. In doing so you may retain all your actual coins, scrapping little by little half-crowns and four-shillings. The only change would be in the value of the penny, which, becoming 1/10 of the shilling instead of 1/12, would have to be completed by a more liberal use of coins of one and two farthings, in order to keep down the cost of small and cheap objects at the same value as before.

There would be no objection to using the name of pound for the 20 shillings coin, so there would be no change of habit. You could call it pound as now and write it 20 shillings, as in France some people talk of a louis and write it 20 francs.

Valence, France, May 5. L. GOICHOT, M.I.E.E.

[This correspondence is now closed.—EDS. *E.*]

PARLIAMENTARY INTELLIGENCE.

COMPANIES (FOREIGN INTERESTS) BILL.

Last week the House of Lords took the committee stage of this Bill, which prohibits the alteration (except with the consent of the Board of Trade) of articles of association or regulations which restrict foreign interests in companies.

LORD WRENBURY moved a series of amendments, including one which brought within the scope of the Bill companies other than those with a share capital. The Bill did not deal sufficiently with the question of companies whose members were not, but whose directors were, aliens, and he proposed to include directors. For the word "foreigner" he proposed to substitute "alien."

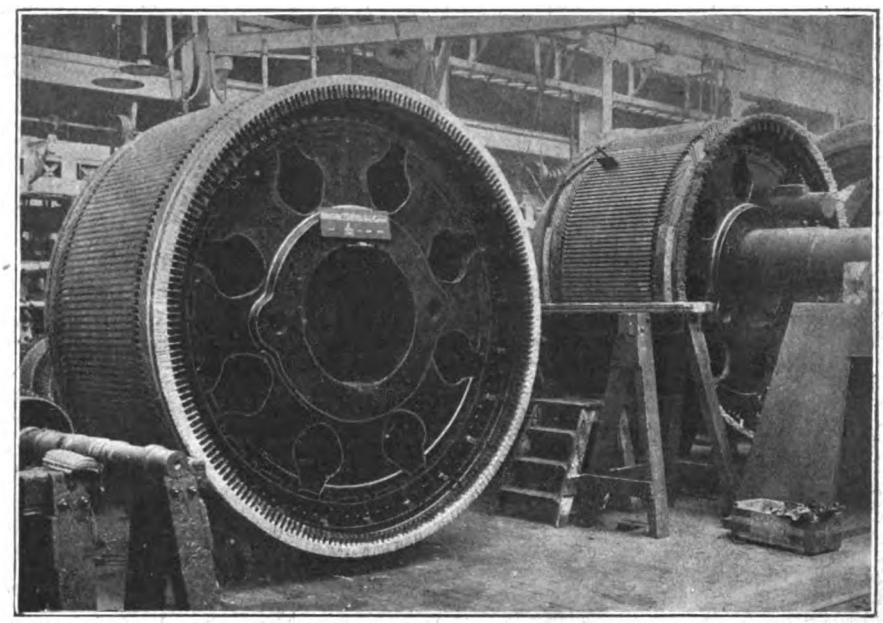
The LORD CHANCELLOR said the amendments would promote the efficient working of the Bill, and he would accept them.

On the motion of LORD WRENBURY a new clause was adopted providing that a resolution for the voluntary winding-up of the company should have no effect unless the Board of Trade authorised or ratified it by written consent; and the court which had jurisdiction to wind up the company might refuse to make a winding-up order. The Board of Trade or the Court was to be guided by the consideration whether the winding-up was bona fide, with a view to the discontinuance of the undertaking, or was with a view to continuing the undertaking free from any restrictions or limitations in the company's articles of association.

THE BRITISH WESTINGHOUSE COMPANY.

Last week representatives of the Overseas Dominions, including the Rt. Hon. Sir Robert Borden, the Rt. Hon. W. F. Massey, the Rt. Hon. Sir E. P. Morris, the Maharaja of Bikaner, Sir J. S. Meston, Sir S. P. Sinha and Sir James R. Dunlop Smith, paid a visit to the works of the British Westinghouse Co., and inspected a number of exhibits of engineering interest. These included steam-turbines, condensers, pumps, gas and oil engines, railway and tramway equipments, transformers, switchgear, heating and cooking plant, meters and instruments. The range of sizes manufactured was illustrated in turbines by turbo sets ranging from 15,000 kw. for electricity supply undertakings down to small sets of 100 kw. for ship lighting. Motor armatures were shown varying from 1/32 H.P. up to 7,500 H.P. and 15,000 H.P. There was also a shaft approximately 20 tons in weight belonging to a 15,000 H.P. reversing rolling mill motor. One of these exhibits is shown in the adjoining illustration.

It is interesting to note that a large number of women are now being employed at these works, special canteens being provided for their use, and their general welfare is in the hands of a lady superintendent of women workers.



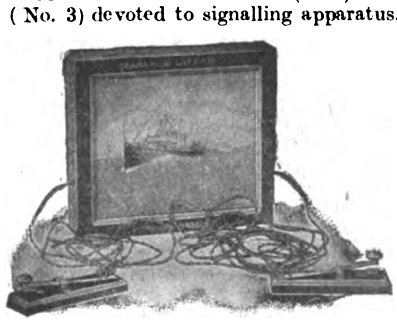
TWO D.C. WESTINGHOUSE MOTORS FOR MOUNTING ON A ROLLING-MILL MOTOR SHAFT.

In August, 1914, an Employees' War Relief Fund was started, and since that date up to the end of 1916 no less a sum than £36,394 has been contributed. Out of this fund over £20,000 has been paid to dependents, and over £10,000 has been set aside for investment, to constitute a "Disablement and Dependents' Fund" to meet future contingencies, besides which Christmas gifts have been sent to every man, and donations made to national and local funds.

An interesting innovation started by the Westinghouse Co. is a school within the works for the instruction of apprentices. The Company accepts two grades of apprentices, one consisting of graduates in engineering and other technically trained men who are allowed to take a two or three years course of a varied character in the shops, testing departments and offices of the Company; the other consists of boys who enter the works between the ages of 14 and 16 years who remain until they are 21. During this time the boys are given experience in various departments in the shops and also are provided with instructions in the Works Trade School. The whole of the lecturing is undertaken by members of the Company's staff, the lecturers numbering about 40 in all.

SIGNALLING APPARATUS.

Messrs. Graham & Latham (Ltd.) draw attention to a recent catalogue (No. 3) devoted to signalling apparatus. The "Stevens" picture signalling instructor, illustrated in this list, consists of a box having a hand-painted lid on which torpedo boats, manœuvring at night, are represented. Small holes are pierced at the mast heads through which miniature lamps glow, and two silent keys are provided, enabling the effect of signalling from one ship to the other to be produced.



The catalogue also contains particulars of various buzzer telegraph sets for practice work.

Digitized by Google

LEGAL INTELLIGENCE.

North of Scotland Electric Light & Power Co. v. North of Scotland Fish Guano Co.

At Edinburgh last week Lord Mackenzie disposed of this action for the recovery of £93. 14s., said to be due, and also for £1,000 as damages for breach of contract. Pursuers alleged that in April, 1913, they entered into an agreement with defenders to erect certain electrical plant in Montrose, for which defenders undertook to pay pursuers £500 for electric energy in addition to certain charges for hire of plant. In December, 1915, defenders intimated that they were closing their Montrose works, and asked pursuers to dismantle and take away the electric motors. Pursuers contended that defenders had no power to terminate the contract in such a manner, and stated that in order to carry out the contract they had to increase their generating plant at a cost of £3,420.

Defenders maintained that the difference between the parties should be decided by arbitration. The termination of the contract was justified by the action of the King's enemies and the existence of a state of war, as the whole fishing trade of the north and east of Scotland and the import of raw material for defenders' works at Montrose had been stopped. It was, therefore, impossible for them to carry on business there, and the contract had become impossible of performance.

The action was taken out of court by joint minute, having been settled by a payment to pursuers of an agreed sum for damages and expenses.

Security for Electric Supply.

At Lambeth (London) Police Court on Friday last, Mr. H. S. Laycock applied to the magistrate to determine the nature and amount of security to be given by him to the South London Electric Supply Corpn. in respect of the supply of electric energy to certain premises in Acre-lane, Brixton.

Mr. Laycock said that he was leaseholder of a hall, and on March 12, 1915, he entered into an agreement with the company for the supply of electricity on special terms. The account was to be paid weekly, and no security was asked for, as under that arrangement the company had power to cut off the supply if he failed to pay. On April 18 last the company demanded a deposit of £20, on the ground of the difficulty of obtaining payment of his accounts. He replied that the weekly payments had been regularly made, and refused to make a deposit, seeing that he had made a claim of £39 against the company in respect of alleged overcharges. The yearly consumption was about £250, and the account had been regularly paid every week. After he refused to make a deposit the company cut off the supply, and he had to deposit £20 under protest.

Mr. Parsons (an official of the company) said their case was summed up in the letter of April 18, which said: "Owing to the difficulty which is always experienced in obtaining payment of your account." There were always two or three weeks owing. The sum of £39 was in dispute. They did not admit that they owed anything. The company were only able to obtain payment of their accounts by threatening to cut off the supply, and pointed out that Mr. Laycock was liable to be called up at short notice. Although the company did not ask for any deposit when the agreement was entered into, they were entitled to ask for one at any time they thought it necessary.

Mr. Biron came to the conclusion that, in all the circumstances, £20 was not an unreasonable amount for the company to require as a deposit.

Extraordinary Traffic on Roads.

In the case Abingdon Rural Council *v.* City of Oxford Electric Tramways (Ltd.), the Court of Appeal recently decided an important point as to the right of a road authority to recover the expense of repairs made necessary by extraordinary traffic. The extraordinary traffic was that of a service of motor-omnibuses in the district. The Council brought the action to recover £498 as expenses incurred in repairs to Foxcombe Hill-road and Wootton-road between Oxford and Abingdon, because of damage done by the company's motor-omnibuses. In June, 1914, defendants began to run motor-omnibuses along the highways between Oxford and Abingdon, and plaintiffs alleged that defendants thereby subjected the highways to excessive weight and extraordinary traffic.

Mr. Justice Sankey held that the mere demands of the district for traffic which was extraordinary could not turn that traffic into ordinary traffic, although the traffic might be necessary traffic, and might in future become ordinary traffic. He decided that the traffic in question was extraordinary traffic and gave judgment for plaintiffs for £350.

The defendants appealed, but the Court dismissed the appeal.

Lord Justice Swinfen Eady said it was beyond dispute that the traffic had caused a large extra expense to plaintiffs, amounting to £104 a mile. But defendants said that the traffic was not extraordinary traffic within the meaning of sec. 23 of the Act of 1878. In 1914 the company established a service of motor-omnibuses, but previously there had been a service of one-horse omnibuses. The motor omnibuses weighed when empty from 3 to 3½ tons, and when loaded from 4 tons 7 cwt. to 5½ tons. There was a daily service. After referring to Hill *v.* Thomas, his Lordship said that the traffic was additional traffic and was of an entirely novel character. It was not traffic which had grown or had actually increased. It was a service of motor-omnibuses put on a country road where the ordinary traffic of the road did not comprise traffic of a similar nature. It was substantially put on at one time and was wholly different in character from the previous traffic. It was contended that when traffic once became extraordinary traffic it was always extraordinary. He could not accept that contention. They were only concerned with the traffic during the year before the commencement of the action, and they were not concerned with the point whether traffic which was extraordinary traffic during that period would at some later period become ordinary traffic.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 Specifications.

2,861 Marconi's Wireless Telegraph Co. & Swann, F. P. Receivers for wireless signals. (25/2/16.) 105,081.

Relates to wireless receivers comprising Fleming valves and comprises a method by which the Fleming current in a valve of this type first rises and then falls to practically zero as the positive potential increases, so that it is possible practically to reduce the effect of atmospheres or very strong signals down to or even below that of the weak signals it is desired to detect so that the latter may be easily read. The object is attained by employing a grid surrounding the filament and a third electrode or sheath surrounding the grid and by applying a fixed small potential between the sheath and the filament.

4,407 Muirhead & Co. & Squier, G. O. Telegraphy. (24/3/16.) 105,089.

4,596 Joel, H. F. Portable electric battery lamps. (29/3/16.) 105,100.

4,629 Miller, R. Electric ignition of explosives. (29/3/16.) 105,104.

4,703 Harvey, J. E. Thermostatic circuit-breaking apparatus for electric heaters. (3/4/15.) 100,252.

5,104 Curtis, A. H. & Igranic Electric Co. Enclosure for switch gear. (6/4/16.) 105,124.

6,121 Lipinski, A. V. Process and apparatus for effecting chemical reactions by means of electric arcs. (28/4/16.) 105,135.

Relates to a process for carrying out chemical reactions by using electric arcs spread by means of magnetic action between practically equidistant electrodes according to which a flowing mass of gas is caused to act against the one and also against the other side of the spread electric arcs in such manner that a permanently uniform uninterrupted gasless mantle of flame is formed.

7,901 B. T.-H. Co. (G.E. Co.). Motor power plant for ship propulsion. (3/6/16.) 105,153.

9,020 Crompton & Co. & Pensabene, N. Dynamo-electric machines. (27/6/16.) 105,165.

10,920 Simms, F. R. Magneto-electric machines. (2/8/16.) 105,180.

10,939 Newton, F. & Newton Bros. (Derby), Ltd. Electric motor starting switches or controllers. (2/8/16.) 105,181.

11,240 Uren, F. W. Means for connecting pipes, electrical conduits and the like. (9/8/16.) 105,1c2.

14,767 British Westinghouse Electric & Mfg. Co. Vapour electric systems for conversion of direct electric currents into alternating currents. (29/11/15.) 102,484.

A vacuum electric apparatus for converting direct electric current into alternating current comprising a pair of main electrodes of opposite polarites, and means for regulating the flow of current there between by the electrostatic control of negative electrons.

1917 Specifications.

1,997 Sprague Safety Control & Signal Corporation. Detectors or relays. (31/12/14.) (Divided application on 18,213/15.) 104,176.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

February 27, 1917.

2,895 Philips-Brinton Co. Ignition systems for engines. (U.S. 23/3/16.)

2,900 Chloride Electric Storage Co. & Dean. Electric cable connectors.

2,903 Burke. Excess watt-meters. (U.S. 24/2/16.)

2,907 Fletcher. Portable electric lamps.

2,912 British Westinghouse Electric & Mfg. Co. Mercury rectifier distributing systems.

February 28, 1917.

2,940 Fessenden. Transmission of sound, &c., impulses.

2,973 Cie. Gen. d'Electro-Chimie de Bozel. Production of hydrogen. (17/11/15, France.)

2,994 Peyman. Incandescent lamps.

March 1, 1917.

3,039 Cohen. Wireless signalling by arc system.

3,044 Ellis. Electric switches for hand lamps, &c.

3,046 Guardiola. Drawn filaments for lamps.

3,061. Igranic Electric Co. & Curtis. Lifting magnets.

3,062 Igranic Electric Co. & Curtis. Resistance grids.

VOLUNTEER NOTICES.

1st London Engineer Volunteers.

Officer Commanding, Lieut.-Col. C. S. Clay, V.D.

Orders for the week :—

Officer for the Week.—Lieutenant W. J. A. Watkins.

Next for Duty.—Lieutenant Hughes-Hallett.

Monday, May 14th.—Technical for No. 3 Company, Right Half Company at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class.

Tuesday, May 15th.—Lecture, 6.30, Capt. Castell, "Knots and Lashings and Trestle Bridging." Physical drill and bayonet fighting, 7.30 to 8.30.

Wednesday, May 16th.—Drill, No. 1 Company, Right Half Company, 6.15.

Thursday, May 17th.—Drill, No. 2 Company, Right Half Company. Ambulance class by M.O., 6.30. Signalling class.

Friday, May 18th.—Technical for No. 3 Company, Left Half Company, Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' Drill, 6.30 to 8.30.

Saturday, May 19th.—Commanding Officer's parade, 2.45. Uniform, for drill in Hyde Park.

Sunday, May 20th.—Special work at Bombing School. Parade Clapham Common Station (City & S.L. Tube Railway) 9.45 a.m. Uniform, haversacks, water-bottles, mid-day rations to be carried. As this work is very important, the Commandant would like to see much larger parades.

Armlets.—Members are warned that armlets must be worn at all plain clothes parades.

Musketry.—For all Companies, see Notice at headquarters.

Note.—Unless otherwise indicated, all drills will take place at headquarters (Balderton-street, Oxford-street).

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

The British Trade Corporation. Arrangements have been completed for the creation of a British Trade Corporation for developing British commerce and trade. A Royal Charter for 60 years has already been granted and the Corporation, which will have a nominal capital of £10,000,000 in £10 shares, will act as the Government's agent in many financial matters. The directors are Lord Farringdon, Mr. F. Huth Jackson, Mr. Arthur Balfour, Mr. F. Dudley Docker, C.B., Mr. W. H. N. Goschen, Mr. J. H. B. Noble and Sir J. Hope Simpson.

Many questions about the scheme have been asked in the House of Commons as the new departure has aroused considerable interest in financial and commercial circles. In reply to questions, Mr. Roberts stated last week that the Financial Facilities Committee suggested that the new institution might act as an agent for H.M. Government, should the Government desire to assist, by means of advances, educated young men who after the war might wish to go into business abroad. The Government had, however, come to no decision on that suggestion. The chairman and managing directors of the Corporation would not be appointed by the Government, but in the manner provided for in the deed of settlement. He intended to issue the text of the charter at an early date. It was not proposed that the Government should exercise direct supervision over the actual working of the Corporation, but in carrying on its business in any part of the world the Corporation must exercise its powers with due regard to the interests of the Government, and where the Corporation acted as agent for the Government it would be strictly accountable to the Government as such.

It is well known that German banking methods had an important effect in building up the Teutonic commercial fabric and in assisting German traders and manufacturers to secure such a dominant position in the markets of the world. British trade has suffered all over the world through the operations of these banks, and the formation of this British institution will initiate a new era for British industry and commerce. The Information Bureau, which Lord Faringdon is engaged in creating, will be an important part of the scheme. The President of the Board of Trade has given instructions that the Department of Commercial Intelligence should place themselves in the closest possible touch with the Information Bureau and the Corporation, and give them all the assistance in their power. Apart from the financial facilities which it will be the first object of the Corporation to afford, it will be possible to have the prospects and bona-fides of any industrial scheme thoroughly investigated by reliable experts.

* * * *

Engineering Organisation. An additional step in the organisation of British engineering firms after the war has been taken by the affiliation of the British Engineers' Association with the British Empire Producers' Organisation.

The latter organisation now represents an aggregate of over £500,000,000 of invested capital, and has powerful connections amongst associated industries of the dominions and colonies concerned with both agricultural and manufacturing production. It is mainly to such markets, many of which are largely undeveloped, that British makers of machinery and rolling-stock must look in the future for the prosperous maintenance of their business. The reciprocal advantages of an alliance between the great overseas producers and British engineering manufacturers are obvious.

* * * *

The Power Famine. A leaflet issued by the British Empire Producers' Organisation refers to the great difficulty in obtaining electric generating plant, and a case is cited in which four municipalities recently competed for permission to commandeer big turbo-generating plant under construction for the fulfilment of an order from overseas. The sets were of 12,500 E.H.P. each, and it is significant that the city which has succeeded, with the authority of the Ministry of Munitions, in obtaining these great machines has hitherto been regarded as only a second or third-class town. It is one, however, which on the demand of war work has increased its output of electrical energy by many millions of units, and will now again double this quantity by installing plant costing about £400,000, the power production of which is wanted for the manufacture of steel.

It is significant also that new plant of this character can be installed at a cost of from £12 to £15 per kilowatt, compared with a general average throughout the country of an accumulated capital expenditure of about £45 per kilowatt. On the one hand there is an insatiable demand for cheap power, and on the other a great aggregation of antiquated generating plant. To modernise the electric power supply of the United Kingdom will, in the opinion of the British Empire Producers' Organisation, tax the entire capacity of the electrical manufacturing industry after the war, and if any export trade is also to be sought there must be great extensions of factories.

* * * *

British Trade in Neutral Countries. As announced in our last issue, information is being collected by the Foreign Trade Department of the Foreign Office from His Majesty's Consular officers abroad, in regard to firms in neutral countries with whom British Houses could trade in place of firms of enemy origin or association which have been placed on the statutory list.

The reports from Consular officers will give the names of firms desirous of trading with the United Kingdom, with references, bankers, commercial reputation, general nature of business, method of transport, principal goods immediately required and whether the firm trades on own account or on commission basis. The following bodies have agreed to disseminate the information :—

The Association of Chambers of Commerce of the United Kingdom, Parliament Mansions, Orchard-street, S.W. 1, and its associated Chambers of Commerce ; the London Chamber of Commerce, 1, 2 and 3, Oxford-court, Cannon-street, E.C. 4 ; the Federation of British Industries, 39, St. James's-street, S.W. 1 ; and also certain approved trade associations and federations not associate members of any of these organisations.

Firms who are members of the above associations should apply for the information through one of these channels. H.M. Consular officers have also been instructed to send duplicates of their reports to the Board of Trade, and the information will also be available at the office of the Department of Commercial Intelligence of the Board of Trade, 73, Basinghall-street, E.C. 2.

* * * *

Excess Profits Duty. On the application of the Cable Makers' Association, the Board of Referees, on April 26, increased the statutory percentage as respects the business of manufacturing in the United Kingdom insulated wires and for cables for the transmission of electrical current to 7 per cent. in the case of a company and 8 per cent. in the case of any other business.

* * * *

Machine Tool Makers' Co-operation. Ten of the leading machine tool manufacturers in this country have formed a new organisation entitled the Associated British Machine Tool Makers. It is proposed to recognise the manufacturing as well as the selling side of the industry, and particular attention will be paid to foreign markets. It is intended to issue a joint catalogue of the firms in the Association in Russian and Spanish, and, where necessary, in the languages of other countries. Technical representatives will be sent abroad in order to develop foreign connections.

* * * *

The Increase of Public Officials. At the recent annual meeting of the National Chamber of Trade the Executive Council's report dealt with trade organisation, educational reform, the increase of public officials, &c.

Mr. J. W. CLARK pleaded for more efficient organisation on the part of employers. During the war there had been an enormous increase of public officials and public departments, which possessed almost autocratic power. It was most important that the employers' point of view should be put before the heads of the new Government Departments. Over and over again regulations had been issued which had had to be cancelled simply because they could not possibly be carried out. That would never have happened if the officials understood the whole facts of the case. Nobody could understand such a complicated system as the trade of this country unless they heard both the sides of the employers and the workers. Traders did not claim to possess the wisdom of the world, but yet they could prove, by their own efficient organisation, that they were capable of rendering good service to Government Departments.

Mr. C. AVELING (Southport) said the Government was gradually assuming control of everybody and of everything, so much so that the poor trader was apt to get lost in a maze of regulations which were being continually drafted. He hoped that in future there would be closer working with national organisations, such as the Chamber of Commerce and large national organisations such as those connected with the specific trades. The various organisations would have to consult more together in the future if their just demands were to be conceded.

The report was adopted.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Burton-on-Trent.—Subject to the consent of the Ministry of Munitions, it is proposed to purchase induced draught plant for the electricity works.

Gloucester.—The Corporation have applied to the L. G. Board for sanction to borrow £1,000 for an electrically-driven fan for the boiler-house.

Liverpool.—Last week Mr. Gates protested against an expenditure of about £30,000 on two new cooling towers, two rotary converters and switchgear, &c., but the chairman (Mr. Russell Taylor) explained that the expenditure was absolutely necessary in order to give a supply of electrical energy to factories. No money could be spent without a Government certificate.

The committee's recommendations were then approved.

Luton.—It is necessary to lay additional mains for augmenting the supply of electrical energy to some large works in the district.

The chairman of the Electricity and Tramways Committee (Ald. Wilkinson) referred at the recent meeting of the Council to the latest breakdown and said the repairs would be completed in about a couple of months. Commenting on the question of extension he said that works were cropping up both on the eastern and western parts of the town, and particularly would they require additional facilities to meet the Vauxhall requirements and there were also three or four large places.

St. Helens.—The Council have received sanction to borrow £6,200 for mains and switchgear, £4,456 for a water-tube boiler and £710 for boiler house extension.

Sheffield.—The mains are to be extended at a cost of £149 to supply the University glass technology department.

The women stokers at the generating station are to be paid 6½d. per hour, exclusive of the war bonus of ¾d. per hour paid to all women workers. Application is to be made to the L.G. Board for permission to borrow £15,000 for sub-stations and their equipment.

GENERAL.

Baildon.—The Council has been in negotiation with Bradford Corporation and Shipley Council as to a supply of electricity and it has been decided to accept the terms offered by Bradford.

Bath.—A recommendation by the Electric Lighting Committee to insure the Diesel engine at a net premium of £194. 8s. caused considerable discussion at the last meeting of the Council.

Ald. Oliver moved as an amendment that an engineer having experience of the manufacture and working of Diesel engines be called in to report upon the plant, and that no further expense be incurred on the engine until the report has been prepared and circulated among the members. In the course of his speech he went fully into the history of the plant, and said he wanted to get someone who could tell them whether they could put it into repair.

On the amendment being put 15 voted for and 15 against, and as the Mayor declined to give a casting vote a further amendment was moved to ask the committee to reconsider the position. Ultimately the debate was adjourned, but at a subsequent meeting the report was adopted.

Beckenham.—Mr. P. Sjollema has been reappointed chairman and Mr. J. Crease deputy chairman of the Electricity Committee.

The committee is to approach the L.G. Board in order to obtain authority to postpone the repayment of loans during the period of the war.

Dublin.—On Monday the Council had before it a further report by the Special Committee on the question of the administration of the electric supply undertaking.

It will be remembered that in February last the committee had referred back to it their original report together with the letters of Mr. Ruddle and from Mr. L. J. Kettle on the subject. The committee now report that "in order to achieve the results which Col. P. W. D'Alton has outlined in his reports as results which he, if he were in charge, could achieve for the betterment of the electricity undertaking, your committee recommend that Mr. Ruddle be appointed during a period of two years, to take entire charge, not only of the electrical engineering department, but also of the commercial department of the undertaking."

Increased Charges for Electrical Energy.—The charges for current are being increased at the following places:—

At Okehampton, where the works owned by Mr. Henry Green have supplied current at 5d. per unit since the undertaking was started 30 years ago, the price has now been increased to 6d.

Rathmines Council has increased the charge for current to 6d. per unit for all lighting consumers, 3d. per unit for heating and other domestic purposes, and 2d. for supplies to cinematograph lanterns.

Blackpool Electricity Committee is increasing its charges by 10 per cent.

St. Anne's-on-the-Sea Council is increasing its charges to 5½d. per unit (flat) and 7d. and 2½d. (m.d.) for lighting, 1½d. for power, heating and cooking, and 3d. for cinemas, outside signs and "illuminations."

At East Ham the charge to general consumers (including public lighting) is increased from July 1 by 10 per cent., making 20 per cent. above pre-war charges, and for tramway traction 5 per cent., making a total of 10 per cent.

At Stoke-on-Trent, a further increase of 5 per cent, (making a total increase of 25 per cent) is to be made in all the electricity department's charges.

Islington (London).—The Lighting Committee recently issued its report on the recommendations of the Special Committee regarding public lighting, and after discussion the Council decided to adjourn further discussion pending a report from an expert on lighting, who is to be selected by the Parliamentary and General Purposes Committee.

Lancaster.—The Corporation has given a bonus of £75 to Mr. J. B. Patterson, who has acted as borough electrical engineer during the absence of Mr. Milnes on military service.

Linking-up in South Wales.—A conference has been held on the proposal to link up the electric supply system of Swansea, Neath and Llanelly.

In a report on the matter the borough electrical engineer of Swansea (Mr. J. W. Burr) states that it is felt that the proposals offer not only considerable possibilities locally in respect of interchange of load, but of further development of the respective supply areas, particularly Swansea and Neath, through which the linking-up main would pass, and it was hoped that definite proposals would be made within a few months.

Manchester.—There has been trouble at the Dickinson-street station owing to the employment of five coloured men from Jamaica, but we are informed that the matter has now been arranged satisfactorily.

On the 28th ult. three of the new men were put to work and the white labourers at once protested, and on Monday demanded the dismissal of the negroes. The chief assistant engineer (Mr. A. C. McKenzie) who, in the absence of the chief engineer and the chairman of the Electricity Committee, was in charge of the works, refused to accede to this demand, but he assured the men that the negroes had only been engaged because white labour could not be obtained, and he undertook to replace them as soon as possible. On Tuesday last the men decided to stop work on Friday morning unless the negroes had been discharged.

In a statement by Mr. McKenzie it is pointed out that for the last six months the electricity department had had a claim upon the books of the Labour Exchange for general labourers, and they had engaged all the men that had been sent to them. Even so, they could not get the labour they required. Last week there was special need for men in the boiler-houses. The Labour Exchange was not able to find any white men, but sent along three blacks. "We should have been glad," said Mr. McKenzie, "to get men of any colour to keep the work going, so we accepted these men, as we had accepted all the other labourers sent to us. They are employed on exactly the same conditions as the other men."

Rotherham.—The Borough Treasurer recently presented to the Finance Committee his annual statement on the borough finances.

The revenue of the electricity department during the past year was £49,068 (increase £15,856), and the net profit was £5,324 (from which £500 is required as a provision for excess profits duty), compared with £7,585 for the previous year, the decrease being due to the extra charge of £2,860 for service of debt and interest, high price of coal, and increased wages and income tax.

The general manager and engineer (Mr. E. Cross) reported that coal cost 14s. 4¾d. per ton (against 9s. 8d. in previous year), and cost of materials and wages have increased at least to the same degree, while the charges for current for power and traction have not increased.

Tramway revenue was £70,529 (increase £18,285), and the surplus for the year was: Tramways £12,277, trolley vehicles £768, and after deducting £1,013 loss on petrol 'buses, the total surplus for the year was £12,032 (increase £1,338). Out of this £3,500 is set aside for excess profits duty, leaving £8,532 available.

LIGHTING AND INDUSTRIAL POWER.

Board of Trade Electric Power Committee.—Many local authorities have now adopted the suggestion of West Ham Corporation, and have passed resolutions of protest against the under-representation on the committee recently appointed by the Board of Trade to consider and report upon the question of a cheap supply of electric power.

Among the authorites who have done this are Bath, Colchester and Islington.

Digitized by Google

Clayton-le-Moors (Lancs).—Electric lighting is to be introduced into the parish church at an early date.

Electricity in Gold Mining.—At the recent meeting of the Balaghât Gold Mining Co., Mr. Edgar Taylor said that the equipment of the mine had been improved. A new underground electrically-driven hoist had been erected in Tennant's section of the mine and a new 150 H.P. air compressor would soon be started up at surface.

Electrolytic Production of Zinc.—The report of the Amalgamated Zinc (De Bavay's) (Ltd.) for 1916 states that the Electrolytic Zinc Co.'s experimental unit, capable of producing 250 lb. to 300 lb. of zinc daily, is now running, and the results confirm the American practice. The erection of the unit capable of producing 10 to 11 tons of zinc daily is proceeding satisfactorily.

Lincoln.—The chairman of the Electricity Committee (Ald. W. S. White) has replied to the criticism of the policy of the department by Mr. P. W. Robson at the recent meeting of Messrs. Clayton & Shuttleworth.

Ald. WHITE said he heartily agreed with Mr. Robson's speech, but he was sorry Mr. Robson did not go a little further. The Corporation were unable to fulfil their contract for the supply of electric current, but it was right the public should know the reasons why. They would remember the Corporation had got statutory powers to double the capacity of their works and to spend about £40,000, but they were unable to get that through unless they inserted a clause that they would not seek powers to borrow the money until 12 months after the war, so that their hands were tied. They had done their best; they realised it was war time, and the current they were supplying was to help to win the war. The quantity of electricity supplied to the firm in question to March 31, 1915, was 802,000 units; to March 31, 1916, a million and a half units; and this year they supplied about three and a quarter millions. When they considered all that had been done with the plant in operation before the war started they had done splendidly. They had had to bring some of their old plant into operation, and that was getting most costly. They did not begrudge that, because it was serving a useful purpose. The cause of their failure was simply the clause inserted in their Act. He thoroughly approved the remarks of Mr. Robson. Lincoln would be a very different place in 10 years' time, and a good deal depended on the action of the Corporation. Electricity would be wanted far more in the future than in the past, and it would be their aim as an Electricity Committee (but they should have the unanimous support of the Council) to try to help these firms at the smallest cost possible, because the interests of the city were so linked up, through the Corporation, with these firms that they would do well to take Mr. Robson's advice. The King had used the words "Wake up, England." He would like to apply that to Lincoln. We had a lot to learn; we were too conservative in our ideas, and he was afraid we talked about this lamp-post being in the wrong place and that slab being up, and lost the substance for the shadow.

Utilisation of Irish Peat.—The Scientific Research Branch of the Reconstruction Committee have appointed a Joint Engineering Committee for Ireland to make investigations and report on the utilisation of Irish peat for post war industries. The following are the members of the Joint Committee:—

Messrs. P. C. Cowan, D.Sc., L.G. Board (*Chairman*), Mark Ruddle, M.Inst.C.E., John Hy. Grindley, D.Sc., M.I.Mech.E., Prof. Pierce F. Purcell, M.A., M.A.I., M.Inst.C.E., Samuel Geoghegan, Arthur Hassard, B.A., M.A.I., A.M.Inst.C.E., and Sir John Purser Griffith, M.Inst.C.E. (representing the Institution of Civil Engineers); Peter C. Cowan, D.Sc., M.Inst.C.E., Arthur E. Porte, M.I.E.E., John Holliday, M.I.M.E., and R. N. Eaton, A.M.I.E.E. (representing the Engineering and Scientific Association; and Capt. O. T. O'Kelly Webber, R.E., Wm. Tatlow, Joseph P. Tierney, Thomas Tomlinson, B.A., M.Inst.C.E.I., and G. Marshall Harriss, M.Inst.C.E.I. (representing the Institution of Electrical Engineers, Dublin Section).

The hon. secretary is Mr. R. N. Eaton, 12, College-green, Dublin.

ELECTRIC TRACTION.

Dublin and Lucan Electric Railway.—The Board of Trade, who were recently invited to take over this railway on behalf of the Government, have intimated that they cannot do so, as the line is simply a tramway, and does not come within the provisions of the Regulation of the Forces Act, 1871.

Electric Omnibuses at York.—In a report by the tramways Committee on the working of their electrically-driven motor omnibuses, it is stated that the charge for electricity supplied to the 'buses for a year has been £737, while it is calculated that had petrol been used the cost would have been considerably over £10,000.

So well satisfied are the Committee with their experience that they have recommended the Corporation to purchase another electric motor omnibus for use in a working class district.

Hampstead (London).—The Borough Council have agreed to order two one-ton electric vans for disinfection work, at a cost of £1,606.

Sheffield.—It has been arranged to make an additional allowance to all daily and weekly municipal employés of 5s. per week and 1½d. per hour to other hands.

The cost of the increase to the tramways department will be £18,616 per annum, or more than the estimated profit on the year. It is, therefore proposed to abolish all halfpenny stages.

Tramway Employees' Wages.—The London & Provincial Licensed Vehicle Workers' Union has applied to the L.C.C. Tramway Committee, the motor omnibus companies and the Metropolitan tramway companies for a war bonus of 10s. a week to all drivers and conductors.

Wolverhampton.—The application of the tramway employés for an increase of wages of a penny per hour and time and a half for special cars and special duties is to be submitted to arbitration. The award is to be made retrospective to April 1.

IMPERIAL NOTES.

Canada.—Sherbrooke (Que.) ratepayers recently approved a by-law authorising the purchase of the Two Miles Falls hydro-electric plant, at £71,000.

The number of telephones in use at the end of the financial year in March was 548,000, or one for every 14 persons in the country. Owing to the immensely greater distances and to the isolation of farmsteads and villages, telephones are more of a necessity in Canada than they are here. No fewer than 1,852 miles of new railway were opened, bringing the total up to 37,434 miles of line.

The annual report of the Canadian Government railways shows that the total expenditure, including that on the Quebec bridge last year, amounted to £8,725,465, of which over £4,000,000 was charged to capital, some £3,000,000 to revenue and £343,330 to income. A total of £23,722,945 has been spent on canals and £75,429,339 on railways.

The Canadian Minister of Finance has been appointed "Public Custodian of Enemy Property in Canada." He is collecting information as to property (real or personal) in Canadian territory belonging to enemy subjects; debts due to or held on behalf of enemy subjects resident or carrying on business in enemy territory, &c.; and claims of British subjects resident or carrying on business in Canada against enemy Governments.

Electrical Employers' Association of N.S.W.—In the annual report of the Executive Committee of the Electrical Employers' Association of New South Wales for the year ended Feb. 17 last it is stated that in spite of the continuance of the war the electrical industry in the State has not suffered any considerable diminution of trade.

Difficulties had been created by large numbers of enlistments for active service and enrolments for Home Defence, and the industry has suffered from shortage of supplies of material not manufactured in Australia. During the year certain persons and firms have had to be removed from the roll of members, but several firms of good standing have joined or are joining at an early date.

Johannesburg.—The "British and South African Export Gazette" reports that the Corporation have experienced trouble with 10 of the 13 large underground cables.

The 10 faulty cables are of the paper and bitumen insulated steel-armoured type, and were laid in 1905-6, but after a few years of service it became apparent that this type of cable was entirely unsuited to the conditions of running in Johannesburg. Early in 1912 drastic action had to be taken, and to save the comparatively enormous expense of replacing the faulty feeders the cables were relaid on the "solid" system. Although the position improved, fresh difficulties presented themselves, and since 1914 the cables have only been kept going at comparatively enormous expense out of the vote for maintenance. Early in 1916, to replace at least two of the feeders, the Corporation thought it desirable to order sufficient new cable of the type employed on the three cables which had given satisfaction, and are still in excellent condition. They are of the paper-insulated, lead-covered and steel-armoured class, and the whole of the new cable, which cost £10,870, is now in commission. The Corporation is, however, again faced with the necessity of renewing the remaining faulty feeders, which will now cost £65,000.

New Zealand Market for Electrical Plant.—The Wellington (N.Z.) correspondent of the London Chamber of Commerce says the exclusion of Germany as a supplier of electrical equipment has afforded a fair opening for American enterprise in New Zealand, British manufacturers being otherwise engaged.

American houses are taking the opportunity of consolidating their already extensive business connections in New Zealand in the matter of electrical supplies. The strange idea is current that British manufacturers are not accustomed to manufacturing plant for high tension, and that Americans are better qualified for the work.

At Whangarei (Auckland province) the largest cement works in the Dominion is about to start operations, relying upon hydro-electric power, the turbines and generating plant being at Wairua Falls, 17 miles distant. The plant is almost wholly American and the value of the electrical equipment is about £400,000. The structural iron and steel at the works is English. Soon after the war the country will resume its practical interest in utilising the large amount of power available for the generation of electricity. Those concerned will require to be educated to the fact that British manufacturers are able to undertake the installation of h.t. electric plants of any size. The possibilities of the profitable use of electric power for hauling in mines, and heavy work generally, are likely to be great in New Zealand in the near future, especially as manual labour is very dear.

Digitized by Google

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says a decree has been drawn up declaring forfeited the concession for a line of tramways in the Port of the capital granted to Senores Gandulfo and Diaz Velez in terms of law 6,864.

Guatemala.—The President stated in his recent annual address to the Legislative Assembly that the Government's telegraph receipts in 1916 were $3,920,550 currency (increase $822,381) and $36,521 gold (increase $26,863), and that extensive improvements had been effected in the radio-telegraph section.

Russia.—The British Vice-Consul at Kharkov reports that a group of Moscow merchants is interested in an important projected electrical undertaking in the Donetz Basin.

The first sum of 50,000,000 roubles to finance the project has been secured, and it is proposed shortly to raise the share capital to 120,000,000 roubles. The company proposes to supply electrical energy to the metallurgical industries of the Donetz Basin, which in 1913 produced 190,000,000 pouds of pig iron out of a total of 283,000,000 pouds for the whole Russian Empire.

Steam turbines are to be used for driving the generators, and it is also proposed to utilise the waste gases of the coke ovens.

Russian Exhibition.—At this exhibition, which is being held during the present month at the Grafton Galleries, Bond-street, London, W., there are a Russian Commercial Bureau and a Russian Press Section, where information can be obtained on matters affecting Russian commerce and industry.

Russian Year Book.—We have received a copy of the 6th (1916) edition of this useful annual, compiled and edited by Mr. N. Peacock.

The book contains some 780 pages, or 160 more than last year, and the information given is compiled from special sources under facilities from the Russian Government. Amongst the useful matter in the present issue are an explanation of the Russian law as affecting foreigners, a study of the economic position of Russia since the beginning of the war, and a section dealing with openings for British trade in consequence of the stoppage of commercial relations with Germany. The book also contains the new Russian Patent Law, information as to the application of the Industrial Tax to foreign firms, the new Customs Tariffs, &c. We should have liked some more information about the electric supply and traction undertakings of the vast territory of our great Ally, but probably this will be remedied in the next edition. The price of the Year Book, which is published by Messrs. Eyre & Spottiswoode, is 10s. 6d.

Taxation of Travellers in Chili.—A Chilean law which came into effect on Jan. 1, 1917, provides for an annual tax of 1,000 pesos (about $140) on representatives of foreign concerns having no selling agency in Chili.

This fee is to be payable in each department of the country in which the traveller may do business. There appears to be considerable doubt, however, as to how strictly the law is to be enforced. It is generally agreed that the imposition of such a fee in each of the 80 departments of Chili would be undesirable, and it is believed that the aggregate fees will be reduced.

MISCELLANEOUS.

Charity Football Match.—The football match played on April 7 for St. Dunstan's Hostel for blinded soldiers and sailors by the teams of C. A. Vandervell and the Davis A.C. resulted in £122. 12s. being handed to this most deserving institution.

Electrician's Wages.—The Committee on Production have increased the wages of all electrical wiremen, whether in the shipbuilding and engineering or in the building trade, by a war bonus of 5s. per week. Apprentices and youths have also received a bonus of 2s. 6d. per week. This is the second increase the men have received since the beginning of the present year. On Feb. 17 the arbitrator awarded 3s. increase to electricians.

Enemy Firms Wound Up.—The total number of businesses controlled by alien enemies and ordered by the Board of Trade to be wound up is now 444.

The latest include the Tandem Smelting Co. (Ltd.), Christ Church-road, Merton Abbey, London, S.W. (Controller, B. D. Holroyd, 6, Great Winchester-street, E.C., to whom claims are to be sent by July 7), Kroll & Co., Bayham-place, Camden Town, London, N.W., metal workers (Controller, R. B. Tyler, 1, Queen Victoria-street, E.C., to whom claims by June 4), and the London Emery Works Co. (Ltd.), Marsh-lane Park, Tottenham, London, N. (claims to the Controller, R. E. Smith, 53, New Broad-street, E.C., by June 16).

Interest in British Mines.—On May 2 His Majesty in Council ordered the following addition after Reg. 30 B in the Defence of the Realm Regulations:—

30 B.B. No person shall, without the consent of the Board of Trade, transfer or agree to transfer to or for the benefit of an alien or a foreign controlled company any interest in any mine to which the Regulation applies or any share, stock, debenture or other security issued by any company owning such a mine, or accept or agree to accept such a transfer. This regulation applies to any mines in the United Kingdom from which ores of copper, lead, tin, tungsten, zinc, or any other metal which may hereafter be added by the Board of Trade, are abstracted.

London Chamber of Commerce.—At the annual meeting last week Mr. Stuart A. Russell was unanimously elected chairman of the Electrical and Allied Trades' Section, in succession to Mr. W. L. Madgen, resigned.

The deputy-chairman, Mr. A. M. Sillar, also resigned, but this office was not filled. It was left to the discretion of the chairman to express to the Special Committee on Trade After the War the views of the Section on the question of the proposed tariffs on goods of enemy, allied and neutral nations. A special committee was appointed to consider the evidence to be put before the Board of Trade Committee on the position of the electrical trades after the war.

Poster Restrictions.—There appears still to be some doubt among advertisers as to what is permitted under the recently amended Order, and Mr. H. C. Hill, chairman of the Colour Printers' Committee of the London Master Printers' Association, points out that the present position with regard to posters is as follows:—

New posters may be produced up to 60 in. by 40 in. size, or its equivalent in square inches.

Posters in any size (including those advertising goods offered for sale by retailers), with or without the retailer's address, the production of which was commenced before March 2, may be completed and exhibited on hoardings or elsewhere as before.

There is no restriction on the exhibition of posters of any size or kind which were in stock on March 2nd, excepting those making an announcement with respect to a newspaper or periodical.

Posters for export can be printed in any size.

Prohibited and Restricted Exports.—On May 13 the Privy Council made the following amendments in the schedule to the Customs (Export Prohibition) Proclamation of May 10, 1916:—

Delete.—(A) Iron and steel plates and sheets, except when made from crucible cast steel or fromcarbon steel not manufactured in the United Kingdom by the Siemens or Bessemer processes, provided such crucible or carbon steel does not contain more than 5 per cent. of chrome, cobalt, nickel or vanadium. (B) Steel articles containing chrome, cobalt, nickel or vanadium. (A) Steel flats, rounds, and other sections with the following exceptions: (1) When made from crucible cast steel (II.) carbon steel for tools not manufactured in the United Kingdom by the Siemens or Bessemer processes; provided such crucible or carbon steel does not contain more than 5 per cent. of chrome, cobalt, nickel or vanadium. (A) Steel rails, sleepers and springs.

Add.—(C) Celluloid articles (partly manufactured). (C) Oxides of iron. (C) Manganese compounds, not otherwise prohibited. (C) Vanadium compounds. (A) Iron and iron articles containing chrome, cobalt, molybdenum, nickel, tungsten or vanadium. (A) Iron angles, channels, joints, tees and other sectional material. (A) Iron bars, including flats, rounds, and other sections and shapes. (A) Iron billets, blooms and slabs (A) Iron ingots. (A) Iron pipes (wrought). (A) Iron plates and sheets. (A) Iron plates, sheets and bars. (A) Iron tubes. (A) Steel and steel articles containing chrome, cobalt nickel or vanadium. (A) Steel bars, including flats, rounds, and other sections and shapes. (A) Steel plates and sheets.

Prohibited and Restricted Imports.—Recent decisions of the Department of Import Restrictions are as follows:—

Prohibited.—Carbon brush-holders (not for motor cars); insulated cables and wire; electrolytic wire; flexible cords; and zinc sulphide.

Not prohibited.—Leather belting; electricity meters; graphite; and thorium.

Tribunal Cases.—At Blackpool last week application was made for the exemption of 10 employés at the electricity works, including two switchboard attendants, one single, aged 31, and the other married, aged 28.

The Mayor referred to the ages of the men, which were not high when they were taking men of 36. The electrical engineer (Mr. Furness) would have to make out a very strong case indeed for men between the ages of 31 and 36.

Mr. FURNESS said he was not representing the men, but the service. The works had to run 24 hours a day and 365 days a year. They had to work three shifts of eight hours a day, for men could not stand more in such an atmosphere.

The certificates of the 10 men were cancelled, substitutes to be found.

At the Brighton Tribunal last week it was stated that owing to the drain upon the municipal electricity employés for military service, only two lamplighters remained, and the number of men conversant with the intricate system of underground cables was reduced to two.

Unemployment Insurance.—The Umpire has decided that contributions are payable in respect of—

Workmen engaged in the installation in buildings or ships of accumulators for use in connection with electrical machinery.

U.S.A. Telegraphs and Telephones.—The War Department has taken over the control of all telegraph and telephone lines and the Navy Department has taken control of the submarine cables. Only cables passed by the American censor will be transmitted abroad in future.

EDUCATIONAL.

University of Sheffield.—At a meeting of the Court of Governors on Tuesday separate Faculties of Engineering and Metallurgy, in place of the hitherto existing Faculty of Applied Science, were sanctioned.

West Ham Municipal Technical Institute.—A special course of seven lectures, with practical work, will be given on "Some Industrial Applications of Electricity," on Tuesday evenings, from 7 p.m. to 9 p.m., commencing May 15. The fee for the course, a brief outline of which is given in our advertisement columns, is 2s. 6d.

Digitized by Google

TENDERS INVITED AND ACCEPTED.

Mechanical Stoker.

WARRINGTON Electricity and Tramways Committee require tenders by noon May 22 for an Underfeed Type Mechanical Stoker. Specification, &c., from the Borough Electrical and Tramways Engineer.

Wiring and Fitting.

Tenders are required for the Electric Lighting of the BINGLEY Primitive Methodist church and school. Particulars from the Rev. C. R. Dalton, 10, Trinity-place, Bingley, to whom tenders by May 12.

Tenders are required by May 15 for Electrical Installation Work in the ward block in course of erection at the War Hospital, Morton Banks, KEIGHLEY. Specifications from the Borough Electrical Engineer.

Electric Lamps.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. May 23 for supply of 8,250 Incandescent Electric Lamps during the year ending June 30, 1918. Specification, &c., from the Commissioner's Offices, Spencer-street, Melbourne.

LONDON COUNTY COUNCIL.—The Council has accepted the following tenders :—

Western Electric Co., supply and laying of h.t. and l.t. cables in connection with additional supply of power for Woolwich district, £24,971. 17s. (also tendered : Siemens Bros. & Co., £25,799. 3s. 7d., and British Insulated & Helsby Cables, £26,492. 17s. 6d.) ; A. Reyrolle & Co., h.t. switchgear, £2,596. 12s. (also tendered : British Thomson-Houston Co. £2,990. 10s.) ; Midland Electric Wire Co. (£1,257) and London Electric Wire Co. (£1,04[illegible]. cotton-covered copper wire ; British Westinghouse Electric & Mfg. Co. (value not stated, indefinite quantities involved), Alfd. Clare & Co. (£848. 19s.), Dick, Kerr & Co. (value not stated), and Manchester Armature Repair Co. (£2,172. 18s. 4d.), motor and generator spares ; British Westinghouse Electric & Mfg. Co. (value cannot be stated) and Dick, Kerr & Co. (£51. 7s. 6d.), controller, circuit-breaker and other switch details and magnetic brake spares ; British Westinghouse Electric & Mfg. Co. (£262. 16s. 6d.), Dick, Kerr & Co. (£9. 9s.), E. Showell & Co. (£1,141. 10s. 1d.), and Tramway Supplies (Ltd.) (£172. 2s. 11d.), contact fingers and parts, &c. ; Midland Electric Wire Co. (£997. 10s.), Liverpool Electric Cable Co. (£1,087. 19s. 1d.), Callender's Cable & Construction Co. (£568. 8s. 4d.), Hooper's Telegraph & Indiarubber Works (£177. 10s.), London Electric Wire Co. & Smiths (£3,294. 5s.), and British Insulated & Helsby Cables (£5,031. 3s. 2d.), electric cable, fuse wire and cotton-covered copper wire ; M. Mole & Son, pressed brass and steel articles, £392. 8s. ; British Westinghouse Electric & Mfg. Co. (£82. 10s.), Woodite Co. (£6. 2s. 2d.) and Litholite, Ltd. (value cannot be stated), moulded insulators other than rubber ; Micanite & Insulators Co., mica and micanite articles, £8. 15s. ; Bullers, Ltd. (£304. 3s. 4d.), Gaskell & Grocott (£157. 10s.) and Doulton & Co. (£73. 6s. 8d.), insulators and porcelain ; E. Showell & Co. (£223. 9s. 10d.), Gabriel & Co. (£135) and C. D. Peters & Co. (£23. 17s.), car furniture ; Anti-Attraction Metal Co., machined bronze bearings, £5.309. 7s. 6d. ; Breckneil, Munro & Rogers (£450) and E. Showell & Sons (£583. 14s.), machine finished articles (brass, gun-metal, &c.) ; British Westinghouse Electric & Mfg. Co. (£69. 10s. 6d.) and Wilkes, Ltd. (£314. 2s. 9d.), machine finished articles (iron, steel, &c.) ; F. W. Rowlands & Co., gear and prism wheels, ratchet worms, &c., £1,861. 11s. ; British Westinghouse Electric & Mfg. Co. (£277. 8s.), Armstrong Stevens & Co. (£1,089. 17s. 4d.) and Low Moor Co. (£18), drop forged stampings ; Hurst, Nelson & Co. (£37. 2s. 6d.), Male & Jordan (£118. 18s. 6d.), Warren & Sons (£40. 13s.) and Wilkes, Ltd. (£410. 0s. 9d.), iron and steel forgings ; Crown Spring Co. (£114. 17s. 3d.), C. Salter & Co. (£2. 6s.), Smith Bros. & Hill (£31. 17s. 6d.), Joseph Steel & Co. (£241. 2s. 6d.), Tempered Spring Co. (£33. 4s. 6d.) and West Bromwich Spring Co. (£516. 2s.), springs ; John Crowley & Co. (£207. 8s.), H. Newton Knights & Co. (£270), Bullers, Ltd. (£74. 1s.) and Thos. Summerson & Sons (£483. 15s.), machined iron castings ; Brightside Foundry & Engineering Co., Robert Hyde & Son and Joseph Williamson & Co., iron castings (values cannot be stated) ; Pease & Partners, brake shoes, £4.162. 10s. ; Bullers, Ltd. (£591. 9s. 1d.), John Crowley & Co. (£20. 7s. 3d.) and Ley's Malleable Castings Co. (£666. 14s. 6d.), machined malleable iron castings ; John Crowley & Co., malleable iron castings (value cannot be stated) ; Edgar Allen & Co. (£182. 19s. 1d.), Hadfield's Ltd. (£437. 1s. 2d.) and Saml. Peace & Sons (value cannot be stated), steel castings ; Morgan Crucible Co., crucibles, £458. 3s. 5d. ; Hy. Bessemer & Co. and Cammell Laird & Co., each for 1,500 driving wheel tyres at £3. 5s. each and 750 pony wheel tyres at £3. 2s. 6d. each ; P. R. Jackson & Co., re-winding 10 armatures, £15. 7s. 6d. each.

MANCHESTER.—The Tramways Committee has accepted the tender of F. Smith & Co. for supply of copper trolley wire.

The Electricity Committee has accepted the following tenders : British Insulated & Helsby Cables and the Pirelli General Cable Works, cables; Richardsons, Westgarth & Co., turbo-alternator and condensing plant ; British Westinghouse Electric & Mfg. Co., alternator; Mather & Platt, motors and pumps ; Birmingham Condenser Co., oil coolers ; Sir W. G. Armstrong, Whitworth & Co., steel forgings ; Arton & Co., pipework ; W. R. Davies & Co., 10 tipping wagons ; Hans Renold (Ltd.), chains and wheels for cooling tower fans ; J. Hopkinson & Co., steam valves.

SALFORD.—The Tramways Committee recommends the Corporation to accept the following tenders :—

L. Andrew & Co., carbon filament lamps ; Tandem Smelting Co., babbitt metal; British Westinghouse Electric & Mfg. Co., m.f. lamps, &c. (estimated £567. 18s. 4d.).

The Electricity Committee recommend the acceptance of the tenders of the British Westinghouse Electric & Mfg. Co., supply and erection of a 300 kw. rotary converter and transformer at Irwell Park Wharf substation, at £1,465, and 12 months' supply of traction metal filament lamps, &c., at £567. 18s. 4d. and that of the New Conveyor Co., 600 steel trays for coal conveyor plant, at £253.

GLASGOW.—The Corporation has accepted the tender of Fraser & Chalmers for a 15,000 kw. turbine and alternator, condensing plant and transformers for the new generating station at Dalmarnock. The alternator and transformers are by the British Westinghouse Co., the turbine by Fraser & Chalmers, and the condensing plant by the Mirrlees Watson Co.

SHEFFIELD.—The Council has accepted the following tenders :—

Willans & Robinson, increasing the capacity of No. 3 turbo-alternator from 4,500 kw. to 6,000 kw. ; Electric Supply Department of Corporaton, 22½ H.P. motor for Health Department, £86 ; John Brown & Co., 500 steel tramway tyres, 73s. 6d. per tyre.

EAST HAM.—The Council has accepted the tender of Docker Bros., for six months' supply of paints ; that of M. G. Davis & Co., for brushes ; and that of Middleton Bros., for sundries.

DERBY.—The Council has accepted the following tenders :—

British Thomson-Houston Co. switchboard extension, £340 ; W. Rickard (Ltd.), cable, £523 ; Newton Bros., motors, £525 10s.

BUSINESS ITEMS.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of June 14. *Further particulars are set out in an advertisement.*

Plant for Sale.—The Trafford Power & Light Supply (Ltd.), Trafford Park, Manchester, advertise for sale two 600-kw. Mather & Platt dynamos suitable for coupling to oil or gas engines, and two 600-kw. Brush-Mather & Platt steam dynamos.

The Midland Electric Corpn. for Power Distribution, Ocker Hill, Tipton, advertise for sale one 800 kw. Ferranti steam alternator (two phase, 50~), with exciter, air and circulating pump, &c.

CATALOGUES, &c.

G.E.C. Leaflets.—We have received three leaflets which have recently been published by the General Electric Co. (Ltd.), 67, Queen Victoria-street, E.C.

Leaflet No. L. 2,093 deals with G.E.C. haulage road signalling in collieries, Leaflet V. 2,088 with moulded insulation terminal blocks, and Leaflet O. 2,104 with the "Kingsway" miners' electric hand lamp. We hope to refer more fully to these in an early issue.

Condensers.—The Telegraph Condenser Co., Vauxhall-street, Kennington Oval, S.E., recently issued an illustrated catalogue of its patent artificial lines for duplex working, condensers for submarine cables, standard condensers, adjusting resistances, &c. In a supplementary catalogue, which has just been issued, illustrated particulars and prices are given of various types of condensers, including the T.C.C. telephone and high-tension and wireless condensers, the Mansbridge form of condenser, &c.

Switch Cubicles.—Messrs. Ferranti (Ltd.), of Hollinwood and London, have just issued a new list (Pa 550/E), which describes their standard high-tension ironclad switch cubicles of the type H.C.I.a.

The pamphlet describes the general and special features of these cubicles, which are for three-phase systems, for pressures not exceeding 6,600 volts (3,800 volts to earth), and currents not exceeding 300 amperes. The cubicles, which are primarily intended for sub-station use, are made on the unit principle, and any number can be assembled together to form a complete switchboard. They are totally enclosed, but not explosion proof. The cubicle is provided with a complete mechanical interlock ; all the gear inside it is accessible from the front, and a very wide range of equipment is provided. Details of the construction, prices, typical diagrams of connections, &c., are included.

Osram Lamps.—The General Electric Co. (Ltd.), 67, Queen Victoria-street, E.C., has recently issued a four-page leaflet (O.S. 2,110) and folder O.S. 2,108, giving the revised prices of Osram drawn wire lamps, including the Atmos type, which is recommended for the illumination of shipyards, dockyards, engineering works, railway stations, &c., Both leaflet and folder have as frontispiece the company's new well-known "Elephant" design.

Electric Motors.—Messrs. T. W. Broadbent, Ltd., of Victoria Electrical Works, Huddersfield, have sent us a copy of a new leaflet (No. 6) describing their R type motors.

The R type motor is of the "slip ring" induction type and is provided with short-circuiting device and brush lifting gear. The motor is of robust construction and is suitable for all classes of industrial work. It is standardised for the 50 cycle three-phase circuit, but is wound for other periodicities and for single and two-phase circuits when required. The standard winding is for 220 or 440 volts. Copies of the leaflet, which gives particulars of construction, output, price, &c., can be obtained on application to the firm.

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against Fredk. Brown, electrician (formerly a partner in the firm of Hugh Bros. & Brown), 8, Stafford-street, Llanelly, are to be sent by May 12 to Mr. H. W. Thomas, 4, Queen-st. Carmarthen.

A supplemental dividend of 5¾d. will be payable on May 16 at Bankruptcy-buildings, London, W.C., to creditors of Joseph G. S. Cunnington and Harry P. Allison (trading as Laing, Wharton & Cunnington), electrical engineers and contractors, 7, Great Newport-street, London, W.C.

Digitized by Google

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Cuba Submarine Telegraph Co. (Ltd.)

The eighty-seventh ordinary general meeting was held on May 2, Mr. CHARLES W. PARISH, chairman of the company, presiding.

Mr. A. C. AUSTIN (the secretary) read the notice convening the meeting and the report of the auditors.

The CHAIRMAN, after making a feeling reference to the death of Mr. Geo. Keith, said: Gentlemen, Our traffic receipts for the year amounted to £46,814, which compare with £40,584 in 1915, £34,076 in 1914, £34,393 in 1913, £39,090 in 1912 and £35,167 in 1911; so that compared with the year 1911, we have £11,000 increase, or more than 20 per cent. You will at once appreciate we have been very busy. Doubtless some of this increase is due to the war. It is very difficult to estimate how much this may be, but generally speaking you may assume that our prospects are satisfactory. During 1916 our main cables have remained in good working condition, and so continue, and we have had only a small expenditure for repairs to the shallow water and bay cables, the cost of these repairs being £685, against £13,654 expended in 1915; and thus our expenses, including the repairs, are only £15,812, against £27,540 in 1915. After allowing for the interest from investments, &c., we have a net profit of £33,756, and adding £7,581 from last year the total is £41,337. After transferring £14,000 to reserve fund and £2,500 to pension fund, and paying the 10 per cent. dividend on the £60,000 of preference shares and 5 per cent. (free of tax) on the ordinary share capital, we propose paying to our ordinary shareholders a bonus of 2 per cent., also free of tax; and we are very pleased to be able to do so, for I believe the position fully justifies the recommendation, and I cannot help feeling that in these troublous times it is hardly fair to keep from our shareholders any part of our earnings which may be reasonably distributed. As you are aware, we have been gradually providing for the possible depreciation of our investments, and our last year's accounts showed a provision amounting to £19,644. The foundation of true safety in a cable company lies in its reserve fund, which is a stand-by for possibly making up dividends in case of necessity, but should more accurately, to my mind, be regarded as an assurance or depreciation fund to meet the cost of repairs or renewals to the cables. Some of you, perhaps, may remember the difficulty this company was in four years after its foundation by the failure of our cable and the necessity of borrowing money at 10 per cent. to meet the cost of a new cable and the necessary repairs. Our reserves have naturally been invested from time to time, and when we found that the latest valuation represented a fall of £24,000 from the figure standing in our balance-sheet on Dec. 31, 1915, it seemed evidently a wise and desirable precaution to transfer this amount from our reserve fund to the credit of the investment account. I do not think it is good business to have items standing in our balance-sheet at a figure which could not be realised. I much prefer a figure which will probably prove on the low side, for I hope that, when peace comes, we shall see an improvement in the value of all securities, and in the meantime we may live in the satisfactory knowledge that our balance-sheet is a very prudent and wise one, and has the complete approval of our auditors. Referring to the death of Mr. Robert Edgar, who went to Cienfuegos in February, 1881, and became their manager and clerk-in-charge in 1893, after Mr. Keith's return to England, he said Mr. Edgar stayed in the service until 1916, when he came home broken in health, and died shortly after. I am glad to inform you that we have been very fortunate in securing Mr. Nosworthy as a director and engineer in the place of Mr. Keith, for it was a vacancy not easy to fill, and I believe we have done so beyond our expectation. Mr. Nosworthy was for many years the general manager of the Amazon Telegraph Co. in Brazil, and has great experience of all cable work and the management of a large staff of employés. On Mr. Keith's death he came over to England and succeeded him as managing director of the Amazon Co., and this enabled us to secure his services on our board. After working with us here for some months he went to Cuba to make himself acquainted with the cables and our staff and the local conditions of our business. He is still in Cuba, but I hope that when we next meet we may have the pleasure of seeing him with us. I wish to explain the necessity for the extraordinary general meeting which will follow this one. The truth is we are growing a very old company, and, when I remind you that it was started in 1870 you will not be surprised when I tell you that our articles of association have become very antiquated in view of the Companies Acts which have been since passed, and of the modern practice and experience in company management. Indeed, I hope when we return to peaceful and normal times we may be able to adopt, with your assistance, an entirely new set of articles, but in the meantime it is necessary, in view of Mr. Keith's death and Mr. Nosworthy's appointment, to alter some of the wording of an article passed in 1897, so that any director may be appointed as engineer and not only Mr. Keith. The other alteration which is suggested refers to your directors' remuneration. There were seven directors on the prospectus, who were remunerated, not as usual by a lump sum, but in accordance with the articles of association, £300 for the chairman and £200 for the directors with power to have two more directors under the articles, so that the total fees provided for amounted to £1,900. As a matter of fact, the board gradually became smaller, and I believe under existing circumstances a board of four is enough. It is proposed that you should fix a remuneration of £1,200 to be divided among them as they think fit, and that you should have the power to increase this amount by a resolution of an ordinary general meeting if circumstances arise to make it expedient to have additional directors. As you are probably aware, the shareholders of many of the important cable companies have decided to pay their directors' fees without deducting income tax, on the ground that the dividends and employés are paid free of tax, and it seemed hard on the directors that they alone should suffer in this respect. But we have not made this suggestion, and have simply put forward the proposal which appears in the report. We have had a somewhat troublesome time of late in Cuba; promoted probably by German money, there has been a good deal of political unrest which has caused our staff considerable anxiety, although, I am glad to say, only slight damage has been done to our property. Here in London our secretary and his clerks have been kept very busy. I thank them and our Cuban staff for all they have done in the interests of the Company, and I am certain you will join with me in doing so. In 1870 this company was started with 670 miles of cable, &c., from Ratabano to Santiago. Gradually connections were made with Cienfuegos and other coast stations, and now we have as many as 1,600 miles of duplicate lines, bay cables and harbour lengths within our area, so I do not think we can be accused of having stood still. I move that the report and accounts now submitted be received and adopted.

Mr. ALEXANDER G. LOW seconded the resolution, which was carried unanimously.

The final dividends and bonus as recommended were declared. Mr. Frederick Edward Nosworthy was re-elected a director, and Messrs. Gane, Jackson, Jefferys & Freeman were also re-elected auditors of the company.

At the subsequent extraordinary general meeting the proposed alterations in the articles of association were unanimously approved, after a brief explanation by the chairman, and after a question as to the position in Cuba had been answered, a vote of thanks to the chairman and directors terminated the proceedings.

BABCOCK & WILCOX (LTD.)—The net profit during the year 1916 amounted to £438,323 and with £42,125 brought forward the total is £480,448. The interim dividends (paid in November last) of 3 per cent. on the preference, 2½ per cent. on the second preference and of 6 per cent. on the ordinary shares, absorbed £107,076, leaving £373,372. The directors recommend that the following dividends be paid for the half-year ended Dec. 31, 1916, viz.:—Dividends of 3 per cent. on the preference and of 2½ per cent. on the second preference shares (less tax in both cases) and of 9 per cent. on the ordinary shares (tax free), that £150,000 be placed to reserve and that £10,000 be granted to the staff pension fund, leaving £56,495 to be carried forward. The increase in the reserves for estimated further expenditure on orders invoiced is required because of the greater cost of materials and labour, &c., which affect the completion of contracts taken into the accounts. A larger reserve for fall in value of investments is also necessary owing to the diminution in value to which trustee investments have been subject.

BATH ELECTRIC TRAMWAYS (LTD.)—The accounts for 1916 show after placing £6,000 to contingencies and renewals account and paying the year's dividends on the preference shares, a credit balance of £6,147 (against £8,486 in 1915), which is to be carried forward to provide for contingencies and replacements. The report and accounts were adopted at the recent meeting.

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—The total revenue for 1916, including the amount represented by sale of current to the tramways, amounted to £373,467, an increase of £62,697, or 20·17 per cent. The total expenditure was £156,688, an increase of £14,597, or 10·27 per cent. The net receipts aggregated £ 16,779, an increase of £48,100, or 28·52 per cent. After deducting debenture interest, depreciation, &c. there remains £114,373, and £9,602 was brought in, making £123,976. The directors recommend a dividend for the year on ordinary shares at the rate of 10 per cent. per annum. They propose writing down securities to the extent of £6,666 and to pay a bonus of one month's pay to the company's officers and employees, leaving £5,214 to be carried forward. The gross receipts from the traction branch amounted to £198,765, against £172,051; the working expenses were £87,826 against £79,665. The balance of receipts over expenses was £110,939, against £92,387. The gross receipts of the supply department, including amount represented by sale of current to tramways, amounted to £171,167, against £138,021; the working expenses amounted to £62,293, against £58,132; and net receipts were £108,874, an increase of 36·28 per cent.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—At the meeting on Monday, the chairman (Mr. E. Garcke) explained that the profit made during the past year could not be spared for distribution as dividend, seeing that in the past three years £41,141 had been expended on additional plant and buildings without any increase of capital. It was a

Digitized by Google

matter of regret, not only from the company's point of view, but on national grounds, that the Chancellor of the Exchequer had found it necessary to increase the excess profits tax from 60 to 80 per cent. No one was in favour of large and exceptional profits being earned by individuals or by companies by reason of war activity, and all excess profits of that character rightly accrued to the community. Moreover, it was recognised by everyone that the great cost of conducting this unparalleled war to a successful issue must involve taxation all round; but it was also evident that after the war the nation would be badly in need of reproductive capital, not only to replace the accumulated capital which was unavoidably destroyed by the war, but also to provide for expansion of industry. The President of the Board of Trade had told them that an employer should not be satisfied with carrying his business to a certain point of expansion—that there should be no standing still in business, and that they must go forward. That could not be done without the constant renewal and increase of capital. Practically the only source of new capital was the surplus provided by production in excess of consumption, and to take that surplus at the source by way of taxation to the extent of destroying the fund out of which future capital was obtained was like eating the seed and foregoing the fruit. The president of the Association of Chambers of Commerce had expressed the view that the Government was at present squeezing out of the producers the reserves that ought to be available for business after the war. If that policy was continued, the responsibility for unemployment must rest upon the Government, and not upon the manufacturers. American manufacturers had been able to accumulate enormous reserves in their businesses, and the German Government had deliberately abstained from an excess profits tax in order to leave their industries in the strongest possible position after the war. He feared that at the present time, when the indispensability of labour was being so strongly impressed upon us, we were apt to forget that capital was equally necessary, and, what was more, that labour could not be employed without it. The orders secured by the company during 1916 were satisfactory in volume, and the same could be said of the order list as it stood that day. Experience had confirmed the great advantages of the Ljungstrom turbine, for which they had a larger number of orders on hand than ever before. They were all familiar with the demands for higher wages made by all classes of employés to meet the increased cost of living. In order to expedite the settlement of such demands the Government had made direct awards bringing the advances granted into practically immediate operation. In cases like their own, where firms were engaged on contracts at fixed prices, which ran into large sums of money and often took many months to complete, it might, he thought, not be unreasonable to expect that such Government awards should be accompanied by regulations for the purpose of automatically reimbursing manufacturers for the increased cost they were put to in respect of contracts which were unfinished at the time the increased wages became payable. That, unfortunately, was not the case, and although manufacturers might be able in some instances to obtain an advance on their contract prices, that was always a matter of difficulty, and there must be many cases where, so far as unfinished work was concerned, the bonus paid to employés came out of the manufacturers' small margin, and not out of increased profit. That was a matter which should be well considered by the Government departments concerned in dealing with similar applications in future.

CITY OF BRISBANE ELECTRIC LIGHT CO. (LTD.)—The accounts for the year ended Jan. 31 show, after making additions to the franchise and purchase sinking fund, and renewal, replacement and contingencies account, a credit balance of £25,711, which, with the balance brought forward, makes £27,280. The interim dividend paid in September amounted to £10,884, and the directors have declared a further dividend of 3 per cent. on the preference and 5 per cent. on the ordinary shares.

CORK ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The revenue for 1916 was £67,011 and the expenses were £47,770, leaving £19,241. With £4,041 brought forward the total was £23,282. Interest on debentures absorbed £4,600, the half-yearly dividends on the 5 per cent. cumulative preference shares £6,163. 10s., and after adding £6,500 to reserve for depreciation and renewals, writing £1,534 off wiring consumers' premises, repair shop equipment, plant on loan, &c., and writing £569 off investments, the directors recommend that the balance of £3,915 be carried forward. The lighting and power business continues to show progress, agreements for 91 connections being concluded during the past year, the additional connections representing a total gain of 557 kw. compared with 405 kw. in 1915. The revenue amounted to £67,011 compared with £63,905, an increase of £3,106. The lighting and power revenue was £2,480 in excess of the previous year; the traction revenue showed an increase of £661, but the other revenue items showed a decrease of £35. The expenses were £47,769 compared with £42,415, an increase of £5,354, entirely due to operating under war conditions—the high price of coal and war bonuses and allowances. The directors regret that they are unable to recommend a dividend on the ordinary share capital as it is desirable to carry forward a larger sum than usual to provide against still further increase in the price of coal and other materials during the current year and the carrying out of repairs to rolling stock, &c., which could not be executed owing to lack of skilled labour and difficulty in obtaining materials. As expenses had increased to such an abnormal extent the lighting and power tariff was again raised from July 1 last, but the additional charges to the consumers represents a very small percentage of the increased cost of operating and the revenue has also been affected by the "Daylight" Saving Act. The capital expenditure during the year (£11,668) has been for the 1,250 kw. Curtis turbine and condensing plant, house services and cables. The Curtis turbine was put into commission in September last and has already effected substantial economy in coal consumption.

CRAIGPARK ELECTRIC CABLE CO. (LTD.)—At the meeting yesterday (Thursday) the directors reported that the net profit for the year ended March 31 was £7,966 (after making provision for excess profits tax), which with £900 brought forward made £8,866. The directors recommended that £2,000 be appropriated for depreciation off buildings and machinery and £500 placed to reserve, that dividends of 6 per cent. per annum be paid on the 6 per cent. preference shares (£2,950) and on the ordinary shares (£2,250), leaving to be carried forward (subject to directors' fees for the past year) £1,266. The volume of business done throughout the year had been satisfactory, although production had been handicapped by shortage of labour and scarcity of raw materials.

INDIAN ELECTRIC SUPPLY & TRACTION CO. (LTD.)—The surplus on the working for 1916 in Cawnpore (including £106 for interest accrued) was £20,220, against £15,932 in 1915, and including further interest in England and transfer fees the total is £20,314. London expenditure was £2,411, against £1,688, and after providing £3,900 for debenture interest the profit is £14,004; with amount brought in (£800) the balance is £14,803. Of this amount an interim dividend of 2½ per cent. has already been paid. The board have placed to general reserve £3,000, to reserve for depreciation and renewals £3,000, to debenture issue expenses written off £1,000, and they now recommend payment of a final dividend of 5 per cent., making with the interim dividend 7½ per cent. for the year, leaving to be carried forward £1,757.

At the meeting last week the chairman (Mr. J. G. B. Stone) said that they had spent £8,919 on capital account, representing additions to the generating station, car shed and mains. The net revenue account showed a marked improvement, the total being £20,220, against £15,932 for 1915, and the expenses (including debenture interest), £6,311 against £5,588. The units sold increased by 478,418; the revenue had risen Rs. 67,598 (about 21 per cent.) and the average price rose from 1·82d. to 1·87d. per unit. The total connections at the end of the year were equivalent to 82,701 eight candle-power lamps, against 72,607. The position of the tramways remained practically unaltered and the improved earnings were offset by higher costs. The increase of 300,000 in the passengers carried was due to the improved earnings of the labour classes. In addition to prohibitive cost of all plant and material they had great difficulty in arranging shipments to India, but they had been able to dispatch a 500 kw. turbine, which had arrived in India. They were forced to adopt a waiting policy now, but they looked forward with confidence to the future.

LONDON & LANCASHIRE FIRE INSURANCE CO. (LTD.)—The fifty-fifth annual meeting was held on April 25, when the report and accounts for 1916 were submitted. The total premiums for the year amounted to £3,269,730, and the total underwriting profit, after providing for the increased unexpired liability and after deducting income tax, to £242,444. The reserve funds, apart from capital, now amount to £4,010,993 and the total security to policy holders has reached the sum of £6,652,243.

NORTH OF SCOTLAND ELECTRIC LIGHT & POWER CO. (LTD.)—The gross profit for 1916 was £7,550, compared with £7,038 in 1915, and after meeting interest on debentures and loans amounting to £2,781, writing off £138 from suspense account and adding £2,046 brought forward, there remains £6,677. The directors recommend a dividend at rate of 3 per cent. for the year, that £2,000 be placed to renewal reserve account, £1,000 to general reserve, and that £2,177 be carried forward.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—The gross earnings for the year 1916, including dividends and interest from subsidiary companies, amounted to £133,991. Adding amounts received in respect of fees payable by subsidiary companies (£2,344) and balance from 1915 (£15,467), the total is £151,802. 4s. 1d. Deducting working expenses, maintenance, &c. (£44,493), depreciation of securities (£250) and interim dividends, debenture interest and redemption charges (£18,307), there is a balance of £88,753. The directors recommend for payment a final dividend of 3 per cent. (less tax) for the year on the preference shares (£1,500), a final dividend of 6 per cent. (tax free) on the ordinary shares, making 10 per cent. for the year (£10,759), to transfer to general reserve £55,000 and to staff pension fund £2,000, carrying forward £19,494. All the company's exchanges, together with those of the subsidiary companies, continue to show improved revenues. The underground cabling extensions at Madras and Singapore have been completed. Singapore exchange was destroyed by fire on Dec. 9 last. Prompt measures were taken to re-establish temporary communication between subscribers, and on Feb. 3 last the number of exchange lines working was 700 out of a total of 1,850. It was expected that the service to the whole of the subscribers would be resumed by April 30. Arrangements are in progress for reconstructing the exchange in accordance with the most modern practice, but, owing to prevailing trade conditions, considerable delay must occur before the necessary equipment can be manufactured and installed. The Indian companies again report a substantial increase in the number of subscribers to their exchanges, with correspondingly improved revenues. The capital of the Bengal Telephone Co. was increased from Rs.15,00,000 to Rs.20,00,000 to enable the company to purchase a site for the erection of a new telephone exchange, owing to the continued expansion of its business, and the work connected therewith has already been commenced. The Telephone Co. of Egypt and the China & Japan Telephone & Electric Co. have had a satisfactory year, both continuing to pay the previous rate of dividend of 10 per cent. In August last the China & Japan Co. increased its nominal capital from £20,000 to £75,000, and paid a bonus of £2. 3s. per share (tax free). The proceeds of this distribution in respect of the Oriental Company's holding of 14,136 shares were applied in taking up 23,941 of a new issue of 25,000 shares which was made in September.

Digitized by Google

RICHARD JOHNSON, CLAPHAM & MORRIS (LTD.)—The net profit for the past year, after providing for the excess profits duty, &c., was £49,886 (against £32,215 in 1915-16). The directors recommend a dividend of 7½ per cent. on the ordinary shares, making 15 per cent. for the year, with £10,000 to reserve (against £20,000) and £31,523 carried forward.

SHROPSHIRE, WORCESTERSHIRE & STAFFORDSHIRE ELECTRIC POWER CO.—The net revenue for the year 1916 from sales of current, interest and dividends on investments, &c., amounted to £55,997. 13s. 6d. After deducting administration and general expenses, debenture and loan interest and adding £1,983. 16s. 7d. from last account, there remains £28,745. 8s. 8d., which the directors propose should be applied as shown in the accounts, viz.:—Place £12,079. 19s. 4d. to reserve, including sinking fund and to pay a dividend at the rate of 4 per cent. per annum on the ordinary shares (£12,000), leaving to be carried forward £4,665. 9s. 4d. The expenditure on capital account incurred during the year was £34,872. 1s. 8d. The increasing consumption of electrical energy for power purposes due to the demands of Government and other factories in the district made it necessary to prepare for the installation of additional plant, &c., during the present year. To meet this expenditure an issue has been made of £50,000 in 7 per cent. redeemable cumulative preference shares. An amount of £200,000 6 per cent. second debenture stock has been created during the year, of which £100,000 has been issued and employed as security for loans from bankers. The total number of units sold was 44,614,872 and compares with 20,797,771 in 1915, an increase of 115 per cent. At Jan. 1, 1917, 25,125 kw. of plant were installed and in process of installation at the Smethwick main power station and 3,200 kw. at the Dudley power station, the total amount of generating plant now installed and in course of installation being 28,325 kw. These two stations have been connected by high-tension mains, and inter-connected with the sub-stations in Dudley, Halesowen, Oldbury and Smethwick. By reason of the increasing cost of fuel and materials and other costs of operation, the rates charged to consumers have been increased during the year, and the increase in the gross receipts is partly due to this cause. The directors again recommend an increased contribution to the reserve fund, and the first payment of £1,000 has been made to the sinking fund for the redemption of the first debenture stock and charged against revenue.

WESTERN UNION TELEGRAPH CO.—The gross operating revenues for 1916 were $61,919,140, and after deducting operating expenses (including repairs, reserve for depreciation, rent for lease of plants, taxes, &c.) the balance was $13,191,219. With income from loans and investments ($1,702,460), and after deducting interest on bonds of the Western Union Telegraph Co. ($1,331,850), &c., there remained $12,395,405. The surplus at Dec. 31 last amounted to $24,568,068.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The report for the six months ended Dec. 31 states that the amount to credit of revenue is £49,118, compared with £33,553 in the corresponding half-year of 1915, and the expenses have been £32,189, against £22,987. The balance is £16,929, to which is added £1,656, interest on investments, and £2,280 brought forward, making a total of £20,866. The directors have placed £4,000 to reserve, leaving an available balance of £16,866, out of which it is proposed to pay dividends for the half-year on the first and second preference shares at 6s. per share (absorbing £10,369 and £1,401), and on the ordinary shares at 6d. per share (tax free), absorbing £2,208, and leaving £2,888 to be carried forward. As in previous half-year, the traffic receipts show an increase due to the same cause—viz., prices of produce being favourable to the planters. The cables continue to be maintained in good working order. The extension of the date of maturity of the £80,000 of 5 per cent. debentures from Dec. 31, 1916, to Dec. 31, 1926, has been carried out. In order that there may be an annual meeting and annual accounts, the articles of association must be slightly altered.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

AABACAS ENGINEERING SUPPLY CO. (LTD.) (147,237.)—Private company; reg. April 24, capital £2,000 in £1 shares, to take over the business carried on by a concern of similar name at Birkenhead, and to carry on the business of engineers, machinists, agents, dealers in electrical plant, &c. First directors, M. G. Clayton and another to be appointed at the first general meeting (both permanent).

BRITISH & ALLIES ELECTRICAL AGENCY (LTD.) (147,350)—Private company. Reg. May 2, capital £1,000 in £1 shares, to carry on the business of electrical engineers and contractors, manufacturers of and dealers in railway, tramway, telephone and other apparatus, &c. First directors are A. W. Pollock (permanent managing director and chairman) and F. W. Dennis. Reg. office: 5-6, Palace Chambers, Westminster, S.W.

CLEMENT CLARKE & CO. (LTD.) (147,210).—Private company. reg. April 21, capital £2,000 in 250 preference shares of £5 each and 750 ordinary shares of £1 each, to carry on the business of scientific and surgical instrument, thermometer and electrical instrument manufacturers, &c. Clement Clarke is one of the first directors. Reg. office: 46, Wigmore-street, W.

EXPRESS LIFT CO. (LTD.) (147,366.)—Private company. Reg. May 3, capital £10,000 in £1 shares. Manufacturers of and dealers in hydraulic, electric and steam elevators and lifts, &c. First directors are E. W. J. West and J. A. Phelps. Reg. office: 17, Victoria-street, S.W.

GRACE BROTHERS (INDIA) (LTD.) (147,382.)—Private company. Reg. May 4, capital £25,000 in £1 shares, to carry on business as bankers, financiers, concessionaires, merchants, exporters, importers, constructors and controllers of public works and conveniences (including railways, tramways, docks, electric light and power works, &c.). Reg. office: 144, Leadenhall-street, E.C.

LEON CORNELIS (LTD.) (147,354.)—Private company. Reg. May 2, capital £1,000 in £1 shares, to take over the business of a manufacturer of electrical appliances and accessories carried on by L. Cornelis. First directors are L. Cornelis and A. R. Robert. Reg. office: 265, Strand, W.C.

LINGFORD, GARDINER & CO. (LTD.) (157,296.)—Private company. Reg. April 27, capital £20,000 in £1 shares, to take over the business of general engineers carried on as Lingford, Gardiner & Co., also to carry on the business of electricians, &c. First directors are N. Kilburn (chairman), W. T. Clemitson, E. T. Gardiner and T. Gardiner.

MODERN ELECTRIC WELDING CO. (LTD.) (9,840)—Private company, reg. in Edinburgh April 19, capital £5,000 in £1 shares, to carry on the business of welders of iron, steel and other metals, &c. First directors are:—W. Slack, W. Stewart, H. Slack and J. Maxwell.

RAILWAY PHONOPORES (LTD.) (147,251.)—Private company; reg. April 24, capital £5,000 in £1 shares, to carry on the business of electrical and mechanical engineers and machinists, manufacturers of phonopore and other induction coils, &c. First directors are E. W. Smith and C. Isaac.

RIVERS ENGINEERING CO. (LTD.) (147,389)—Private company. Reg. May 4, capital £5,000 in £1 shares, to take over the business carried on as the Rivers Engineering Co., and to carry on the business of mechanical, electrical, aeronautical and general engineers, brass founders, boiler makers, &c. First directors are Stanton W. Cole, Moritz Kahn, William Black and Robert O. Williams. Reg. office: Cremorne Wharf, Lot's-road, Chelsea, S.W.

THAMES ELECTRIC CO. (LTD.) (147,375.)—Private company. Reg. May 3, capital £250 in 5s. shares, to take over the business of an electrical and illuminating engineer and wholesale and retail vendor of electrical and scientific goods and accessories carried on by F. P. Sexton at Kingston-on-Thames as the Thames Electric Co. First directors are F. M. Sexton and F. P. Sexton. Reg. office: 48, London-road, Kingston-on-Thames.

MORTGAGES AND CHARGES.

ENFIELD ELECTRIC CABLE MFG. CO. (LTD.)—A memorandum of satisfaction in full on April 17, 1917, of mortgage and further charges dated 1914, 1915 and 1916, securing £15,000, £11,250 and £2,750, has been filed.

W. A. & R. J. JACOBS (LTD.)—Issue on April 4, 1917, of £700 debentures, part of series of which particulars have already been filed.

CITY NOTES.

MEMORANDA.—(May 8).—Consols, 55⅞. Consols Pay Day, June 1. Stocks and Shares Ticket Day, May 29. Pay Day, May 30. Price of Silver, 37 11/16 d.

CITY OF SANTOS IMPROVEMENTS CO. (LTD.)—The directors have declared a half-yearly dividend at the rate of 6 per cent. per annum (less tax) on the 6 per cent. preference shares, and a dividend of 3 per cent. (less tax) for 1916 upon the ordinary share capital.

BRITISH EVER READY CO. (LTD.)—The directors announce a final dividend on the preference shares at the rate of 10 per cent. per annum for the half-year to March 31, making 10 per cent. for the year, and at the rate of 10 per cent. on the ordinary shares, plus a bonus of 5 per cent., making 15 per cent. for the past year.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.).—The number of units sold to consumers during the four weeks ended Feb. 23, 1917, amounted to 1,763,149, compared with 1,362,833 units in the corresponding four weeks of 1916.

CALCUTTA TRAMWAYS CO. (LTD.)—The directors recommend payment of a final dividend on the ordinary shares of 6s. 6d. per share (less tax), or 5s. 6d. per share net, making 9½ per cent. for 1916.

MELBOURNE ELECTRIC SUPPLY CO. (LTD.)—The directors recommend an interim dividend on the consolidated ordinary stock at the rate of 10 per cent. per annum (tax free) in respect of the half-year ended Feb. 28 last.

RAMSGATE & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The gross profit for the year 1916 (including £1,146 brought forward) was £3,878. A dividend of 5 per cent. has been declared and a sum of £1,000 has been placed to reserve, leaving £860 to be carried forward.

SHANGHAI ELECTRIC CONSTRUCTION CO. (LTD.)—The directors have declared a dividend of 5 per cent., making 10 per cent. for 1916.

Digitized by Google

THE ROUND TABLE.

By "KVA."

BON MOT OF THE WEEK.—"When I was young we used to flatter ourselves that progress inevitably meant peace and that growth of knowledge was always accompanied as its natural fruit by the growth of good will among the natives of the earth. Unhappily we know better now."—Mr. Balfour, in U.S.A. House of Representatives.

* * * *

We now have meatless, potatoless and breadless days, and appear to be in prospect of beerless and tobaccoless days, but A.C. engineers can console themselves with the thought that not even the Food Controller can deprive them of their wattless currents!

* * * *

A useful suggestion reaches me from a Chelsea reader of Round Table. He points out that Mrs. C. S. Peel, the Director of Women's Service Ministry of Food, is the wife of an electrical engineer who is attached to the staff of a prominent manufacturing company. He suggests that the services of Mrs. Peel, who is an "electrifying" public speaker and lecturer, should immediately be requisitioned by the electrical industry, lest, "unhaply," she should fall into the hands of the B.C.G.A., which heaven forbid. From what I have seen of Mrs. Peel's electrical articles, and from what I know of her better half, the latter seems absolutely impossible.

* * * *

I hear on good authority that the only subjects now discussed at the Engineers' Club, Manchester, are allotments, potatoes, vegetables and cognate week-end hobbies. I am also told that if there is much more of it everybody will be suffering from horticultural cramp!

* * * *

A correspondent asks me if it is true that "Inland Water Transport" really means "Teetotalers' Battalion." I must absorb this before I can give an opinion.

* * * *

The "Yorkshire Weekly Post" cannot shout it out loud enough that York Tramways Committee paid £737 for charging their Edison electric 'buses last year, whereas the same service would have cost them £10,000 for petrol. Shades of Shrapnell Smith, that's "some" difference! The "Y.W.P." does not miss the opportunity to dig the oil trust in the ribs, thus:—

Electricity would have the great advantage of freeing us to some extent from the grip of the oil companies, for it is pretty clear that the days of cheap petrol are gone, never to return, at least in the lifetime of this and the succeeding generation. Anything that would rid motorists of that incubus would be welcome.

Will central station engineers please use "electrics" after this, just as soon as they can get them.

* * * *

Trust an American to produce something startling in the way of pamphlets describing a new invention. A New York reader has kindly sent me a copy of one such, which is the product of the Evolution Phone Co., and describes their "Theraphone." This is said to be a wonderful and simple invention by which the public may now be benefitted because it is the "improved, economic, non-confusing, non-tiring, shock-impact, diverting, hygienic, agreeable in tone and health regenerating earpiece. It is the expression of thorough research, development and refinement in acoustical, physiological and mechanical science and design, and of priority, prestige and leadership." The writer finally runs short of adjectives, and has to bring the pamphlet to an insipid conclusion!

"The position of copper has remained stationary," says a newspaper "par," which I hope is true in the case of underground cables and the stator windings of turbo-generators.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, May 8, 1880.]

MANCHESTER AND THE TELEPHONE.—The question of telephonic and telegraphic wires is exciting considerable attention in Manchester, and has been referred to a committee to report on the whole question.

THE ELECTRIC LIGHT.—Makers anticipate a large business in electric lighting apparatus during next winter. Last winter there was a revulsion of public feeling against the light, the sale of plant was rather slack. Nevertheless we hear that Messrs. Siemens Bros. have turned out over 1,000 apparatus, about 500 of which have been used in Britain, and 500 abroad, chiefly in Russia. The lighting of the New Victoria Docks permanently by 30 of the Siemens lamps will be the next important undertaking of the kind.

DEATH FROM ELECTRIC SHOCK.—The "Scientific American" recounts how a gentleman was recently induced to try an electric shock "just for fun" from the machine of one of those peripatetic electricians sometimes seen, as it appears, in America as well as in England. On receiving his charge the victim walked away, but had not gone far when he was seen to stagger and fall. He was picked up unconscious, and remained so until he died, two days after. The physicians pronounced it a case of apoplexy brought on by an electric shock.

Norwegian Water Power.—The United States Consul-General at Christiania recently reported that the Norwegian Government had been advised by a Committee of the Storthing not to allow foreigners or foreign companies to acquire waterfalls in Norway, except in special circumstances.

The power contained in the Norwegian waterfalls has been estimated at from 6,000,000 H.P. to 10,000,000 H.P., and the development of these falls has been largely by the aid of foreign capital. At present the position is governed by the laws of 1909 and 1911. By the law of Sept. 18, 1909, only the Norwegian Government or Municipalities or Norwegian subjects are permitted to acquire waterfalls of more than 1,000 H.P. without Government sanction for each individual case. By the law of August 4, 1911, a tax is made payable to the local authority and the State.

A Royal Commission has now submitted to the Storthing a Bill under which it will be more difficult for foreigners to invest capital in Norwegian industrial enterprises and other real property. It is also proposed that foreign subjects and companies shall not be allowed to acquire concessions except in special cases, as, for instance, when an industrial concern already in operation wishes to acquire or regulate a waterfall. Joint stock and other limited liability companies must in future have an entirely Norwegian board, with registered offices in Norway, and exclusively Norwegian capital, in order to obtain permission to acquire waterfalls.

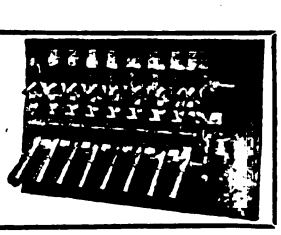
In 1909 38 per cent. of the capital of industrial companies in Norway was in foreign hands; 85 per cent. of the capital in electro-chemical undertakings was held by foreigners; and 80 per cent. of the capital invested in mining enterprises was foreign.

British Columbia Copper.—British Columbia is rapidly becoming one of the world's leading copper producers.

In 1915 the increase in amount was 11,908,706 lb. and $3,714,181 in value over 1914. For 1916 there is a still further increase over 1915 of about 17,000,000 lb. in quantity and about $8,500,000 in value. The estimate for 1917 is 73,000,000 lb., and allowing for the usual charges for mining and transportation to foreign refineries, the value in British Columbia may be placed at about $18,250,000. The 1916 figures create a record for copper production, and it is stated that the copper output will steadily increase, as there are new metallurgical plants and new mines with reserves capable of increasing the production of the past year by 50 per cent. The time is not far distant when the copper produced in British Columbia will be practically all smelted and refined in the province.

'IGRANIC'

No. 30. MULTIPLE SWITCH STARTERS
with TOGGLE JOINT interlocking levers
and HEAVY LAMINATED CONTACTS.



High inertia machinery, such as crushing mills, individually driven by electric power impose abnormal stresses on the motor starter for which special provision must be made. Sliding contact starters under such conditions have only a short life and require constant renewals. Toggle Joint Multiple Lever Starters always withstand this severe service satisfactorily and give full protection to the motor.

IGRANIC ELECTRIC Co LTD 147, QUEEN VICTORIA STREET, LONDON.

Digitized by Google

SIEMENS

STANDARD
ELECTRIC MOTORS

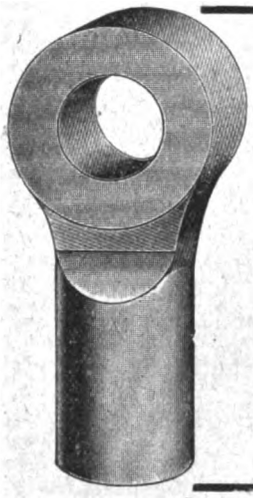
For Direct Current.

For Three-phase Current.

for

ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.



E. SHOWELL & SONS, LTD.
STIRCHLEY, BIRMINGHAM.

Cast
Cable Sockets.
Suite E74. Made in all Sizes.
Type A.—Straight.
„ B.—Offset.
„ C.—Right angle.
Illustrated Dimensioned Showcard for Drawing Office use supplied free on application.
Sole Agent for the Electrical Trade:—
LIONEL ROBINSON, 3, Staple Inn, London, W.C.
TELEPHONE: Holborn 6323.

Electrical Engineers and Manufacturers
The House for Electric Heating.
Special Offer of "Quead" and "Ensign" Fires from Stock.
Be Patriotic and Save Coal.
Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.
Telephone: Gerrard 7601 (2 lines)

Petrol Engine Sets.
Manufactured in sizes from 2 kw. to 20 kw.
Quotation for larger sizes on application.
F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON

THE CHANNEL TUNNEL.

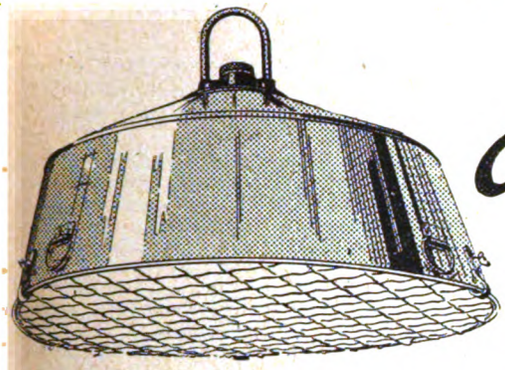
Sir Francis Fox recently delivered an interesting address before the Royal Geographical Society on the "Geographical Aspects of the Channel Tunnel." In the course of the address he said that in deciding upon the actual route of the Channel tunnel the one great precaution which had to be, and had been, taken was to keep the work well within the thickness of the grey chalk, but as the line might, near the two coasts, have for a short distance to run out of that bed, it was so arranged as there to enter the gault, which was another equally good and water-tight material.

In the Channel above the sea-bed the maximum depth of water would be from 160 ft. to 180 ft., and as they would be asked to leave undisturbed such a cover of chalk over the roof of the structure as would guard against any possible hostile contingency, that solid protection had been fixed at a minimum of 100 ft The tunnel would consist of two tubes, as in the case of the great Simplon tunnel (12¼ miles in length). The reasons for adopting twin tunnels were numerous and included better facilities for ventilation, drainage, repairs to the structure and permanent way when required during traffic, as well as greatly increased safety in case of derailments. It was proposed that the work of excavation should be performed by revolving cutters, fixed in Greathead shields, by which system a rapid rate of advance would be attained, the débris being removed from the "face" by high-speed endless belts. These would be so arranged as to deliver their load direct into wagons without the necessity of shovelling or of manual labour. All the work would be carried on by electrically-driven machinery, by which the volume of air required for ventilation would be greatly reduced, and arrangements would be made so that excavations and other operations could be carried on simultaneously at many points, thus abbreviating the period required for construction. The diameter of each tunnel should be 18 ft., so as to accommodate main line rolling stock. At intervals of 200 yards along the entire length cross tunnels would be formed, both to enable empty wagons to be brought in by one line, full wagons despatched on the other, and also to permit a most excellent system of ventilation to be installed. The workmen would be conveyed to their various duties and brought out again at the end of their shift by electric trains. It was anticipated that the daily rate of progress would be such as had never been attained heretofore in any tunnel. The tunnel could be worked, ventilated and pumped by electricity supplied from a power-station in Kent, possibly 10 miles inland. The problem of ventilation when regular traffic was running would consequently be comparatively simple, no combustion of coal on the railway being necessary. The tunnel would be maintained under the authority of the War Office, and a dip in the level of the rails, forming a "water lock"—by which the tunnel could in case of emergency be filled with water from floor to roof for a length of a mile—would also be under the control of the Commandants of Dover Castle and the neighbouring forts. That water would not injure the tunnel works, and it could only be pumped out by the energy developed at the power-station inland. Entrance and exits of both tunnels would likewise be under the gunfire of all the forts and of vessels in the naval harbour of Dover.

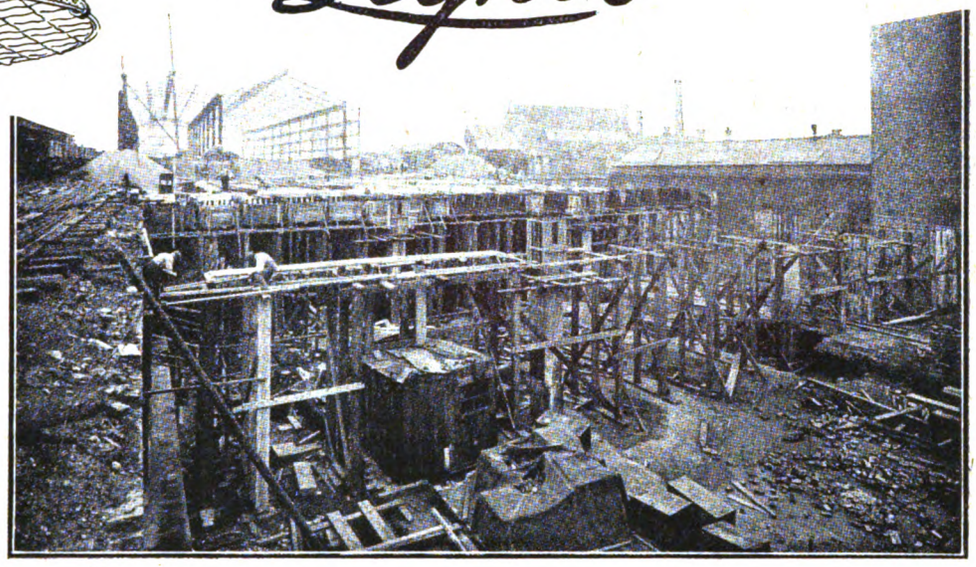
The gauges of the English and French railways were very similar, as was proved by the fact that at the present time hundreds of the largest English and Scottish locomotives with thousands of trucks were running in regular traffic on French railways, rendering invaluable service in the transport of the Allied forces. Trains would be run direct from London to Paris in less than six hours. Doubtless in course of time more than two pairs of rails would be required to deal with the enormous volume of traffic which must inevitably develop in each direction. The probabilities were confidently anticipated by Baron Emile d'Erlanger, Chairman of the Channel Tunnel Co., that the traffic would, as the result of the opening of a submarine railway, double or treble itself not only in regard to passengers but also in respect of perishable goods requiring prompt delivery, and, further, that the financial return upon the capital expended would be highly satisfactory. The Tunnel Co. would simply be required to construct the works, operate the pumping and ventilation machinery, maintain the permanent way and keep the signalling and telegraphic equipment in order. Everyone could now realise of what enormous value the tunnel would have proved had it existed at the beginning of the present war, in saving so many valuable lives, in vastly reduced suffering of the sick and wounded, and in immunity of ships from floating mines and submarines. The immense reduction which would have been possible in the army of dock labourers at the Channel ports of England and France must also be taken into account, and, added to that, the great facilities available for the transport of troops, stores, guns, ammunition, &c.

Mr. Arthur Fell, Chairman of the House of Commons Channel Tunnel Committee, has given notice of his intention to move a resolution (as soon as the Government can afford an opportunity for discussion of the subject), "That in the opinion of this House the progress of the war has demonstrated the great advantage which would have accrued to this country and the Allies if a railway through a tunnel under the Channel had been in operation, and that the time has arrived for H.M. Government to declare their intention to support the proposal, so that the final plans may be prepared and the powers obtained, and arrangements made for the commencement of the work as s on as possible after the end of the war."

Digitized by Google



Simplex Cargo Cluster Lights



Simplex Cargo Lights

for:

Dockyards, Factory Construction, Permanent Way Repairs, and other special conditions where strength is demanded.

Mechanically and electrically a sound engineering job.

SIMPLEX CONDUITS, Ltd., Works—GARRISON LANE, B'HAM.

LONDON—113-7, Charing Cross Rd. BRISTOL—10-11, Denmark St. NEWCASTLE—61-5, High Bridge. GLASGOW—72A, Waterloo St.
LEEDS—6, White Horse St. CARDIFF—4, Westgate St. MANCHESTER—16, Corporation St. LIVERPOOL—96, Whitechapel.
SWANSEA—14, Heathfield St. SHEFFIELD—281-3, Attercliffe Common.

M·E·M

IRONCLAD SWITCH AND FUSE GEAR

ACCURACY

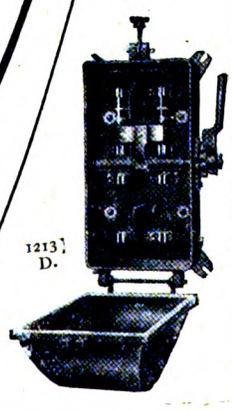
The QUALITY products

In modelling the design of M.E.M. "Gear," our experts have adopted the practical user's standpoint—with RELIABILITY as the actuating factor. Every essential characteristic to ensure Absolute Reliability—STRENGTH, HIGHEST EFFICIENCY, SAFETY and ACCESSIBILITY—is present in its most convincing form—with the result that "M.E.M." Fitments are reserved by experienced engineers for their most important needs.

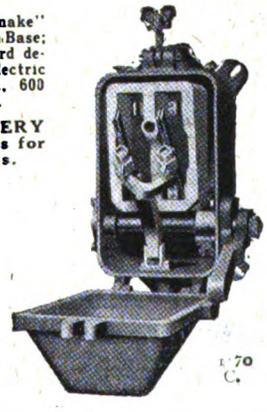
Again—"BRITISH MANUFACTURE" (and all made to H.O. Regulations) furnishes an additional "M.E.M." guarantee of excellence. Now study below several salient points of two of our most popular Switches:—

1213. D. "MEMCO" Ironclad Changeover Switch. Standardised and Interchangeable Units; parts easily renewable; contacts undamageable by quick closing. &c.. D. or T.P., 60 to 200 amps., 600 volts.

1170. C. "CAMLOC" Ironclad "quick-make" Switch. Best English Vitreous Porcelain Base; exceptionally high insulation; standard detachable glands, tapped standard electric thread; D.P. without fuse, 30 amps., 600 volts. Also supplied as a Switch Fuse.



1213 D.



1170 C.

We can give PROMPT DELIVERY from Stock of all standard lines for War-work Factory requirements.

Now let us have your enquiries.

Midland Elec. Mfg. Co., Ltd.

Head Office and Works:
Barford Street, BIRMINGHAM.

'Phone: Mid. 671 & 672. 'Grams: "Kilowatt B'm."

Branches:

Lon: 2, Gresham Bgs, Basinghall St., E.C. 'Phone: Lon. Wall 723. Manch: 4, Carr St., Blackfriars. 'Phone: City 1391 Glasgow: 40, W. Campbell St. 'Phone: Cent. 4187 & 4183. Newcastle-on-Tyne: Milburn House. 'Phone: Cent. 2524.

R.H.S.

Digitized by Google

LOAD AND EXPERIMENTAL
RESISTANCES
MADE TO ANY SPECIFICATION.
Particulars of Standard Types will be found in our List, to be had on application.
RAPID DELIVERIES GUARANTEED.
ISENTHAL & CO., Ltd.,
(DEPARTMENT 4)
Denzil Works, Willesden, London, N.W. 10.
Contractors to the Admiralty, War Office, India Office Colonial Office, Postmaster General, etc.

FOR
High and Low Tension
SWITCHGEAR
THE
NEW SWITCHGEAR CONSTRUCTION CO., Ltd.
SUTTON, SURREY, ENGLAND.
ABC Code 5th Edition. Telephone: Sutton 773.

John E. Raworth,
70/71, Queen Anne's Chambers, Broadway, Westminster, London, S.W. CHARTERED PATENT AGENT.

WOLVERHAMPTON
FOR NEW WORKS SITES.
EXCEPTIONAL TRANSPORT ADVANTAGES BY RAIL AND WATER.
Cheap Electricity, Gas, Mond Gas and Water.
Low Assessments.
Excellent Educational Facilities.
Electric Tramways.
Male and Female Labour Plentiful.
For particulars apply to:—GEORGE GREEN, Borough Engineer, Secretary Development Committee, Town Hall, Wolverhampton.

ELECTRIC POWER IN IRELAND.

Mr. J. F. Crowley, D.Sc., who was recently appointed Irish representative on the Electric Power Committee of the Board of Trade has been interviewed by a representative of the "Freeman's Journal."

In the course of the interview Dr. Crowley said that the provision of cheap power was a question that interested all parts of the country, from the industrial North to the agricultural South. There were many possible applications for electricity which would undoubtedly come to the front if it could be purchased at a sufficiently cheap rate. Such applications had already been made on a large scale in other countries.

Among possible applications which had not been made at all in the country were electricity as applied to the predominant industry, *i.e.*, agriculture. That application might take two forms :—

(*a*) By application to growing plants in the form of high-tension electricity carried on a network of wires over the area on which it was intended to carry out intensive cultivation. This had been done on the Continent with very satisfactory results, very large increases in production being obtained. Experiments were now being carried out in England on a scale sufficient to test the possibilities of the merits of electricity in this connection.

(*b*) Its application to the driving of the usual machines on farms from a central point of distribution. Temporary extension cables wound on drums were used for the purpose on the Continent, and America supplied electricity from a central point, or points, to the place where it was required. In view of the great extension of the use of motor tractors, the use of electrically-propelled tractors had long passed the experimental stage in many countries.

A further possible application of electricity which might have very far-reaching results would be the application of electric propulsion on canals. That had been done on many large canals both on the Continent and in America. The usual method of operation was for a small, specially-designed electric locomotive to run on a prepared track on the canal bank and propel one or more barges in the usual manner. How far that would be applicable in Ireland was a matter that would require very careful investigation from a technical and commercial point of view. Such a system would enable greatly increased traffic to be carried on existing canals. The system had many advantages over the screw-propelled barges employing suction gas and other sources of power, as the screw propeller, with its low efficiency, was altogether eliminated.

Many other applications of electricity would suggest themselves, among others its application to textile factories largely centred in the north of Ireland and to the various other industries in the country. The importance of cheap power to a country that hoped to become even moderately successful in industry could not be over-estimated.

As to the utilisation of the country's great peat deposits, Dr. Crowley said that, without entering deeply into the matter, he thought it might be said that it was undoubtedly a problem where State action would be desirable. In Holland the State, and indeed private enterprise also, recovered lands under peat, utilising the peat deposits and letting the land so reclaimed at a remunerative rate to its people. The Dutch Government also, as was well known, recovered land by its dykes from the sea ; and it was surely not too much to expect from a benevolent State body that it would take steps to recover a large area in the country now under peat and so add it in the future to that great area of increased tillage that it was so much in the interests of the State to secure in the future. The problem was too much for private enterprise, and one for a body like the State that could afford to wait for a due return on its capital expenditure.

TUNGSTEN FILAMENTS.

Our contemporary "Engineering" gives some particulars of a peculiar method of preparing tungsten filaments, which are ductile in spite of being squirted.

The process, which was described by Dr. W. Böttyer before the December meeting of the Bunsen Gesellschaft, is employed by Julius Pintsch, and is due to Messrs. O. Schaller and Orbig. Members of the society were able to watch the process in the works after the meeting. The metallic powder is mixed with 2 per cent. of thoria and kneaded into a paste with addition of some binding agent ; a thread is then squirted. The thread is first pre-heated and then rapidly heated up to 2,400°C. or 2,600°C., the object being to make the crystallisation of the metal more rapid then the passage of the wire through the hot zone. The first apparatus used for this delicate operation had the dimensions of several metres ; the actual apparatus is only a few centimetres in height. The resulting wire is said to consist of crystals several metres in length, though only a few hundredths of a millimetre in thickness, the cross-section of the wire comes out octagonal rather than circular. There are very few joints in a wire. A re-crystallisation of the filament after long-continued use of the lamp is said not to occur.

"ANTI-SULPHURIC" ENAMEL
Should be used in all ACCUMULATOR ROOMS
For Protection from Acid Fumes,
SOLE MAKERS: GRIFFITHS BROS. & CO., LONDON, LTD., Mark's-rd., Bermondsey, LONDON, S.E.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

PRESCOT AUTOMATIC TROLLEY REVERSER

Juggling is interesting enough on the stage, and is said to be a congenial form of exercise with a certain class of financier, but on a tramway system with heavy traffic it is in these days a little out of place.

In order to help the Tramway Engineer out of a difficulty that has hitherto faced him, we have designed a set of fittings which effectively achieve the automatic reversal of the trolley.

The result is beneficial to the Tramway Concern in that the lights are not extinguished, and the reversal is accomplished in a shorter time than by the old process, while it removes from the mind of the fair conductress a source of carp, fret, dole, care, worry, and sore neck.

Particulars on Application.

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED **SECOND HAND**

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Viamister, Sowest London.

For Effective Impregnation

use "LACWATT"
Black or Golden Brown.
JENSON & NICHOLSON, Ltd.,
Insulating Varnish Department,
Goswell Works, Stratford, E.15

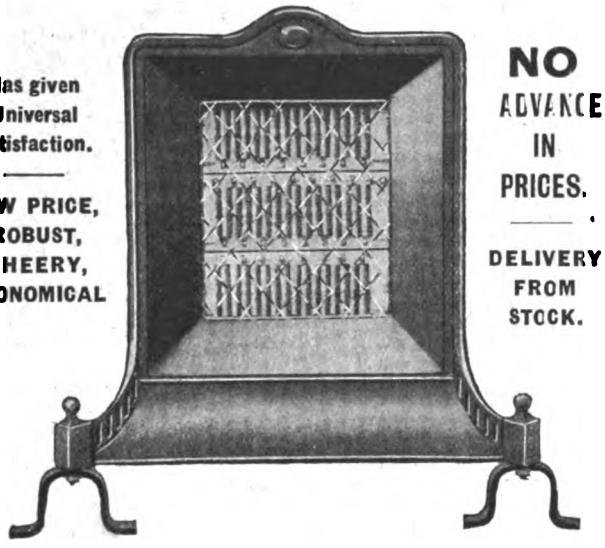
Digitized by Google

— THE —

ARORA

ELECTRIC

FIRE



Has given Universal satisfaction.

LOW PRICE, ROBUST, CHEERY, ECONOMICAL

NO ADVANCE IN PRICES.

DELIVERY FROM STOCK.

Write for LIST G (Fires and Cookers).

to Sole Manufacturers—

THE ARORA CO., LOUGHBOROUGH.

Canadian and Indian

MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite—Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1912 to 1917.

ATTWATER & SONS,

Telegrams: Attwaters, Preston. Telephone No. 1045 (2 lines).

Hopwood St. Mills, PRESTON.

Established 1868. Codes: 5th Edition A B C & Western Union.

THE OVERSEAS TRADE.

At the annual meeting of the Manchester Association of Importers & Exporters on Monday, Mr. E. H. Langdon delivered his presidential address. He mentioned that the Council had accepted the sub-committee's report on Mr. Drummond Fraser's proposal for the establishment of a credit association, and the creation of such an association was recommended, but it was left to Mr. Fraser to elaborate details as to its constitution and capital.

As to ways and means to combat German aggression in the future, Mr. Langdon said he held that chambers of commerce and associations of manufacturers and similar bodies should devote their attention at once to the problems awaiting us at home. Those appeared to him at present equally, if not even more, important as subjects of study than trade after the war. With regard to finding work for all who came back from the war, taking into account the increased numbers of women workers, he quoted the Prussian plan already devised and advocated the formation of a register of employers for the use of the War Office. After the war the industry of this country would require even harder work, and there must be a more careful organisation of the nation's business if we were to retain our position in international trade, and this was as much the duty of the employed as the employers. Dislocation and disturbance at home would not only stop our exports, but would cause a diminished consumption of imports, and, above all, an increased cost of all products consumed at home. Railway reorganisation and utilisation and improvement of canals required our study.

In regard to the future of the export trade, he said he was afraid the Government Departments were being forced into misdirected action. Ingrained conservatism and inability to foresee the immense future that lay in the adoption of certain new processes and machines, which were "turned down" when offered to British manufacturers, drove trade to the more far-seeing foreigner. Happily, Lancashire men were not as blind as the Nottingham and Leicester manufacturers, and new types of machinery had been readily given a trial. He thought that the prosperity of the district could show a record of efficiency, both in the engineering and textile trades, which no dry nursing by Government could extend. While he did not modify his old Free Trade views, he felt that certain trades would have to be assisted for national reasons, even if economically this might be wrong. But what we had to look to was to increase and foster our trade in neutral countries. Many of those countries had prospered beyond reason owing to the war. In that district they had an intimate acquaintance with the requirements of all foreign countries, and it was in those countries, especially the neutral markets, we should have to fight the hardest with the hitherto well-organised penetration of the Germans. As one of the ways to increase our trade, existing banks or the proposed credit association should assist merchants to develop resources—in plantations—overseas. Germany had an immense pull in the ownership of plantations overseas—in the monopoly of much of the produce of both the eastern and western hemispheres. Nitrates from Chili, coffee from Guatemala, tobacco from San Domingo and Bahia, and copra from the East, all found their largest markets in German ports, and these imports facilitated the voyages of steamers direct between Germany and those countries. There were many ports where no British steamers had called, and if we could obtain the produce and market it in London, Liverpool and (he hoped) in Manchester, then the steamship lines would come of their own accord, finding both inward and outward freight, and that must facilitate an increasing import and export trade. We should be in a difficulty in the near future, but Germany and all the combatant nations would encounter the same even to a greater degree. Death and disablement had robbed us of the services of so many capable young men, who were being trained to be sent out as travellers and pioneers for our trade. Only the weak and elderly ones were left at home. We should therefore have to take our chance of obtaining the outlet for our production through agents resident abroad, or be compelled to find men of neutral nationality, until the new generation had grown to manhood. We had to look to the Education department to re-ogranise our educational system, so that we might in the quickest time train a new generation of young people, both men and women, for commercial life.

BRITISH X-RAY INDUSTRY.

The Secretary of the British Electrical and Allied Manufacturers' Association (Mr. D. N. Dunlop) has issued an announcement that a section of the association has been formed. It is proposed to enrol British manufacturers of X-ray and electro-medical apparatus, with the object of improving the status and prospects of the industry by co-operation and research.

Mr. Dunlop points out that since 1914 great strides have been made by individual British manufacturers and it is hoped that the enrolment of its members as a section of this association will further help to place it and maintain this important industry in a position where it can supply not only the home trade but the whole of the Empire. British manufacturers have been at a serious disadvantage owing to lack of co-operation by which to meet the keen competition which existed in the world market. The section views most hopefully the future of the X-ray and electro-medical industry in this country and earnestly invites the co-operation of medical men and hospitals with the object of supporting and strengthening the movement towards the exclusion of foreign-made apparatus.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,035. [Vol. LXXIX. No. 7.] FRIDAY, MAY 18, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 255
Arrangements for the Week 257
The Theory of Armature Windings. By S. P. Smith, D.Sc. Illus. 258
Internal Temperatures of Alternating-Current Generators. By Ralph Kelly. Illustrated 260
The Choice of Voltage for Railway Electrification on the Direct-Current System. By F. Lydall. Illustrated.—*Continued*.... 263
Speed Control of Induction Motors for Steel Mill Drive. By J. D. Wright. Illustrated 266
WORKS ORGANISATION 268
REVIEWS 271
High-Tension Overhead Transmission Lines.—*Discussion*—*Concluded* 272
Textile Mill Electrification. Illustrated 274
Proposed Parliamentary Action in Regard to Wayleaves 276
CORRESPONDENCE 276
Ironclad Switchboards. Illustrated 277
PARLIAMENTARY INTELLIGENCE 278
LEGAL INTELLIGENCE 278
Volunteer Notices 278
COMMERCIAL AND INDUSTRIAL SECTION 281
Electricity Supply 282
Tenders Invited and Accepted 286
Financial Matters 287

NOTES.

The British Trade Corporation.

As a result of the recommendations of Lord FARINGDON'S Committee to establish a British trade bank, arrangements have been completed for the creation of the British Trade Corporation, and the proposed Royal Charter of incorporation has been issued. The first directors are Lord FARINGDON, the Right Hon. F. HUTH JACKSON, Mr. ARTHUR BALFOUR, Mr. F. DUDLEY DOCKER, C.B., Mr. W. H. N. GOSCHEN, Mr. J. H. B. NOBLE and Sir JAMES HOPE SIMPSON. Some particulars of the Royal Charter will be found in another column. From these particulars it will be seen that the Corporation can deal with concessions, patents and similar property, and can collect information and carry out experimental research. It will be generally agreed that German industrial concerns have benefited considerably by German banking methods, and that the financing of such concerns has been more easy in Germany than in this country. There is a certain class of financial work of an industrial kind that is not undertaken by present British banks, nor is it desirable that such work should be so undertaken. Our banks admittedly hold the highest position in the financial world, and it is better that they should continue along present lines. The fact, however, remains that they have no means of investigating industrial processes, which nevertheless ought to receive financial support. Such matters can very well be investigated by a trade corporation, such as that which is now to be formed. That some new body is desirable was clearly the opinion of Lord FARINGDON'S Committee, whose members included a number of prominent bankers. In fact, the committee stated: "There is ample room for an institution which, while not interfering with the ordinary business done by British joint-stock banks, would be able to assist British interests in a manner that is not possible under existing conditions." It is, of course, highly desirable that such a corporation should not interfere with work which is now normally carried on by our present banking institutions, and for that reason we are glad to see that it is not called a bank. We think that a certain amount of suspicion has been aroused through lack of information on this point. It appears that the activities of the Corporation are limited by an agreement which, so far, has not been published. Before matters go further it seems desirable that the public should be in possession of all the facts.

Compulsory Powers for Obtaining Wayleaves.

Two Papers have been read recently before the Institution of Electrical Engineers, prepared at the request of the Council, which have a very direct bearing on the future of electricity supply in this country. One was on "Wayleaves," by Mr. C. VERNIER, and the other on "Transmission Lines," by Mr. G. V. TWISS. If electric power supply is to be provided on a cheap and adequate scale it is essential that there should be, firstly, greater centralisation of power generation; and, secondly, longer transmission lines, which would generally be carried overhead. The extended use of overhead lines has been largely hampered by the difficulty and cost of obtaining wayleaves. We are, therefore, glad to see that a joint committee of the Incorporated Association of Electric Power Companies and the Incorporated Municipal Electrical Association is drafting an Electricity Supply Bill, which it is proposed to present to Parliament at an early date. The Chairman of this Committee is Mr. W. A. CHAMEN, and in his remarks on Mr. VERNIER'S Paper, which we give in abstract in another column, some particulars of the Bill in so far as it relates to wayleaves will be found. Undoubtedly, the sooner some such Bill becomes law the better. As is pointed out by Mr. CHAMEN, the bare fact of the existence of powers such as are proposed would suffice in 9 cases out of 10 and probably in 99 cases out of every 100 to cause the property owner to make a reasonable agreement without the actual powers being brought into operation. Such an Act will make the life of a supply authority a comparatively happy one as regards wayleaves, assuming that the Board of Trade, the proposed arbitrating body, is not bound by ideas of the past.

War Organisation in America.

In view of the special problems which the electrical industry in this country has had to meet since the outbreak of war, it will be interesting to observe the measures taken for the national organisation of the leading electrical firms in the United States. References to this subject in the American electrical press indicate that these problems are already being taken up energetically and, as one would have anticipated, there is evidence that the spirit of self-sacrifice shown will not fall behind that shown in this country. We notice the interesting statement that the copper producers in the United States have agreed to furnish the Government with all the copper required for the army and navy at a price of 17 cents per lb., which is roughly half the present market price. According to the "Electrical Review and Western Electrician," approximately 50,000,000 lb. will be supplied at this price during the current year, leading to a saving equal to the interest on an issue of bonds of $200,000,000. What is perhaps an even more striking offer is that coming from a number of leading electrical firms, which are stated to have offered to turn over to the Government, *without profit*, their entire organisations.

Digitized by Google

Société Internationale des Electriciens.—The Committee of Management of this society, which was founded in 1885, has submitted an amended code of regulations. Among other alterations it is proposed to alter the title to the Société Française des Electriciens.

Petrol Engine Ignition.—According to the "Engineer," the provision of electric starting and lighting sets on motor cars in America has almost revolutionised the ignition problem. The major portion of the cars in use at the present time on the other side of the Atlantic have battery ignition instead of magneto. In this country, of course, the magneto is very largely used.

A New Rectifier for Charging Batteries.—A new type, the "Tungar" rectifier, has been introduced by the General Electric Co. of America for use in garages, &c., for charging batteries. The apparatus operates at about 75 volts and 6 amperes, and is suitable for use on an alternating supply of 115 volts and 60 cycles. There are no moving parts, and the battery cannot be discharged through the rectifier should the alternating supply fail. The cost of charging a three-cell battery for a 13 hours' charge is about 2¼d. (9 cents).

Tramways and Light Railways Association.—The annual congress will be held at the lecture theatre of the Institution of Civil Engineers, Great George-street, S.W. 1, at 2.30 p.m., on June 29.

The first business will be the annnual general meeting of the association, at which new members of the Council will be elected.

Mr. Arthur Norton, A.M.Inst.C.E., A.M.I.E.E., will read a Paper on "The Manufacture, Life and Maintenance of Tramcar Tyres," illustrated by diagrams and lantern slides. Among the subjects to be discussed will be "Standardisation of Conditions of Labour and Rates of Pay," by E. H. Edwardes, A.M.I.E.E., general manager and engineer, South Lancs. Trams Co.; and "Fares," by A. V. Mason, M.I.E.E., general manager, South Metropolitan Tramways Co.

Chromium Steel Permanent Magnets.—An investigation into the suitability of chromium steel for permanent magnets has recently been carried out in Germany and reported upon to the Physikal-Techn. Reichsanstalt. Figures are given for five bars of chromium steel, these being compared with five bars made of tungsten steel, the product of remanence and coercive force being taken as a criterion of quality. The remanence of the chrome-steel bars was further tested under 20 hours' heating at 100°C., six heatings up to 100°C. and 20 falls from a height of 2½ metres on to a wooden block. It is concluded that carefully prepared chromium steel is a suitable substitute for tungsten steel.

Large American Power Station.—The Milwaukee (Wis.) Electric Railway & Light Co. proposes to commence the erection of a steam driven generating station this summer, which will have an ultimate capacity of 200,000 kw., but at the outset only 65,000 kw. will be installed. The company has already three plants, and it purchases power to the extent of 12,000 kw. from a hydro-electric power company on the Wisconsin River. Owing to the cheap rates at which energy is supplied there is a large demand for power for industrial purposes, while the heating and cooking load is steadily increasing. The rate is so designed that practically all energy for cooking is paid for at 2 cents per kilowatt-hour gross.

New Physico-Chemical Institute in Japan.—The "Elektrotechnische Zeitschrift" contains a note on the new physico-chemical research institute being established in Japan. It is stated that 2,000,000 yen has been allotted and that the buildings were partially completed by the end of 1916. Among the subjects to be dealt with at the institution are: Electrical and electro-chemical researches, testing of instruments and thermometers, research on optical glass, synthesis of colours, rubber and oil, the fixation of atmospheric nitrogen, microscopy of metals, vibrations of ships, &c. The programme also provides for a systematic study of the natural resources of Japan, Korea, Manchuria and the South Sea Islands.

Induction Effects in Electric Furnaces.—Mr. T. R. Hay, in the "Electrical Review and Western Electrician," refers to one important point in the design of large electric furnaces—the heating effect due to the large reactance and high currents in the secondary leads from the transformer. These leads should be brought in at the top of the furnace for connection to the electrodes. Otherwise they heat up the adjacent iron-work unduly. In very large furnaces the secondary leads should be interlaced. This has the additional advantage of diminishing the first cost of the transformer by increasing the current-carrying capacity of the leads. On account of the "skin-effect" which appears in copper conductors at high currents, the addition of more copper when the current exceeds 4,000 amperes in the secondary leads is not of much assistance.

Case-Hardening of Iron by Boron.—A contribution by Prof. N. Tschischewsky in the "Journal" of the Russian Metallurgical Society, suggests that boron is a promising material for the case-hardening of iron, and further particulars of this method were recently given at a meeting of the Iron and Steel Institute. Alloys of iron and boron are extremely hard, and experiment shows that a penetration to a depth of 1 mm. can be fairly easily produced. Cementation is effected most easily by using powdered ferro-boron. It is interesting to note that boron confers the property of hardness without annealing or other special heat treatment. Further experiments are needed to reveal the best methods of using boron industrially. Its comparative scarcity may render it unsuitable for armour plate work, but for machine parts which are subjected to severe wear it may prove to have useful applications.

The Efficiency of Optical Projection.—In a recent Paper before the Illuminating Engineering Society in the United States, Mr. R. B. Chilas analyses the conditions affecting the efficiency of optical projection in the cinematograph. He estimates that in the most favourable circumstances the screen does not receive more than 5·8 per cent. of the light from the arc, while in many cases it does not exceed 1 per cent. Various arrangements of carbons with a view to avoiding the shadow cast by the negative have been tried, but with the present lens systems it is difficult to utilise more than 17 per cent. of the light from the crater. On the other hand, it is suggested, an improvement might be made by reverting to an old idea explained in a Swiss patent by S. Schuckert, as far back as 1889. This involves the use of an ellipsoidal mirror, the crater being at one focus, the objective lens at the other, and the film in between. Theoretically as much as 75 per cent. of the light from the crater might thus be collected.

The Production of Ultra-Violet Rays.—In an interesting Paper in the "Journal" of the Röntgen Society, Mr. C. A. Schunck discusses some of the chief sources of ultra-violet light, and summarises what is known of the extent of the spectrum produced. The ordinary photographic plate will only record to about $\lambda=2{,}150\ \mu\mu$, owing to the absorption of the rays by the emulsion. Schumann, by using a plate with a minimum of gelatine, has recorded to 1,850 $\mu\mu$; and by the further steps of using fluorite instead of quartz, and by working in vacuo, even to 1,230 $\mu\mu$. Lyman, by taking extreme precautions, has even registered down to 600 $\mu\mu$. Beyond this there is an unexplored region down to 8 $\mu\mu$, where X and gamma rays begin. The short wave-lengths are very readily absorbed even by air. It appears that the richest source for this region of the spectrum is an arc between tungsten electrodes. It is conjectured that the rays between 2,000-3,000 $\mu\mu$ are most useful for therapeutic work, but agreement on this point does not appear to have been reached as yet.

Electric Propulsion of Ships.—Most of the criticism recently aroused against the United States Navy Department's battle cruiser designs apparently originated either from persons financially interested in some form of propelling machinery, which they hoped to have incorporated in these designs, or from disinterested but misinformed persons with a smattering of engineering training, whose superficial knowledge of warship design and lack of understanding of the military value of the various factors governing the design of these particular vessels make their criticisms practically valueless, says "Marine Engineering." Needless to say, the design of every warship represents a compromise, and without a complete understanding of the various factors governing the design, both from a

Digitized by Google

military and from an engineering standpoint, criticisms are of little value. As a matter of fact, says this paper, the new battle cruisers represent a step far in advance of anything which has so far been attempted in warship design in any country, and the features now subject to outside criticisms have received the unqualified approval of the general body of the Navy only after the most careful and mature deliberation.

Student Captives of War.—In our last issue we referred to the useful work being done by the British Prisoners of War Scheme, under which educational and technical books are despatched to those in captivity. We have since received the booklet entitled "Student Captives," by the secretary, Mr. A. T. Davies. The book contains letters from Lord Crewe and Mr. H. A. L. Fisher, expressing their interest in and approval of the scheme, and a number of letters from prisoners are quoted to show with what appreciation such gifts are received. The public has generously responded to the call for food for prisoners' camps, but any educated man can picture for himself the need for some intellectual stimulus to relieve the monotony of life in such conditions. We learn of privates studying French and Russian in order to communicate with their fellow captives and even, by arrangements with the censor, of examinations of Ruhleben captives conducted from the outside world. We can only emphasise again the human value of such work, and express the hope that many of our readers will communicate with Mr. Davies at the Board of Education and give their aid.

Institution of Electrical Engineers.—The following letter has been addressed by the Committee of the Newcastle Local Section to Mr. Sparks, the retiring president of the Institution :—

The Members of the Newcastle Local Section Committee beg to send greetings to you on the occasion of the Annual General Meeting of the Institution in London, and to convey their appreciation of the progressive measures which the Council have entertained during the period of your Presidency. They realise that a very large amount of your valuable time must have been devoted to this work, and are confident that this will have a most important bearing upon the immediate and future development of the Electrical profession.

On behalf of this Local Section they wish to thank you for the attention given to Proxy voting and other steps having for their object a closer touch between the Council and the Provinces.

In their desire to be of more assistance to the Council, they welcome your proposal to advise the Local Sections periodically by letter of any matters of moment which the Council consider opportune to confide in the Local Section Committees.

The members of the Committee also beg to tender their loyal support to your successor in office, Mr. C. H. Wordingham, and respectfully to declare their whole-hearted approval of his nomination as President.

Illuminating Engineering Society.—The seventh annual report of the Illuminating Engineering Society was presented at the annual meeting on the 15th inst. The society, dealing with scientific and industrial aspects of a wide subject, unites on common ground electrical engineers, gas engineers, manufacturers of lamps and shades, physicists, ophthalmic specialists, architects and surveyors. This branch of engineering has been recognised by the appointment under the Department of Scientific and Industrial Research, of a Joint Committee on Illuminating Engineering. The successful union of these various interests is largely due to the efforts of the hon. secretary, Mr. Leon Gaster, during the last 10 years. Mr. Gaster is a British subject of Roumanian origin, and is thus doubly associated with the cause of the Allies.

Mr. A. P. Trotter has been unanimously nominated President by the Council of the Illuminating Engineering Society, and his election took place at the meeting of the Society on Tuesday last.

It is interesting to note that Mr. Trotter is also the chairman of the Joint Committee on Illuminating Engineering, appointed under the Department of Scientific and Industrial Research.

The Training of Engineering Apprentices.—In a Paper before the Society of British Gas Industries in April, Mr. H. A. Bennie Gray discussed the training of engineering apprentices, and gave some account of the steps being taken in connection with the Technical College at Huddersfield. Mr. Gray condemned unreservedly the idea that boys can profit by attending evening classes after a hard day in the workshops. It is now recognised by enlightened employers that provision must be made for education during working hours. At many technical colleges lists of employers willing to give such facilities for education to apprentices are kept. Although theoretically the State should be charged with the education of all children, the question of apprentice training is too urgent to wait for such action. Employers should make it their duty to care for the training and education of all their apprentices. An example of enterprising action in this direction is furnished by the town of Huddersfield, where the leading engineering employers have formed an association to equip, at their own expense, an up-to-date engineering department at the local technical college. The movement has received the full support of the federated trades, which are represented on the controlling committee. Adequate training for apprentices will be given during workshop hours, and facilities will be given for more advanced study. From session to session a careful study will be made of the capacities of pupils and gifted apprentices will be selected for special training, through scholarships endowed by the trade, in the day courses of technical colleges.

OBITUARY.

B. HALL BLYTH.—The death occurred on Sunday of Mr. Benjamin Hall Blyth, head of Messrs. Blyth & Blyth, civil engineers, of Edinburgh, and chairman of the Edinburgh Tramway Co.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported :—

Capt. W. K. Seale Haslam, R.F.A., aged 24, who was killed in action on April 27, was the youngest son of Sir Alfred Seale Haslam, and a member of the Haslam Foundry & Engineering Co., Derby.

Second-Lieut. K. R. M. Wheater, R.E., aged 23, who was killed on May 6, was educated at the City and Guilds Institute and the Imperial College of Science. He obtained the B.Sc. of London University last year.

Capt. A. S. Buckton, R.G.A., aged 28, who died of wounds on April 9, was educated at the East London College and was a B.Sc. of London University and a Whitworth Exhibitioner. He was also an A.M.Inst.C.E. and A.M.I.Mech.E.

Second-Lieut. D. E. Hood (Bedford Regt.), aged 21, who was killed on April 14, was an apprentice at the works of Vickers (Ltd.) when the war commenced.

Sec.-Lieut. B. Tempest (Manchester Regiment), who has died of wounds, was educated at Manchester University, and had been a student apprentice at Messrs. Mather & Platt's works.

Capt. Cyril W. Keenan-Hook (Manchester Regiment), aged 21, who was killed on April 23, was a son of Mr. J. J. Hook, of the Tata Hydro-Electric Co., Bombay. Capt. Keenan-Hook was also formerly with Messrs. Mather & Platt.

PERSONAL.

The Minister of Munitions has appointed Mr. W. R. Bousfield, K.C., F.R.S., to be a member of the Advisory Panel of the Munitions Inventions Department.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 18th (to-day).

ROYAL INSTITUTION.

5.30 p.m. At Albemarle-street, Piccadilly, W. Discourse on "The Complexity of the Chemical Elements," by Prof. F. Soddy, M.A., F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, S.W. Paper on "The Construction of Turbine Pumps," by Mr. A. E. L. Chorlton.

SATURDAY, May 19th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, Piccadilly, W. Lecture on "The Electrical Properties of Gases," by Prof. Sir J. J. Thomson, O.M. (Lecture III.).

FRIDAY, May 25th.

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, S.W. Papers to be read on "An Investigation of Radium Luminous Compound," by Messrs. C. C. Paterson, J. W. T. Walsh and W. F. Higgins; "The Resistance to the Motion of a Lamina, Cylinder or Sphere in a Rarefied Gas," by Mr. F. J. W. Whipple; and "The Effect of Stretching on the Thermal and Electrical Conductivities of Wires," by Dr. C. H. Lees, F.R.S.

Digitized by Google

THE THEORY OF ARMATURE WINDINGS.*

BY S. P. SMITH, D.SC.

Summary.—In this Paper an attempt is made to outline the theory of armature windings in machines with alternate north and south poles.

DEFINITIONS.

The following definitions may be found useful in reading the Paper:—

Symmetrical Polyphase System.—A polyphase system is said to be symmetrical when all the pressures have the same amplitude and are equally displaced from one another in a period—*i.e.*, when $\beta=2\pi/N$, where N is the number of phases and β the angle between successive phases. In such a system, the sum of the N pressures is equal to zero at any instant, so that the N phases can be joined in series (mesh) without causing internal currents to flow.

Hemisymmetrical Polyphase System.—A polyphase system is called hemisymmetrical when all the pressures have the same amplitude and are displaced from one another by $1/N$th of half a period. A hemisymmetrical, N-phase system is one-half of a symmetrical, $2N$-phase system.

Phase-pitch.—The displacement between two successive phases of a polyphase system is called the phase-pitch. The phase-pitch can be measured in any suitable unit in angular or linear measure, or expressed as a number of segments, slots, &c. When measured in radians, the angular phase-pitch is β.

Phase-spread.—The angle subtended in each pole-pitch by the group of coil-sides of a phase is called the angular phase-spread. This will be denoted by σ. According to whether the phase-spread is $1/N$th or $2/N$ths of a pole-pitch, we have the narrow or wide phase-spread.

SYMBOLS USED.

C = total number of coils in a winding, or segments in commutator.
I = R.M.S. value of current.
N = number of phases.
Q = number of slot-pitches per pole-pitch (or slots per pole) $= S/2p$.
S = total number of slots in periphery.
S' = number of slots in a symmetrical polyphase system $= S/a$.
$C/S = u/2$ = segments per slot.
a = any integer, 1, 2, 3, &c.
= number of similar parts (or circuits) in a phase of a symmetrical winding.
e = instantaneous value of electromotive force.
$\hat{e}$ = maximum value of electromotive force.
m = number of coils in a group.
n = any integer.
p = total number of pole-pairs in a machine.
p' = number of pole-pairs in a symmetrical polyphase system $= p/a$.
q = number of slots per pole and phase $= Q/N$.
q_0 = number of wound slots per pole and phase.
u = number of coil-sides per slot.
y_c = commutator pitch measured in commutator segments (or coils).
y_b and y_f = back and front winding pitches measured in coil-sides.
y_p = equipotential (or potential) pitch $= C/a$ segments (or coils).
y_{ph} = phase-pitch $= C/aN$ segments (or coils) $= S/aN$ slots.
β = angular phase-pitch in radians.
γ = angular slot-pitch in radians.
σ = angular phase-spread in radians.
ψ = angular phase displacement between the pressures induced in successive coils in the winding.

1. ARMATURE WINDINGS.

In a heteropolar machine—that is, a machine with alternate north and south poles—the periphery of p pole-pairs represents $2\pi p$ radians, in electrical measure. Denoting the total number of slots in the uniformly-slotted periphery by S, the angular slot-pitch in radians is then

$$\gamma=2\pi p/S. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The phase of the pressure induced in a conductor depends chiefly on the position in the field of the slot in which the conductor lies, and only to a small extent on the position of the conductor in the slot. If no flux whatever passed through the slot, the phase of the pressure induced in each conductor in the slot would be the same. Consequently, in a slotted armature, the position of the slots in the field, or, in other words, the relation between the number of slots and the number of poles, is of fundamental importance. To examine this relation, then, we need only consider the slots filled with coils arranged to form a uniform winding over the periphery. For this purpose we can take an ordinary two-layer winding with two coil-sides per slot—one in the top and the other in the bottom layer. In this winding, the number of coils C is equal to the number of slots S. These coils can be joined up in many different ways, according to whether the constant phase displacement ψ between the pressures induced in successive coils is to be greater than, equal to, or less than the slot-pitch, γ, as can be readily understood from the rules for lap and wave connections, which we shall consider presently.

Ignoring any harmonics that may be present in the pressure wave, that is, assuming a sinusoidal flux-distribution, the pressures induced in the successive coils a, b, c, &c., can be represented by vectors displaced from one another by the angle ψ, as shown in Fig. 1 (a), whilst the resultant pressure obtained by joining m coils in series is shown in Fig. 1 (b). (Small letters are used to denote instantaneous values, and a bar is added to denote maximum values.) If the m vectors in Fig. 1 (b) form a closed figure, as is the case whenever $m\psi=2\pi$, 4π, . . ., or, in general, $2\pi a$, where $a=1, 2, 3$, &c., then it is clear that $\sum_a^m e=0$, and if the m coils represented by these vectors are joined in series to form a closed winding, no internal current will circulate.

In the special case when $m\psi=2\pi$, the m coils form, by definition, a symmetrical m-phase system. If a winding has a such systems all alike, that is, a similar sets of m coils each, it is said to be symmetrical. If like coils of the a similar parts of a symmetrical winding are joined in series or parallel, neither the phase not the shape of the pressure wave will be affected in any way, nor can currents circulate between the several parts.

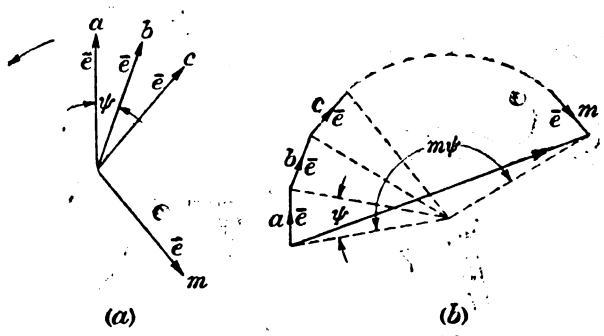


FIG. 1.—PRESSURES INDUCED IN SUCCESSIVE COILS OF A WINDING.
(a) Vector diagram. (b) Resultant of vector diagram.

We shall now see how these conditions can be fulfilled in a winding.

(I.) *Condition for Obtaining a Closed Winding.*—A closed winding may be defined as a winding in which the sum of all pressures is zero at any instant, since no current of fundamental frequency can circulate in such a winding when all the coils are joined in series to form a closed winding.

In order that the sum of the pressures induced in the S coils in the winding may be zero, we must make the total phase displacement $S\psi=2\pi a$, because only in this case do the S vectors form a closed figure.

We must have then

$$S\psi=2\pi a,$$

so that the phase angle ψ must be (*see* equation 1)

$$\psi=\frac{2\pi a}{S}=\frac{2\pi a}{2\pi p}\gamma=\frac{a}{p}\gamma. \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Thus, by making $\psi=a\gamma/p$, we obtain a winding in which $S\psi=2\pi a$, and therefore $\sum_1^S e=0$.

It will be seen presently that the rules for lap and wave connections are developed from the simple relation in equation (2).

In the above argument, it is noticed that a is merely a number—that is, $a=1, 2, 3$, &c.

(II.) *Condition for Obtaining a Symmetrical Winding.*—If a winding in which $S\psi=2\pi a$ has a similar parts, it can be called symmetrical, because the coils in each part then form a symmetrical polyphase system, in which the sum of the pressures is zero at any instant.

Let a be the highest common factor (H.C.F.) of the number of slots S and the number of pole-pairs p. Then $S/a=S'$ and $p/a=p'$ are both integers, and the above formulæ become

$$S'\psi=2\pi, \text{ and } S'\gamma=2\pi p'.$$

* Abstracted from an Original Communication in the "Proceedings" of the Institution of Electrical Engineers, Vol. LV., p. 18. For the parts showing the arrangement of windings and illustrative examples, the original Paper must be consulted.

Digitized by Google

Hence, the phase angle ψ will now be

$$\psi = 2\pi/S' = \gamma/p'. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Thus, by making $\psi = \gamma/p'$, we obtain a winding in which $S'\psi = 2\pi$, and, therefore, $\sum_1^{S'} e = 0$. Each set of S' vectors forms a closed polygon, and there are a such polygons exactly alike. Consequently, such a winding has a similar parts, and each part forms a symmetrical S'-phase system, in which the sum of the S' pressures is zero at any instant.

In this case, then, a has a definite meaning—it is the H.C.F. of S and p, and denotes the number of similar parts in the winding, or the number of times the slot positions in the field recur.

Since from each of a similar systems a similar circuit can be taken, it follows that a represents the number of similar circuits possible in a symmetrical winding. These a similar circuits can be united to form one phase of a polyphase system—the series or parallel connection being used according to the pressure and current required. The several phases can then be interlinked in star or mesh, as desired, unless they are already joined in mesh to form a closed winding. When the circuits are connected in series, the same current flows through all; when they are joined in parallel the current per circuit $I_a = I_p/a$, where I_p is the total current per phase.

In this way the common symmetrical polyphase windings are formed, as shown in sub-section (III.). The chief of these are:—

Symmetrical two-phase winding: Two phases at 180 deg. (diametral tappings).

Symmetrical three-phase winding: Three phases at 120 deg.

Symmetrical four-phase winding: Four phases at 90 deg.

Symmetrical six-phase winding: Six phases at 60 deg.

When the coils of a symmetrical winding are joined in series to form a closed winding, there will always be a coils at the same potential. These a equipotential coils are $S' = S/a$ coils apart, and must be connected to a common terminal by means of tappings or commutator brushes, in order to load the a similar parts of the closed winding uniformly. For this reason we call the distance between successive equipotential coils the equipotential (or, briefly, the potential) pitch—*i.e.*, the potential pitch $y_p = S/a$ slots or C/a coils. Obviously, equipotential connectors (or equalising rings) can be joined to any of the corresponding S' phases in the a similar parts of the winding, when desired.

An interesting case of the mesh connection with the a systems in parallel is the continuous-current machine, where connection is made to a closed winding by means of commutator brushes. In this case a brush does not make connection with two similar circuits, but with the two phases at 180 deg. of a symmetrical two-phase system. The total current I_p in each phase is then equal to half the continuous current I_c, so that the current per circuit $I_a = I_p/a = I_c/(2a)$.

The above conditions can be summarised as follows:—

I. When the total phase displacement of the S coils $S\psi = 2\pi a$, where $a = 1, 2, 3$, &c., then $\sum_1^S e = 0$, and the S coils can be joined in series to form a closed winding.

II. When in addition to $S\psi = 2\pi a$, a is the H.C.F. of S and p, then $S'\psi = 2\pi$, and therefore $\sum_1^{S'} e = 0$; so that the S coils form a similar symmetrical S'-phase systems.

A winding which satisfies conditions I. and II. is called symmetrical, whilst a winding which satisfies condition I. but not condition II. is called unsymmetrical.

These conditions show clearly how the number of similar parts or circuits in a winding depends on the relation between the number of poles and the number of slots. When we come to deal with the actual windings themselves in the latter part of the Paper, it will be found that a certain amount of confusion exists due to a slotting being used for a number of circuits different from the H.C.F. of S and p. In practice this often leads to undesirable results, as will be seen when we refer to two of the commonest examples. In an alternator it is quite common to use a slotting which gives the number of similar parts a equal to the number of pole-pairs p when only one circuit per phase is needed, with the result that tooth effects are repeated throughout the phase, whereas when a is less than p (for example $a = 1$), the tooth effects are suppressed by joining dissimilar pressures in series. On the other hand, in a commutator machine where the a parts are joined in parallel at the commutator or at the slip-rings it is very important to make the winding symmetrical—that is, the a paths exactly similar, to prevent sparking and the circulation of internal currents.

(III.) *Conditions for Obtaining a Symmetrical N-phase Winding.*—Though it is possible to have a similar S'-phase systems in a symmetrical winding, usually only a smaller number of phases $N = 3$, 4 or 6 is required. We must, therefore, see under what conditions the slotting for a symmetrical winding can be divided into N equal parts at an angle $\beta = 2\pi/N$ radians apart to form a symmetrical N-phase system. In other words, we must see when it is possible to derive a symmetrical N-phase system from S' slots and p' pole-pairs.

First, with regard to the slots, let S' be exactly divisible by N. We then get N equal phases displaced from one another by an angle $S'\psi/N = 2\pi/N = \beta$ (since $S'\psi = 2\pi$, in a symmetrical winding), which is what is needed. We can call the integer S'/N the phase-pitch measured in slots, and denote it by y_{ph}—that is $y_{ph} = S'/N$.

Coming now to the poles, it is clear that $2\pi p'/N = p'\beta$ must give the correct phase displacement $2\pi/N = \beta$. This is the case when $p' = nN \pm 1$, where $n = 0, 1, 2, 3$, &c., for then $p'\beta = (nN + 1)2\pi/N = \pm 2\pi/N = \pm\beta$. That is to say, when $p' = nN \pm 1$ the same positions are obtainable for N phases in the field with p' pole-pairs as with one pole-pair. This is not possible, however, if p' is a multiple of N, for when $p' = nN$, $p'\beta = nN(2\pi/N) = 0$. The same result can also be deduced from the fact that in a symmetrical winding S' and p' have no common factor greater than unity, and since S'/N is to be an integer, it follows that p'/N cannot be integral.

Since a symmetrical winding has a similar parts, it follows that each phase in the N-phase system will have a similar parts, and by connecting these a parts in parallel we get a circuits per phase.

Thus, to get a symmetrical N-phase winding, we must have a symmetrical winding (as defined in equation 3), such that—

$$\left.\begin{aligned} y_{ph} &= S/N = S/aN = \text{integer} \\ \text{and} \quad p' &= p/a = nN \pm 1 \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (4)$$

where a = H.C.F. of S and p = number of similar parts (or circuits) per phase.

The numbers of slots that will satisfy equation (4) for $N = 3$, 4 and 6, are determined in the following sections of the Paper, and are tabulated for lap and wave windings in Tables II. and III., whilst the following table shows the relation between the number of phases N, the number of similar parts (or circuits, with parallel connection) per phase a and the number of pole-pairs p in the machine.

Table I. shows that certain cases are not possible; for example, it is not possible to obtain a symmetrical three-phase winding with only one or two similar parts per phase in a six or 12-pole machine, nor is it possible to obtain a symmetrical four-phase pressure from an eight-pole machine unless we have four similar parts in each phase.

Unless a commutator is used, it is not necessary, and with some types of winding not possible, to wind all the slots in each of the N parts; but provided that all N phases are made equal and properly spaced, a symmetrical N-phase pressure is obtained.

An extension to the above rule for obtaining a similar circuits per phase enables us to get $2a$ parallel circuits per phase when N is even. For example, a symmetrical six-phase system is equivalent to two symmetrical three-phase systems at 180 deg., so that by

Table I.—*Possible Numbers of Similar Circuits per phase in a Symmetrical N-phase Winding on a Machine with 2p Poles.*

No. of pole-pairs in machine p.	No. of similar circuits per phase a	$p' = p/a$.	Possible number of phases N.
1	1	1	3, 4, 6
2	1	2	3
	2	1	3, 4, 6
3	1	3	4
	3	1	3, 4, 6
4	1	4	3
	2	2	3
	4	1	3, 4, 6
5	1	5	3, 4, 6
	5	1	3, 4, 6
6	2	3	4
	3	2	3
	6	1	3, 4, 6
7	1	7	3, 4, 6
	7	1	3, 4, 6
8	1	8	3
	2	4	3
	4	2	3
	8	1	3, 4, 6
9	1	9	4
	3	3	4
	9	1	3, 4, 6
10	1	10	3
	2	5	3, 4, 6
	5	2	3
	10	1	3, 4, 6
11	1	11	3, 4, 6
	11	1	3, 4, 6
12	3	4	3
	4	3	4
	6	2	3
	12	1	3, 4, 6

Digitized by Google

joining opposite phases I. and IV., III. and VI., and V. and II. in parallel, we get a symmetrical three-phase system with the same number of circuits as the six-phase system from which it is derived. In this way it is possible to get two circuits per phase in a two-pole machine, or in general to obtain as many circuits per phase as there are poles—a matter of great importance in practice. In a similar way it is possible to derive a hemisymmetrical two-phase winding from a symmetrical four-phase winding.

Obviously, the number of phases in an N-phase system, when N is even, can be halved by joining opposite phases, in series, and this is a very common way of obtaining a three-phase winding.

Before applying these conditions to single and double-layer windings, occasion may be taken here to point out the importance of making polyphase windings completely symmetrical wherever possible. The nature of the effects of dissymmetry in alternating-current systems can be understood by considering what happens when polyphase synchronous machines work in parallel. When the pressures of the several machines are unequal, due to incorrect field excitation, equality is established by reactive currents, which maintain the fluxes in the several machines at such a value that the sum of all the pressures round any circuit is zero at every instant. When there is a phase displacement between a machine pressure and a line pressure, a power component of current flows, and according to whether the phase of the machine pressure is ahead or behind that of the line pressure, the machine acts as a generator or motor. In the same way, when the pressures in the phases of a winding are unequal, reactive currents will flow to equalise them, whilst dissimilar phase angles will give rise to power components.

Where continuous currents are concerned, experience has shown that sparking in rotary converters and flickering in the lights connected on each side of the middle wire of dynamos with static balancers have often been caused by unsymmetrical phases on the alternating-current side. Also, the trouble due to having the parallel circuits unlike one another in a commutator machine are well known. Of course, in some cases, like the rotor of a small induction motor, a certain amount of dissymetry may be harmless.

(To be continued.)

INTERNAL TEMPERATURES OF ALTERNATING-CURRENT GENERATORS.*

BY RALPH KELLY.

Summary.—The paper deals with the internal temperatures of a number of typical large alternating-current generators. A method of calculation for internal temperatures is given which is based on simple heat laws and on data obtained from many tests. In conclusion, it is stated that no one average figure can be used for the difference between internal and surface temperatures for all classes of generators.

There have been many attempts to establish average figures representing the difference between internal and surface temperatures of different classes of alternating-current generator stators. When test results from a large number of generators are reviewed, the engineer's first conclusion is apt to be that there is no relation or consistency between temperatures measured by thermometer and by thermo-couple.

If, however, these test results are checked by calculations, it will be found that widely varying results can be shown to be consistent. Frequency, voltage, quality of insulation, copper and core densities, shape of slots, and core length, all have a bearing on the drop in temperature. In the following, a comparison of typical test results and the corresponding calculated temperatures is given. In one series of tests measured temperatures are available under different load conditions and at all important parts of the slot and core. In the other only the maximum internal slot temperature and the surface temperature readings are available. In such cases, however, if the calculated and tested temperatures agree reasonably, the calculated temperature at the intermediate points in the heat path may be considered reliable. We may confidently use these test temperatures and these calculated temperatures, checked by test, to show the magnitude of the effects of the different factors on the internal temperatures.

In obtaining the calculated results, a part, Fig. 1, of the armature laminations included between two adjacent air ducts, and one tooth pitch in length, is selected for analysis, because the internal temperature rise is usually the highest in this unit package.

Method of Calculation.—The object of the calculation is to determine by the use of simple heat laws and of empirical data the maximum measurable temperature to which the armature insulation is subjected. The calculation applies only to radially ventilated salient pole generators with enclosing end bells. For other types of generators suitable changes must be made in the calculation.

The temperature rise of an air-cooled surface varies with the air velocity and may be determined when the relation between the air velocity and the heat dissipated per unit surface per degree rise are known. It is assumed that the heat dissipated from a surface at any given velocity increases directly with the temperature rise, which permits the use of the equation $W=T/K$ (1), where W=watts radiated per sq. in. of surface; T=temperature rise of surface above cooling air; and K=a constant depending on the air velocity.

The data for the constant K (Fig. 3) has been determined from tests where air at different velocities has been passed over heated surfaces. In Table I. the air velocities through the armature core are tabulated with the corresponding values of K.

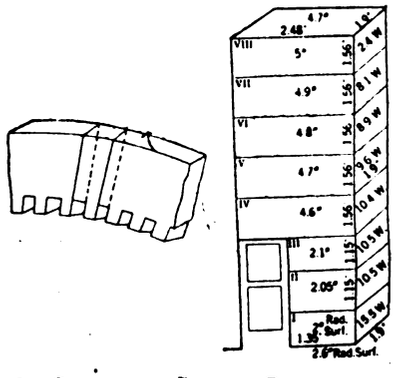


FIG. 1.—SEGMENT OF CENTRAL PACKAGE WITH UNIT PACKAGE SELECTED SHOWN IN DETAIL AT RIGHT.

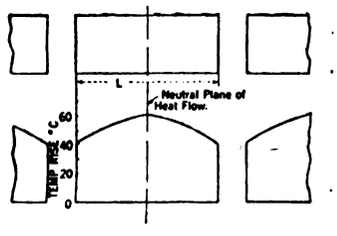


FIG. 2.—TEMPERATURE RISE ACROSS LAMINATIONS.

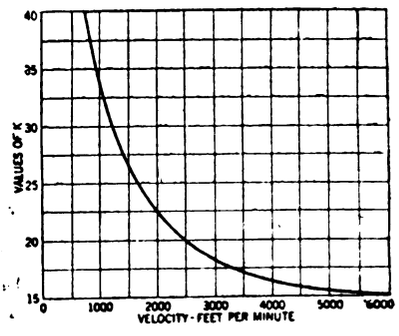


FIG. 3.—HEAT DISSIPATION FROM AIR COOLED SURFACES.

The losses generated in all unit packages are practically identical. For convenience in calculation this unit package is divided into sections as shown in Fig. 1. The iron and copper losses under load conditions are calculated for each section. An allowance is included for increased saturation due to the influence of the armature reactance, for eddy current losses in the conductors, and when operating at high power factors, for distortional losses. Recognising that the density in the core is not uniform, the distribution of the loss across the core depth is assumed to vary in such a manner that the loss in the section next to the bottom of the slot is greater than the loss at the rear of the core by the ratio (pole pitch+core depth)/pole pitch.

The cooling air in passing through the machine has its temperature raised by the losses that are dissipated to it. The amount by which the temperature of the cooling air is raised before it reaches the first section of the unit package may be calculated from the fact that 1 kw. of energy dissipated to 100 cubic ft. of air at an initial temperature of 25°C. will raise the temperature of that air 18°C. in one minute. The temperature rise of cooling air from section to section may be calculated similarly. Due to the rise of cooling air through the air duct, a correction is made for the flow of heat toward the slot

* Abstract of a Paper read before the Am. Inst. E.E.

Digitized by Google

Table I.

—	Test 1.		Test 2.		Test 3.		Test 4.		Test 5.		Test 6.	
K.v.a.	7,660		3,830		4,570		7,500		2,750		20,000	
Amperes	1,100		550		550		578		255(2φ)		1 750	
Volts	4,000		4,000		4,800		7,500		5,400		6,600	
Per cent. inductive P. F.	0		0		0		0		0		0	
Load tooth density, lines sq. in.	114,000		105,500		126,300		118,100		120,500		114,500	
Load core density, lines sq. in.	66,000		60,600		73,200		69,000		97,800		67,700	
Current density, amps. per sq. in.	2,180		1,090		1,090		1,605		2,730		1,845	
Cycles	50		50		50		25		62·5		50	
Revs. per min.	400		400		400		375		375		375	
Core length in inches	23½		23½		23½		45		16½		41½	
Velocity in air gap, cubic ft. per min.	8,250		8,250		8,250		6,460		5,700		8,600	
Velocity in air duct, cubic ft. per min.	3,300		3,300		3,300		2,580		3,800		3,440	
Velocity in core, cubic ft. per min.	2,000		2,000		2,000		1,290		2,140		2,230	
Velocity rear of core, cubic ft. per min.	1,500		1,500		1,500		950		1,600		1,670	
—	Tested values.	Calc. values.	Tested values.	Calc. values.	Tested values.	Calc. values.	Tested values.	Calc. values.	Tested values.	Calc. values.	Tested values.	Calc. values.
Calculated hot spot temp.	...	72·5	...	36·5	...	53·0	...	35·0	...	89·0	...	89·0
Test thermo-couple temp.	73·3	...	39·4	...	59·0	...	36·0	...	82·0	...	93·0	...
Calculated rear of core temp.	...	45·0	...	28·5	...	49·0	...	22·3	...	65·0	...	48·0
Rear of core temp. by thermometer	40·0	...	30·5	...	47·5	...	23·0	...	56·0	...	43·5	...
Max. temp. sec. I.	61·7	61·3	44·7	46·3	66·7	68·5	...	33·1	...	77·2	...	70·8
,, ,, ,, II.	...	61·4	...	46·3	...	69·0	...	32·5	...	77·7	...	70·3
,, ,, ,, III.	...	58·2	...	45·0	...	66·5	...	30·8	...	76·7	...	67·3
,, ,, ,, IV.	54·5	54·0	43·6	41·8	62·5	62·1	...	27·7	...	74·4	...	62·2
,, ,, ,, V.	...	51·1	...	39·5	...	58·3	...	25·7	...	71·1	...	58·5
,, ,, ,, VI.	54·5	48·7	44·4	37·5	62·0	54·8	...	24·4	...	66·8	...	55·7
,, ,, ,, VII.	...	46·9	...	35·8	...	51·8	...	23·6	...	...	...	53·5
,, ,, ,, VIII.	47·9	45·7	38·1	34·0	55·5	50·0	...	23·1	...	...	...	52·0
,, ,, ,, IX.	...	...	...	...	...	...	...	22·9	...	...	...	...
Thermometer rise arm. copper	44·0	...	17·0	...	26·5	...	36·0	...	47·5	...	57·5	...

All temperatures listed are temperature rises above inlet air.

from the back of the core by taking a proportionate number of watts from the rear section and arbitrarily adding them to the losses in the first section.

In figuring the heat flow through the package the following constants are used for heat conductivity through the different materials: Lengthwise in iron laminations 1·1 watts per cubic inch per °C.; crosswise in iron laminations 0·045 watts per cubic inch per °C.; insulation,* 0·0025 to 0·005 watts per cubic inch per °C.; copper, 8 watts per cubic inch per °C.

The heat conductivity of the insualtion not only depends on the materials used but depends greatly on the compactness of the coil.

As the first step in the calculation of heat flow, the temperature rise of the copper above the inlet air is assumed. The heat generated in the armature conductors included in the central package must be transferred to the air duct, to the coil ends, or to the armature iron. The temperature drop through the insulation for a given watt flow per 1 in. length of coil is expressed by

$$T=\frac{\text{single wall thickness of insulation}\times\text{watts conducted}}{\text{mean periphery of coil insulation}\times\text{conductivity of insulation}} \quad (2)$$

Using these equations, the loss transferred from the copper to the air at the air duct may be determined by trial. The temperature difference between the copper and the iron to permit the transfer to the iron of the remaining loss is calculated from (2). This energy is divided equally among the three sections of the tooth.

In determining the temperature difference between the copper and tooth it must be considered that the temperature of the iron of a unit package varies along its length. In any unit package the heat that is radiated to the air duct must be conducted across the laminations. To permit this flow there must be a temperature difference between the laminations at the centre of the unit package and at the air duct. The centre of the unit package (Fig. 2) is the neutral plane of heat flow and consequently the hottest part of that package. The heat flow from the copper to the iron is then variable. This flow varies along the length of the unit package, being small, if any at the centre and increasing from point to point to the air duct. The temperature rise of the laminations in the unit package is assumed to be a straight line. From this assumption it develops that the temperature difference previously calculated between the copper and iron is the temperature difference between the copper and the laminations midway between the neutral plane and the air duct. The heat dissipated to the air duct from section I. is calculated by trial from (1) and from

$$T=\frac{W}{0\cdot045}\times\frac{L}{8},$$

where T = temperature difference between the plane of average temperature and the air duct iron; W = watts flow per square inch from section I. to air duct; and L = unit package length.

This last calculation also determines the temperature of the neutral plane. In figuring the air-duct dissipating surface, one-half the surface of the air-duct spacers is considered as effective radiating surface in addition to the surface of the laminations at the air-duct. From the temperature of the neutral plane and equation (1) the heat flow from section I. to the air-gap can be calculated.

The difference between the total watts in section I. and the watts dissipated to the air-ducts and gap must flow to section II. It often occurs that more than the total watts are dissipated from section I. to the cooling air in which case there is a flow from section II. to make up the deficiency. This heat flow from section I. to II. or *vice versa* causes a temperature difference from which the maximum temperature of section II. is determined. The total watts in section II. consist of the watts from section I., the watts from the armature copper and its own loss. The same procedure is followed as in section I., except that all of the loss dissipated to the cooling air must be by means of the air-ducts alone.

This procedure is followed from section to section until the calculation for the last section is completed when, if the correct copper temperature has been assumed, all of the loss will have been dissipated. If there is any energy loss remaining that has not been dissipated, a higher copper temperature should be assumed; if there is not enough loss to satisfy the condition, a lower temperature should be assumed and the calculation repeated.

The effect of various generator proportions and characteristics upon internal and surface temperatures and on their relative values will be discussed in detail in the following paragraphs.

Table I. gives the calculated and test temperatures for four generators of similar design except for frequency and core length. In Tests 1, 2 and 3 the temperature measurements were made by thermo-couple at several points of the unit package for three conditions of load. In Tests 4, 5 and 6 only the internal copper temperature and the surface temperatures were measured. The close agreement of the calculated and tested temperatures in these last three tests justifies the use of the calculated temperatures for the intermediate parts of the unit package in discussing the effect of different factors on the internal temperatures.

* "Heat Path in Electrical Machinery," Harold D. Symonds and Miles Walker, "Journal" I.E.E., Vol. XLVIII., 1912.

Digitized by Google

Effect of Frequency.—The difference in the internal temperature rises experienced in generators of different frequencies is caused mainly by the difference in the core loss. In the 50-cycle generator the losses are considerably greater than in the 25-cycle generator, even though the core densities in the 50-cycle generator are slightly smaller. The temperature difference in the two machines due to the increased iron loss caused by the higher frequency is accounted for very nearly by the temperature rises in section I. of the tooth. These rises are 70·8°C. for the 50-cycle generator and 33·1°C. for the 25-cycle generator, as compared with the corresponding measured copper temperatures of 93°C. and 36°C. It is noted that the difference between the armature-tooth temperature rises for the two generators is somewhat smaller than the difference of the thermo-couple temperature rises; this being due to a greater temperature drop through the armature insulation in the 50-cycle generator caused by a greater flow of heat from the copper to the iron.

If the 50-cycle generator, Test 6, were operated at 60 cycles with the same armature densities, the additional losses caused by the higher frequency would increase the temperature rise measured by thermo-couple to a still greater value than 93°C. Thus, in comparing the two generators, Tests 4 and 6, on the basis of the extreme commercial frequencies of 25 and 60 cycles, the differences in internal temperature would be even greater than on 25 and 50-cycle basis.

From the test results it is evident that in large 25-cycle water-wheel generators the internal temperature will be approximately the same as the copper thermometer temperature and will always be relatively low. This is confirmed by several tests on 25-cycle generators.

For 50- or 60-cycle maximum rated generators there is always a large difference between thermometer and thermo-couple readings. The thermometer readings in many cases are not appreciably greater than for 25 cycles, but the thermo-couple readings show a large difference over those for the lower frequency.

Effect of Core Length.—A change in core length changes the volume of armature material to be ventilated and to a lesser extent it changes the proportion of heat transmitted to coil ends. The change of armature material to be ventilated with a change of core length is the more important. In the case where a given generator is increased in core length and it is required that the temperature rise be kept constant, it is often possible to change the ventilating fans to increase the air pressure, which results in an increase in air volume. This increase is usually not commensurate with the increase in armature loss, so that this loss must be reduced by using more material. This makes it evident that there is a definite core length in radially ventilated generators for each number of poles and each rotor diameter that it is inefficient to exceed.

The capacity of the end coils to dissipate heat varies with the temperature difference between copper and air, the air velocity and with the quality and thickness of the insulation. With the heat dissipating capacity of the coil ends constant, it follows that with an increase in core length the heat flow decreases from the centre of the embedded armature coil to the coil ends. For long-core generators, *i.e.*, generators with a core length greater than 30 in., it has been found by checking a number of tests, with a normal winding practically no heat flows from the centre of the coil to the coil ends. On the other hand, in short-core generators an appreciable part of the "buried" copper loss will be dissipated from the coil ends.

*Effect of Thickness, Compactness and Quality of Insulation.** — In long-core alternating-current generators the flow of heat from the armature copper to the cooling air is through the insulation to the laminations, so the temperature drop through that insulation is an important factor in determining the internal copper temperature. This temperature drop varies inversely as the heat conductivity, which in turn depends on the compactness and quality of insulation. The numerical value of the heat conductivity of armature insulation varies over a broad range, being different even in samples made up of the same insulating materials; this difference being due to the effect of air pockets in the insulation. Tests made by Symonds and Walker illustrate the great effect of air pockets on the value of heat conductivity of insulation. In these tests the heat conductivity of insulation composed of empire cloth and mica wound tightly was almost double that of the same material wound loosely. These tests, checked by the calculations, indicate that the heat conductivity of the insulation varies within the approximate limits of 0·0025 to 0·005 watts per cubic inch per °C. The lower value is for hand wrapped un-impregnated insulation and the higher value for compact machine-wrapped insulation. The temperature drop through armature insulation also varies with the thickness of the insulation.

In the generators under discussion the armature insulation for the one in Tests 1, 2 and 3 consists of mica and fibrous material; the entire coil being hand-wrapped and thoroughly impregnated to eliminate as completely as possible minute air spaces.

For the generator in Test 5, the armature coil is made up of stranded conductors insulated from each other with asbestos and mica, the whole then insulated with a wrapper of thin paper covered with splittings of mica. This wrapper is applied while heated and under tension, so that when completed the coil is a relatively solid mass with a high percentage of mica.

Effect of Current Density.—The current density largely determines the heat loss that must be transmitted through the insulation. Neglecting the eddy current loss, the drop through the insulation is very nearly proportional to the square of the current density. A low current density reduces the drop not only by reducing the loss but also by increasing the area of the heat path, since a larger slot is required for the increased copper section. With a given limiting temperature drop through the insulation, the use of machine-wrapped mica insulation justifies the use of higher armature copper densities. The test temperatures in Tests 1 and 2 clearly illustrate the effect of the armature current density on the temperature drop through the insulation in the same generator.

Effect of Tooth and Core Densities.—The tooth and core densities have a similar effect on the internal temperature as the generator frequency, since both affect the copper temperature through the core loss.

Tests 2 and 3 bring out very clearly the effect of increasing the saturation of the armature iron, other conditions remaining the same. The conditions for Test 4 were the same as for Test 3 with the exception that the armature voltage was increased 20 per cent., which proportionately increased the tooth and core densities. The result of this increase was to raise the internal copper temperatures from 39·4°C. to 59°C., even though the copper loss remained the same. Both tests and calculations show that a variation of the iron density alone produces a change in the internal temperature of the copper almost proportional to the change in iron loss.

Effect of the End Windings on Internal Temperatures.—It has been previously pointed out that the end coils usually have the capacity to dissipate heat from the embedded part of the armature coil. The test temperatures in Tests 1, 2 and 3 show roughly the effect of this flow under different conditions of load for the same generator.

The calculation of the heat-flows from the central unit package to the end windings in these tests not only confirms the test results but gives more exactly the actual conditions of that heat-flow. In Test 1, 10 per cent. of the buried copper loss of the central unit package was conducted to the end coils. In Test 2 all of that loss was conducted to the end coils besides which 0·4 watts iron loss was conducted from the central unit package through the insulation to the end coils. In Test 3, all of the buried copper loss was again conducted to the end coils, and the iron loss conducted from the central unit package was increased to 1·4 watt. This is equivalent to approximately 25 per cent. of the buried copper loss in the central unit package.

The increase of end-winding temperature of 19·6°C. in Test 3 over Test 2 shows that in fairly long-core machines it requires the cumulative effect of but a very small watt flow from each unit package to raise the temperature of the end windings a large amount. With long-core high-current-density machines with a large temperature difference between the centre of the machine and the cooling air at the end coils, a very small percentage watt flow per inch length of coil will satisfy that difference and this flow may be neglected when analysing the heat flow of the central unit package.

Relation of Internal to Surface Temperatures.—It has been shown above that the maximum tooth temperature of a generator is very closely related to the internal copper temperature. An inspection of the detailed test temperatures will show that the core surface temperature measured by thermometer varies almost in proportion to the tooth temperature.

The variations incurred in measuring the end coil temperatures make the relation between the internal copper temperature and the end coil temperature less direct than in the case of the iron temperatures. Nevertheless, an inspection of Tests 1, 2 and 3 shows that a change in the internal copper temperature results in a corresponding change in the end coil temperature as measured by thermometer.

Conclusion.—The results of the tests show that there is a wide divergence between internal and surface temperatures in alternating-current generator stators. The results of the tests show clearly there is no one value that applies to the temperature difference between surface and internal temperatures for all classes of alternating-current generators. Furthermore, it is evident from the tests that surface temperatures measured by thermometer give no indication of the maximum temperature to which the insulation is subjected, unless all the controlling factors are given due consideration.

* "Rational Temperature Guarantees for Large Alternating-current Generators," F. D. Newbury, "Proceedings," A.I.E.E., Nov., 1916.

Digitized by Google

THE CHOICE OF VOLTAGE FOR RAILWAY ELECTRIFICATION ON THE DIRECT-CURRENT SYSTEM.

BY F. LYDALL.

(*Continued from p. 226.*)

Summary.—The author considers first the conditions which apply to the problems of main line electrification in this country, and assuming that the high voltage direct-current system is adopted, gives reason for supposing that the voltage selected for a general electrification scheme would not be especially high. The number of different classes of locomotive is discussed, and designs for each class are worked out on the basis of four different line voltages—viz., 1,500, 2,000, 3,000 and 4,000. Details relating to these designs are given, and it is shown that even for the highest voltage considered there are no technical difficulties in the construction of suitable locomotives of all classes. Finally, a rough estimate is given of the extent to which the cost of a locomotive of any of the classes proposed is affected by the voltage selected.

4. *Examination of Designs for Locomotives of Each Class.*—Before going into detailed calculations and comparisons of the equipments for each class of locomotive as affected by the line voltage, it will be interesting to make a few general remarks which apply to the high-voltage system as a whole.

The main feature which differentiates the direct-current motor from alternating-current generators and induction motors is the commutator. In alternators the limitation of voltage is almost entirely a matter of insulation, whereas in a high-voltage direct-current motor, although insulation of the electrical windings is a matter of great importance, it is the problem of commutation which has a predominating influence on the design. For any particular motor, then, these two matters need the first attention, the influence of each on the design being more marked the higher the voltage.

(*a*) *Commutation.*—Take the case of a four-pole motor, and for preliminary purposes suppose that the pitch of the commutator segments must be not less than 4 mm., and the average volts per segment not more than 17 volts. Then it is easy to construct a table showing the minimum number of segments and the minimum diameter of the commutator for different voltages, assuming that all motors have four poles.

Table I.

Voltage per motor	Minimum number of commutator segments.	Minimum diameter of commutator.	
		Millimetres.	Inches.
750	176	225	8·85
1,000	235	300	11·8
1,500	352	450	17·7
2,000	460	600	23·6

From this table it is clear at once that a high voltage lead[3] to a big motor whether the actual requirements of the case necessitate it or not. It would be a radical departure from ordinary practice to make the armature smaller in diameter than the commutator; therefore, if a motor is to be wound for 2,000 volts, for instance, the armature must be at least about 700 mm. in diameter. This may not be excessive for a motor of 350 H.P., but it is certainly not required for 150 H.P. apart from the limitations of the commutator. This point is discussed further below in connection with the equipments for the shunting locomotive.

(*b*) *Insulation.*—As the voltage is raised, it is self-evident that greater thickness of insulation is required in the armature slots, and longer insulating surfaces at the ends of the armature windings and of the commutator. The former tends to reduce the amount of copper in the armature conductors, and this has to be compensated for by increasing the armature diameter. For high voltages and large motors this diameter may have to be greater than the minimum figure determined by the number of segments in the commutator; and it is, therefore, important that the design for a high voltage should not be handicapped by making provision for a greater volume of insulation than is really necessary. The latter, *i.e.*, the insulating surfaces, reduce the useful length of active material in a motor which has to be mounted in a limited space such as is available between the flanges of a pair of wheels or between the side frames of a locomotive.

Of these two factors in the design, the latter is largely a matter of practical experience. If the insulating surfaces could be relied upon to keep clean, they might be comparatively short. But in practice this is not possible, especially at the outer end of the commutator. Failing actual experience bearing on this point, it is necessary to try and make a reasonable estimate of the various leakage surfaces sufficient for the different voltages under consideration, and in the calculations for the motors required for the locomotives specified above I have used the values shown in Table II.

Table II.

Voltage to earth	Voltage between brushes.	Length of insulating surface.		
		At outer end of commutator.	At end of core.	
			Long.	Short.
		Millimetres.	Millimetres.	Millimetres.
1,500	750	60	40	34
1,500	1,500	60	46	34
2,000	1,000	65	48	40
2,000	2,000	65	56	40
3,000	750	75	58	52
3,000	1,500	75	64	52
4,000	1,000	85	73	65
4,000	2,000	85	81	65

The thickness of the insulation between the armature windings and the core is also a matter of considerable uncertainty. In practice, of course, it must be determined by the specified test voltage, but this merely shifts the difficulty on to the specification. Standard rules have been laid down for the relation between working voltage and test pressure for electrical machinery, but it is very doubtful whether these rules were intended to apply to high voltage direct-current motors and generators. For example, the test pressure for a 3,000-volt alternator is (according to the rules of the B.E.A.M.A.) 6,000 volts alternating for one minute; that is to say, it is considered reasonable to suppose that the terminal voltage will not rise by reason of surging to more than twice the normal value. If we assume the same proportional increase on a direct-current line, the question arises, What test pressure should be applied to the motor windings to produce the same stress in the insulation as a momentary rise to twice the normal direct-current pressure? It seems reasonable to specify a test of an alternating voltage the root-mean-square value of which is twice the working voltage divided by $\sqrt{2}$. Thus, the test on all motors intended for a 3,000-volt system would be $6{,}000/\sqrt{2}$—*i.e.*, 4,300 alternating for one minute between all windings and body.

It must be admitted, however, that there is no experience available to confirm this argument, and I am convinced that most engineers would agree that under the circumstances and until more reliable data have been collected, it would be rash to cut the margin of safety so fine. Failing adherence to this line of reasoning, however, the specification as to test pressures must be quite arbitrary, and for the sake of fixing matters for the purpose of the present comparison I have worked out the various designs on the basis of the following pressures, in each case supposed to be an alternating voltage applied between all windings and body for one minute.

Table III.

Working voltage above earth.	Test pressure.
1,500	4,500
2,000	5,500
3,000	7,000
4,000	8,000

Digitized by Google

Having now considered general questions which affect the design of high-voltage motors, one may proceed to a more detailed examination of designs for the three classes of locomotives specified above.

SHUNTING LOCOMOTIVE MOTOR.

This is essentially a slow-speed motor. The armature dimensions naturally tend towards a small diameter and at considerable length of core. Even so, however, the core

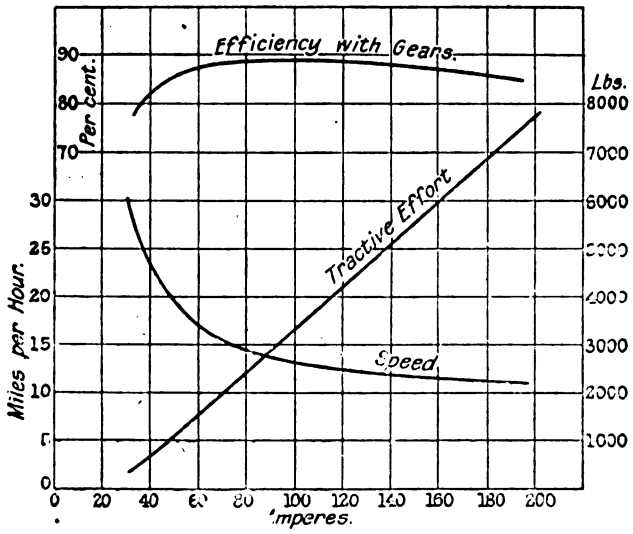


FIG. 1.—PERFORMANCE CURVES OF THE 150 H.P. 1,000-VOLT MOTORS.

cannot be made long enough to correspond to an average voltage of 16 or 17 per commutator segment, and therefore the commutator must be greater in diameter than the dimensions mentioned in Table I.

It is clear, therefore, that the design presents difficulties. The result of careful calculations goes to show that the 750-volt motor for use on a 1,500-volt system is the only one that can be

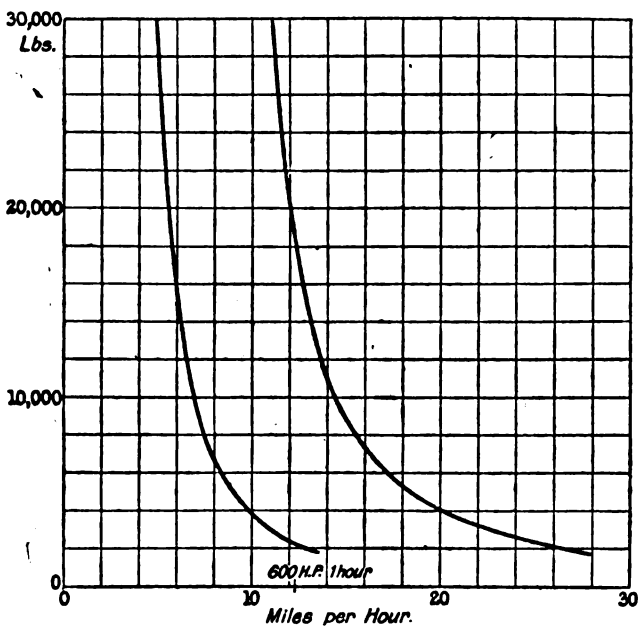


FIG 2.—SPEED TRACTIVE EFFORT CURVES OF SHUNTING LOCOMOTIVE WITH FOUR 1,000-VOLT 150 H.P. MOTORS.

worked out on standard lines in such a way as to fit the requirements without making the motor unnecessarily large. The 1,000-volt motor for a 2,000-volt circuit has a capacity about 10 per cent. greater than that suggested—*i.e.*, it would be rated at 150 H.P. to 155 H.P. instead of 140 H.P. The two motors for the higher voltages of 3,000 and 4,000 become impracticable if the same general design is adopted.

The question, therefore, arises what is to be done about the shunting locomotives if it is found desirable on general grounds to decide upon a distribution voltage of 3,000 or 4,000. There seem to be three alternatives: (1) To double the number of motors permanently in series by abandoning the usual series-parallel system of control and using four motors each designed for one quarter of the line voltage; (2) to double the number of armatures permanently in series, by using two armatures in each motor, as in the design worked out by Mr. Storer, and described and illustrated in his Paper before the Institution of Electrical Engineers; (3) to double the number of commutators in series by using motors standard in most respects, but having armatures each with two distinct windings and two separate commutators permanently in series.

The simplest and cheapest of these three alternatives is obviously the first, but as the duty of a shunting locomotive consists almost entirely in frequent starting and stopping, the equipment would be comparatively inefficient. Of the other two alternatives I incline towards the double-wound armature, as it involves little departure from a standard design, and the motor built on these lines is probably lighter and cheaper,

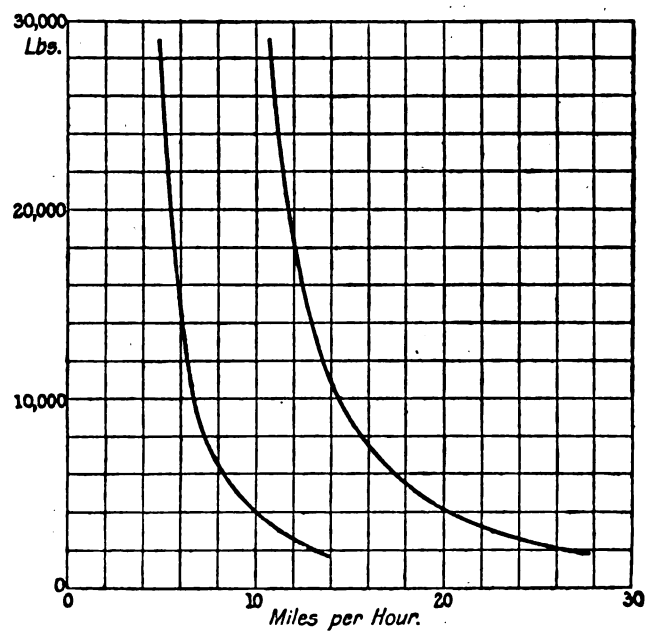


FIG. 3.—SPEED TRACTIVE EFFORT OF SHUNTING LOCOMOTIVE WITH FOUR 750-VOLT 140 H.P. MOTORS.

makes better use of the active material and enables the diameter of the driving wheel to be kept smaller for a given clearance above rail level than would be the case with the double-armature motor.

Opinions may differ on this, but the important point is to ascertain whether on either system it is practicable to design a motor for 1,500 or 2,000 volts for a line voltage of 3,000 or 4,000 volts respectively. I have, therefore, worked out two motors with double-wound armatures and two commutators for these voltages. Particulars are given in Table IV.:—

Table IV.—*Motors for Shunting Locomotive.*

Motor voltage	750	1,000	1,500	2,000
Line voltage	1,500	2,000	3,000	4,000
Horse-power	140	150	140	140
Tractive effort, lbs.	4,270	4,570	4,370	4,370
Speed, miles per hour	12·3	12·3	12·0	12·0
Gear ratio	19 : 93	17 : 79	18 : 86	22 : 93
Wheel diameter	43 in.	45 in.	48 in.	52 in.
Clearance below motor	7·65 in.	7·12 in.	7·48 in.	7·5 in.
Clearance below gear case	6·4 in.	6·5 in.	6·7 in.	7·1 in.
Armature D^2L	100	120	117	160
Weight of motor with gears and gear case, lbs.	6,150	7,400	7,900	9,950
Weight of copper in motor, lb	900	1,100	1,080	1,250

Digitized by Google

Fig. 1 gives the performance curves of the 150 H.P. 1,000-volt motor for a line voltage of 2,000, Fig. 2 the corresponding speed and tractive effort curves of the locomotive equipped with four such motors, and Fig. 3 similar speed and tractive effort curves for a locomotive equipped with four 750-volt 140 H.P. motors for a line voltage of 1,500.

These curves may be taken as typical of all the shunting locomotive equipments, the performance curves being almost exactly the same, except for the somewhat larger output of the 1,000-volt motor.

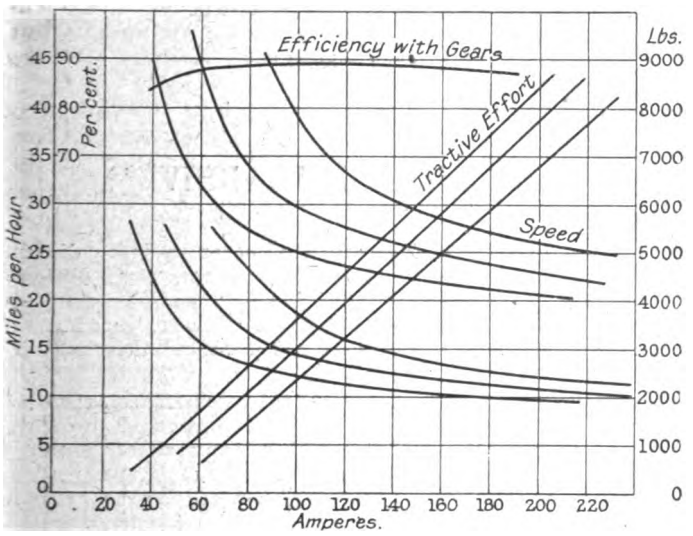


Fig. 4.—Performance Curves of the 2,000-volt 350 H.P. Motors.

All the motors are designed for forced ventilation, although in the first instance, at all events, this provision would not be utilised. It is best, however, when designing a locomotive motor to arrange it so that forced ventilation can be applied in case the duty for which it is originally intended is subsequently increased.

The proposal was to construct the locomotive with a total weight of 56 tons, but it is quite possible that for a line voltage of 4,000 this weight would be exceeded. In any case, however, the excess beyond the specified weight would not be sufficient to be of any importance.

Goods Locomotive Motor.

In this case the speed of the motor at either the continuous or the one-hour rating is higher in comparison with the maximum speed than is usual with railway motors. This implies a high armature peripheral speed, and, therefore, a short armature core in order to keep within safe limits the average and the maximum voltages between commutator segments. As the armature volume increases with increasing voltage, the core length must remain approximately the same and the diameter must be increased to obtain additional room for the extra insulation

On working out the various designs for the different voltages already selected, I find no serious difficulty in keeping to standard lines of construction even up to the highest voltage—viz., 2,000 volts per motor, the line voltage being 4,000. A single commutator is in all cases sufficient, and the armature windings and field coils follow standard practice.

Six designs have been worked out and a number of particulars relating to each are given in Table V. Two of these are for a line voltage of 1,500—viz., 750 volts or 1,500 volts per motor; two are for a line voltage of 2,000—viz., 1,000 or 2,000 volts per motor; one for a line voltage of 3,000, with 1,500 volts per motor; and one for a line voltage of 4,000, with 2,000 per motor. In all cases the peripheral velocity at 45 miles per hour and the capacity on the continuous rating are practically the same for the different designs. The motors are constructed for forced ventilation; they are arranged for twin gearing, and the armature bearings are ring lubricated. The main field coils are designed specially to permit of 50 per cent. reduction of field excitation for speed regulation. This together with the ordinary series parallel control provides for a wide range of economical running.

Looking somewhat forward and anticipating the consideration of the express locomotive, it will be remarked that the specified output for the goods locomotive is nearly half that of the passenger engine. By designing the motor for the former slightly larger than is required by the specification, I find it is quite possible to make use of absolutely the same electrical design for both locomotives, employing eight motors for a complete passenger engine and altering the gear ratio and wheel diameter as may be necessary. This means that the greater portion of the motor is identical for the two equipments—*e.g.*, the complete armature, except the shaft which can be pressed in or out, all the field coils, poles, brush gear and connections. I have, therefore, designed the freight locomotive motors to give a tractive effort of 11,600 lb. per equipment at 35 miles per hour, and the same motors with different gearing and driving wheels to give a tractive effort of 10,000 lb. per equipment at 75 miles per hour for the passenger locomotive.

Performance curves of the 2,000-volt motor insulated for 4,000 volts are given in Fig. 4, the gear ratio being 27 to 102, and the diameter of the driving wheel 56 in. The one hour rating of the motor would be about 350 H.P.

The speed-tractive effort curves of the locomotive are given in Fig. 5, which also shows the curve of (assumed) tractive resistance for a 1,072-ton train on the level. The points at which this curve intersects the curves of tractive effort give the steady speeds at which the train of 1,000 tons and locomotive can be driven on the level without rheostatic losses. Taking

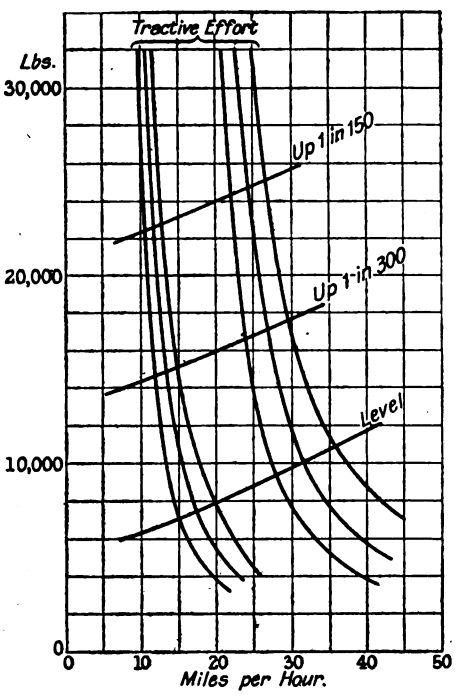


Fig. 5.—Speed Tractive Effort Curves of Goods Locomotive with Four 2,000-volt 350 H.P. Motors.

two degrees only of field reduction, these speeds are 15, 17½, 20, 28, 31½, 36 miles per hour.

Similar curves representing the combined effect of tractive resistance and gravity on gradients of 1 in 300 and 1 in 150 are also shown. From these it will be seen that the maximum speed up the 1 in 300 is 29½ miles per hour, and up the 1 in 150 26½ miles per hour. On the same gradients the minimum economical running speeds are 12 and 11 miles per hour respectively

Digitized by Google

These performance curves may be taken as typical for all the motors for the goods locomotives, except for those cases in which the motor is designed for the full line voltage. In the two cases—viz., for line voltages of 1,500 and for 2,000—four motors can be connected in three groupings (series, series parallel and parallel). This provides a still wider range of speed without rheostatic losses. For example, with the 1,072-ton train already assumed as the basis of the calculations, the economical speeds on the level would be 7·7, 9, 10·7, 15, 17·5, 20, 28, 31·5, 36 miles per hour. Whether the advantage of having these extra low speeds available is worth while, bearing in mind the additional switchgear necessary for the three groupings, is open to question. In any case, it is only practicable with a four-motor equipment when the motors are wound for the full-line voltage.

Table V.

Particulars of Goods Locomotive Motors.

Line voltage	1,500	1,500	2,000	2,000	3,000	4,000
Motor voltage	750	1,500	1,000	2,000	1,500	2,000
Gear ratio	20/89	23/94	23/94	25/99	25/99	27/102
Clearance below motor	7·75″	7·15″	7·15″	7·2″	7·2″	7·55″
Clearance below gear case	6·9″	6·9″	6·9″	6·9″	6·9″	7·4″
Wheel diameter	50″	52″	52″	54″	54″	56″
Armature D^2L	100	128	128	143	143	164
Weight of motor with gears and gear cases, lb	8,200	9,500	9,650	10,300	10,400	11,150
Weight of copper in motor, lb.	1,590	1,540	1,620	1,550	1,610	1,580
Bogie wheel base	9′ 0″	9′ 6″	9′ 6″	10′ 0″	10′ 0″	10′ 4″

One-hour rating of all motors, 350 H.P.; 5,140 lb. tractive effort at 25·6 miles per hour.

(*To be concluded.*)

SPEED CONTROL OF INDUCTION MOTORS FOR STEEL MILL DRIVE*

BY J. D. WRIGHT.

It is the object of this article to describe a modification of the Scherbius system as applied to induction motors for steel mill main roll drives which permits the operation of the roll motor at speeds above and below synchronism.

Main Motor.—The main roll motor is, of course, the usual type of three-phase machine with phase-wound rotor. If the load remains constant (normal conditions being assumed), and the speed is reduced by the well-known method of inserting resistance in the secondary circuit, then the voltage and frequency are practically proportional to the slip in per cent. of synchronous speed. If, instead of the external resistance, a constant voltage at rotor frequency is used to oppose the secondary voltage, the speed of the rotor will adjust itself to such a value that the secondary voltage exceeds the opposing voltage by an amount equal to that necessary to send through the impedance of the circuits sufficient current to develop the required torque. If the opposing voltage is adjustable, the speed of the main motor may be changed simply by varying the opposing voltage. It is the function of the regulating set to provide a source of adjustable voltage which may be impressed on the secondary windings of the main motor.

Regulating Set.—This consists of an induction generator, regulating motor and exciter. The induction generator is an ordinary squirrel-cage machine, which may operate either below or above synchronism. When the speed is less than synchronism the machine acts as a motor, taking power from the line. When the rotor is driven above synchronism the machine acts as an induction generator, and delivers power to the line. The regulating motor is a polyphase commutator motor with an armature similar to that of an ordinary direct-current machine. Its stator is usually wound with three distinct windings—viz., a compensating field winding, an interpole field winding and a main exciting field winding. The exciter is similar to the regulating motor, but is somewhat simplified because of its smaller size and lighter service.

Ohmic Drop Exciter.—In addition to the regulating set, there is required a small auxiliary exciter, which has been called an ohmic drop exciter. The armature is mounted on the shaft of the main motor, so that its speed is always the same as that of the main motor. This exciter has the property of giving a constant voltage with a varying frequency, the frequency always being exactly the same as that of the secondary circuit of the main motor. This necessitates that the machine be wound with the same number of poles as the main motor. The machine consists of an armature like that of a rotary converter, the field punchings which surround the armature being without slots or windings.

As shown in the diagram of connections, Fig. 1, the slip rings are connected through a transformer to the main power lines. If voltage is applied to the slip rings with the armature at rest, the alternating currents in the various coils produce a magnetic field, as in an ordinary induction motor. If the armature of the main motor be rotated at synchronous speed, and if the phase rotation of the ohmic drop exciter be such that the direction of rotation of its magnetic field is opposite to the mechanical rotation, the magnetic field would no longer rotate, but would stand still in space. The armature conductors revolving at synchronous speed would thus cut this stationary flux, and a voltage would be generated which would

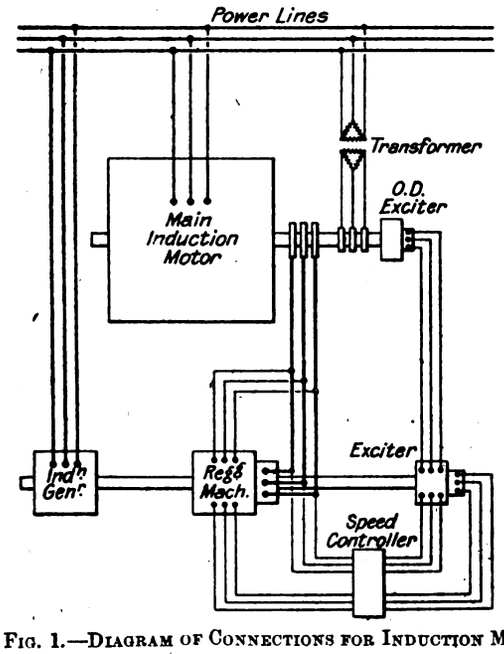


FIG. 1.—DIAGRAM OF CONNECTIONS FOR INDUCTION MOTOR WITH DOUBLE RANGE SPEED REGULATING EQUIPMENT.

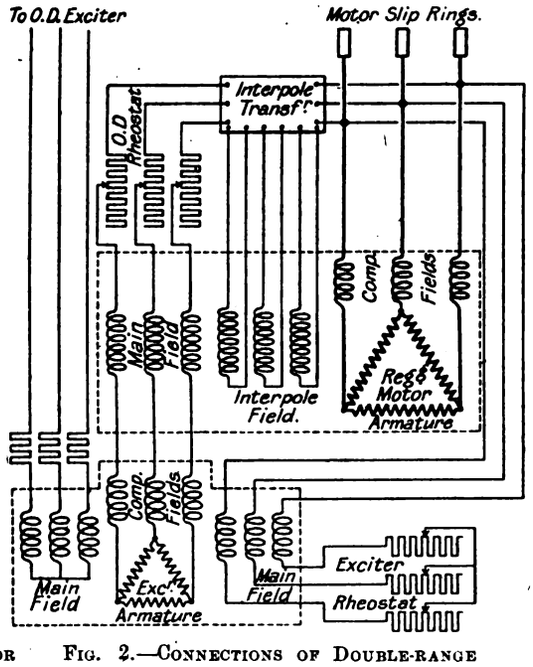


FIG. 2.—CONNECTIONS OF DOUBLE-RANGE SPEED-REGULATING EQUIPMENT.

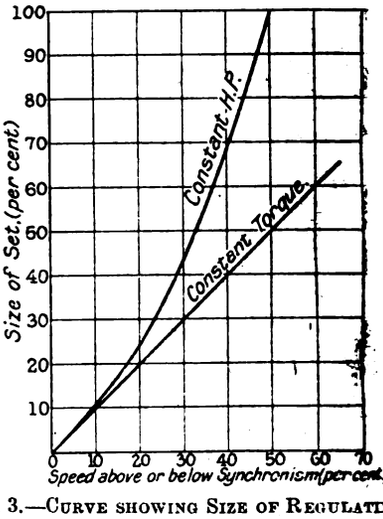


FIG. 3.—CURVE SHOWING SIZE OF REGULATING SET IN PER CENT. OF CAPACITY OF MAIN MOTOR.

* Abstract of an article in the "General Electric Review."

Digitized by Google

deliver direct current from the brushes on the commutator, just as in a direct-current generator. At one-half synchronous speed, for example, the magnetic field would be rotating at half speed and the armature at half speed, with the result that the armature conductors would still cut the flux at the same rate, and the voltage generated would, therefore, be the same as at synchronous speed and at standstill. The frequency would be exactly the same as the frequency of the secondary of the main motor, since, as stated above, the magnetic field of the ohmic drop exciter is rotating in space at one-half of its synchronous speed. At any other speed the voltage generated is constant, and the machine delivers from its brushes alternating current at a frequency equal to the slip frequency of the main motor.

If the armature is driven above synchronism the magnetic field will, of course, rotate in an opposite direction, and the machine will deliver from the brushes alternating-current having a phase rotation reversed from that when operating below synchronism.

The use of this form of exciter has made possible the development of a method of operation of the main motor that retains all the desirable characteristics of the normal induction motor operating with short-circuited slip rings, not only at speeds considerably below synchronism, but equally well at speeds near synchronism, in synchronism or above synchronism.

Operation of the System.—In the regulating motor the exciting winding is a shunt winding connected directly across the main induction motor slip rings. The shunt field, therefore, has practically a fixed flux regardless of variation in load on the main motor; for as the speed of the main motor varies, due to a changing load, the secondary voltage and frequency also vary proportionally, and therefore the flux remains constant.

The exciter armature is connected in series with the exciting winding of the regulating motor, so that it can boost the slip-ring voltage and leave any desired percentage to be applied to the field

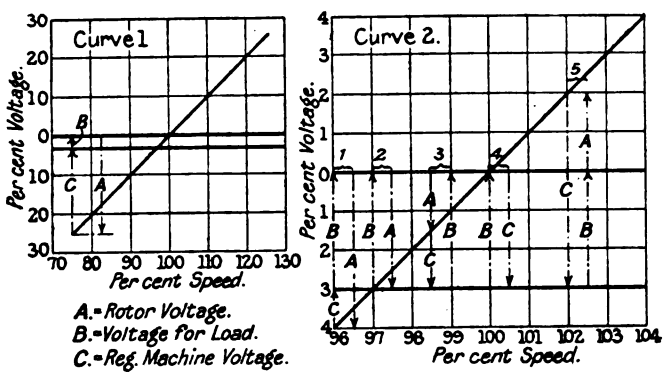


FIG. 4.—CURVES OF SPEED AND SECONDARY VOLTAGE THROUGH SYNCHRONISM RESOLVED INTO THEIR COMPONENT VOLTAGES.

of the regulating motor. It must, therefore, have the property of generating a voltage always proportional to the slip-ring voltage, instead of a constant voltage, like the regulating motor. Since it is an unsaturated shunt machine, its voltage is proportional to its field current. One of the fields is excited from the main motor slip rings over a resistance that is large compared to the reactance of the circuit, so that the field current is practically proportional to the slip-ring voltage.

Thus, since for any particular adjustment of the field resistance of the exciter the exciter terminal voltage is proportional to the slip-ring voltage, the difference between the two is, of course, proportional to the slip-ring voltage, and is therefore of the right nature to apply to the field of the regulating motor to produce constant flux. A change in the exciter field resistance makes the exciter consume a different proportion of the slip-ring voltage, thus altering the regulating motor field and voltage, and as a consequence the speed of the main motor.

Reference to Fig. 2 will show that the exciter has, in addition to the field excited from the slip rings, another field which is excited from the brushes of the ohmic drop exciter.

To illustrate the actions of the different machines, let it be assumed that the main motor is running below synchronism, and that it is desired that the speed be raised above synchronism. Fig. 4 may help to illustrate the various points. Curve 1 shows the variations of speed and secondary voltage. It is assumed that the load is such that a voltage represented by *B* is necessary to send through the impedance of the secondary circuits sufficient current to enable the motor to develop the required torque. At any speed below synchronism the slip-ring or rotor voltage *A* must be greater than *C*, which is the opposing voltage, by an amount equal to *B*. Thus *A*, in addition to overcoming the opposing voltage *C*, also supplies the voltage *B*.

Curve 2 is an enlarged view of the same quantities close to synchronism. Condition 1, curve 2, has been reached by decreasing the voltage of the regulating motor. This regulation toward synchronism was accomplished by increasing the resistance in the ohmic drop rheostat and decreasing the resistance in the exciter field rheostat. Condition 2, curve 2, Fig. 4, is where the regulating set offers no opposing voltage and the voltage *A* is equal to *B*. At this point the conditions are practically the same as when operating the main motor with the slip rings short-circuited. The circuits to the main fields of the regulating motor are completely opened, so that no voltage is generated.

Up to this point it is evident that, since the rotor voltage exceeds the voltage of the regulating set, the regulating machine has been acting as a motor, and the induction generator, being driven above synchronism, has been delivering power to the line. It should be noted that the regulating motor has the characteristics of a shunt-wound direct-current motor; that is, its speed with a given field is proportional to the voltage applied to the armature. When operating the main motor below synchronism it is evident that the induction generator must be driven above synchronism in order that the power delivered to the regulating motor may be absorbed. It is also evident that if the regulating motor were connected to the main motor slip rings without the induction generator the speed of the main motor would continually decrease, and the speed of the regulating motor increase; because, since there would be no torque to resist the torque of the regulating motor, the latter would speed up. Its voltage, opposing the rotor voltage, would therefore increase, with the result that the secondary voltage of the main motor would no longer be sufficient to send through the impedance of the circuits sufficient current to enable the motor to develop the torque required by the load, and the main motor speed would decrease. The rotor voltage would then become higher, causing the speed of the regulating motor to still further increase. This action would tend to continue as long as the rotor voltage could continue to increase.

Referring further to curve 2 it is seen that, in order to regulate toward synchronism from condition 2, it is necessary that the voltage of the regulating machine be reversed. To arrive at condition 3, the regulating machine must act as a generator and assist the rotor voltage *A* by a voltage equal to *C* to supply *B*. At exact synchronism, condition 4, the rotor voltage is zero and the voltage of the regulating machine must be large enough to send through the secondary circuits sufficient current to enable the motor to develop the torque required by the load. If voltage *C* is still further increased the main motor torque increases above that required by the load, with the result that the rotor speed must increase. The rotor voltage, therefore, begins to develop in the reversed direction, so that at condition 5 the voltage *C* of the regulating machine must be equal to *A* plus *B*.

Size of Regulating Set.—The size of the regulating equipment is determined by the amount of speed adjustment required above and below synchronism. The secondary energy from the main motor is equal to the following: $\frac{\text{Slip}}{1-\text{slip}} \times$ shaft horse power. Fig. 3 shows the size of the regulating equipment for any speed adjustment above or below synchronism where the main motor is called upon to deliver either constant torque or constant horse-power.

Efficiency and Power Factor.—Typical overall efficiency and power-factor curves for an induction motor with regulating equipment are given in the original article, together with a diagrammatic arrangement of connections with approximate distribution of losses and calculations of overall efficiency for various assumed conditions.

Control.—Magnetic control is usually provided for induction motors with speed regulating sets, and is especially desirable on account of the ease with which the proper interlocking of the various circuits may be accomplished.

A contactor is provided for opening the armature of the regulating motor and another for opening its field circuit when the main motor is being started from rest. Provision is made for closing these contactors after the motor has been accelerated and all the starting resistance cut out of the secondary circuit.

Advantages of Double Range Regulation.—Double range speed regulating equipments (that is, those that permit operation of the main motor above and below synchronism) evidently possess several important advantages from an operating point of view. The following may be noted:—

Flexibility; low maintenance charges; increased output of the rolling mill; large number of running points; improved power factor; no synchronous machines are used.

Digitized by Google

The Electrician.

FRIDAY, MAY 18th, 1917.

Editorial and Publishing Offices:—

8, BOUVERIE STREET, LONDON, E.C. 4.

Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

WORKS ORGANISATION.

Some six months ago a comprehensive Paper was read before the North East Coast Institution of Engineers and Shipbuilders on the subject of "Works Organisation." It consisted of three parts dealing respectively with manufacturing, costing and selling, and these were each contributed by a different author. We gave an abstract of these Papers at some length in THE ELECTRICIAN at the time when they were read, but they have now been issued in the form of a pamphlet, together with the discussion. Of this pamphlet the Papers occupy 48 pages and the discussion 124 pages, thus forming a valuable contribution to an important subject.

Considering that a great deal of the competition with which our manufacturers are concerned comes from the Continent, it is well to realise what methods are there adopted. Most engineers on visiting Continental factories have been struck with the cleanliness and the order which is generally observable, in regard to which our factories, as often as not, are sadly deficient, though we believe there has been considerable improvement in this respect in recent years. Mr. D. B. MORISON, a Vice-President of the Institution, emphasised, in his contribution to the discussion, the importance of Continental industrial methods, and stated that after every visit to the Continent he had returned "hopelessly pessimistic because of our sluggish reluctance to see what was going on under our very eyes. . . . .When every other country had found the advantage—indeed, the necessity—of co-operation in research, standardisation of product and community of commercial interests, not a few manufacturers in our district had as a goal the ruin of each other by industrial competition." We fear there is much truth in such criticism, but let us hope that this state of mind is rapidly passing away under the present stress of circumstances.

As to the methods to be adopted, no doubt a good deal depends on whether the works is large or small. The larger the works the more complicated the system that may be adopted to advantage. We notice an interesting description by Mr. A. G. SEAMAN of the Hollerith system, as employed by the British Westinghouse Company, for analysing the results of sales. It appears that this system was employed in analysing the last census in this country. It operates by mechanically sorting out and adding up the figures required from the original data. These data are entered up on special cards, the entries on each being made by punching the card; thus the position of each hole punched on any card gives certain definite information. Two machines are employed—a sorting machine and an adding machine. When it is desired to pick out the items in a series of cards, the needle of the sorting machine is set to the particular column, and the cards are then sorted mechanically according to the hole punched in that column into separate packs. The machine sorts cards at the rate of about 250 a minute; the cards so sorted are then passed through the adding machine, and as this performs the addition of about 150 cards per minute, the total is found in quite a short time. Of course such a system would be quite out of place in a small works, but it affords an interesting means of arriving at totals which would involve a great deal of labour in large works, except by some form of mechanical handling.

We notice that in the discussion Mr. GERALD STONEY raised the point of the internal organisation of the shops and the desirability of help in this direction on the part of labour. We agree with his view that there is much to be said in favour of a board of shop management on which labour would have two or three representatives. Such a board would be entirely distinct from a board of directors, on which it would be difficult for labour to play a part, because labour bears no part of the risk and cannot very well do so; but the question of shop management is a very different matter. Such management concerns labour essentially, and the proposed step would probably make things run more smoothly in engineering works. The workmen would see more of the difficulties under which employers are working.

We think Mr. STONEY is also right in his view that the drawing office is frequently a department that is starved. It is undoubtedly a department in which the young engineer prefers not to remain, as he feels it is something in the nature of a blind alley, in which the salaries are low; yet a department which is mainly responsible for designs should be run on truly efficient lines, for such a department is capable of wasting or saving an enormous amount of money in the shops, according to whether work is carried through efficiently, with a view to low shop costs, or the reverse. The cutting down of costs in the drawing office may, therefore, be a very short-sighted economy. It is impossible, however, for perfect designs to be produced unless the draughtsman is thoroughly acquainted with the processes of the shops, and there is much to be said in favour of the view that the draughtsman should, if possible, follow the progress of the work which he has designed through the shops to the state of completion. By so doing he should benefit considerably, and future designs may be correspondingly improved.

A considerable part of the discussion turned upon the accurate determination of costs. Although the cost of labour and material may often be determined with very fair accuracy, there is generally much greater difficulty when it comes to the question of allocating the overhead charges. In the case of large works where there are a number of different departments there is not much difficulty in this allocation, as between various departments, but it is by no means so easy if a number of lines of manufacture are being followed, either by a single department or by a works as a whole. Some people favour this allocation in proportion to the amount of labour alone involved in each class of manufacture, and some prefer to take both labour and materials as a basis. It cannot be said that either course is a very scientific method, though frequently the results so obtained may be sufficiently accurate. Very much depends upon the nature of the work that is carried on. In many cases, however, it would seem preferable to analyse the items forming overhead charges more closely in order to arrive at a proper figure.

There are many topics in this interesting subject on which we cannot touch, but which merit a great deal of thought. In many respects we feel that the contributions to the discussion on these Papers are as important as the Papers themselves, more particularly since each Paper is limited to one kind of works, whereas the discussion is on a broader basis. We think the Council of the North East Coast Institution is to be congratulated upon having Papers of such a commercial character at the present time, and we commend the perusal of this pamphlet to the many manufacturers in this country who wish to make the most of their present opportunities with a view to solid progress in the future.

Digitized by Google

REVIEWS.

Hydro-Electric Power. By LAMAR LYNDON. Vol. I., Hydraulic Development and Equipment, pp. vii.+499, 21s. net. Vol. II., Electrical Equipment and Transmission, pp. vii.+360, 15s. net. (London: Hill Publishing Co.)

This excellent work treats in a concise and comprehensive manner with the whole range of hydro-electric power engineering, from the preliminary survey of the watershed to the transmission lines and sub-stations of the electrical system. It is published in two conveniently sized volumes—the first dealing with the hydraulic side, and the second with the electrical side. The author states that there is no definite point of division between the two volumes, and that, originally written as one volume, it was divided solely to make it less cumbersome and more convenient for reference. The division, however, is very clear and convenient, but while Vol. II. is intended to be a continuation of Vol. I., the greater portion would obviously apply equally to long-distance power transmission from steam as well as from water-power stations.

Nearly all the illustrations and descriptions which deal with actual plants or construction work refer to American practice, but they have evidently been carefully selected to show typical cases, and to serve merely as examples of the application of the principles which should govern good design under varying conditions. These principles are dealt with in great detail throughout, particularly in Vol. I., and the work is very far from being merely tedious descriptions of hydro-electric plant and apparatus.

In Chapter I., Vol. I., the author deals with the general conditions relating to the use of water power, the factors to be considered and the points to be investigated in the development of any water-power scheme. There is one statement, however, which is rather misleading as it stands, and should be amplified or modified to express the facts correctly.

The author says (page 1): "The height of fall is the difference in elevation between the surface of the water at its upper position and the surface at its lower position, measured vertically. No matter what path the water follows in passing from the upper to the lower level, and no matter how long this path may be, the vertical height of the upper surface above the lower level is the useful fall, and is called the 'head.'"

He then gives the usual formula for the determination of the gross (or theoretical) horse-power of the fall, which takes into account the "head" as defined above. He afterwards deducts the mechanical and electrical losses in the water-wheel, generator and transmission line, but makes no allowance whatever for the difference between the gross (or theoretical) horse-power, and the net (or effective) horse-power of the water when delivered to the water-wheel or turbine.

The gross horse power of the fall is obviously not the correct figure to take, as it includes the gross "head"—*i.e.*, "the difference in elevation . . . measured vertically." It might be quite correct to state that the "head" is the same, "no matter what path the water follows . . . and no matter how long this path may be," but, unless the water falls vertically, such "head" is not the "useful fall," and will not give the "effective" horse-power.

The gross horse-power of any fall might be entirely dissipated by the friction of the channel through which the water is conducted, if such channel were long enough; and the friction losses must be determined before the useful fall or head can be ascertained, as it is only the useful and not the gross horse-power which can be utilised by the turbine. Unwin states that "the term head is often used loosely as equivalent to height, but this is misleading. The term head should be restricted to cases in which energy is considered."

Chapter II. treats, in a practical manner, with the various problems connected with the determination of the water flow in streams, and Chapter III. with the discharges over weirs and through orifices. The complete theory of the flow of water through orifices is not attempted, as the author correctly states that it is not pertinent to the subject of the development of water powers. He deals only with the three cases of efflux through sluice gates, flow through penstock intakes and efflux through nozzles or guide vanes of water turbines.

The important subjects of the variable nature of most water supplies and of the power delivered from hydro-electric stations, with the necessity of water storage in consequence, are considered in Chapter IV. There is an essential difference between the storing of water for general supply and for hydro-electric purposes. In the former case nearly the whole of the water in the reservoir can be drawn off in times of need, but, when used for power purposes, the effective head is diminished as the level of the reservoir or lake falls. The author gives it as his opinion that it is not feasible to lower the water level below 75 per cent. of the normal level, and it follows that only "the upper layer of water in the lake, having a thickness equal to 25 per cent. of the normal head, is that useful for power production."

With reference to the loss of water by evaporation from the surface of storage reservoirs, the author considers any calculations to be an unnecessary refinement. This may be so in cases where the annual rainfall is fairly regular, but, in countries where there are very long periods of drought, coupled with dry air at a high temperature, the evaporation losses can be very serious.

Artificial water ways, such as canals, flumes, tunnels, pipe lines and penstocks are very fully dealt with in the next two chapters, and the author there makes the necessary allowances for the loss of effective head, by reason of the friction of the passage of the water along or through the water ways. Many practical points of construction and maintenance are considered.

Chapter VII., Vol. I., dealing with the design and construction of dams, is one of the most important in the work. After dealing with the forces acting upon any dam, and the questions relating to its stability, the author considers in detail three broad classes of dams—viz., (*a*) the gravity dam, in which the weight of the material resists the forces of the water pressures; (*b*) the hollow dam, with an inclined up-stream face; and (*c*) the dam which is curved in plan and acts as an arch.

The circumstances in which it may be advisable artificially to raise the height of the crest of a dam, immediately previous to periods of drought, in order to increase the amount of storage water without raising the maximum level of the water at times of flood, when a good depth of water might be flowing over the dam, and various practical methods which may be adopted for this purpose, are set out in Chapter VIII.

The remaining chapters of Vol.. I. deal with headworks, including sluices and valves; water turbines (called "water wheels" by the author), and speed regulation. They are extremely practical, and contain a large amount of exceedingly useful information. The only types of governors mentioned, however, are of American design, and no descriptions are given of either of the excellent water-turbine governors made by Swiss firms.

As already mentioned, Vol. II. of this work deals with the electrical equipment of, and transmission from, hydro-electric power stations. The subjects of generators, transformers, switchboards and power lines, and the design and testing of power stations are discussed, but by no means exhaustively. The purely American experience of the author is obvious in many places, as, for example, on page 125, where he states "the present practice is almost universally to adopt 60 cycles per second . . . as the frequency of the plant, no matter what the service." While this may be true in America, where the manufacturers have standardised a frequency of 60 cycles, it is by no means true for large power transmission schemes in other parts of the world, even where water power is used.

On page 22, the statement is made that "for voltages in excess of 33,000 all transformers are oil-insulated." The best practice calls for oil insulation for voltages much below 33,000, unless the climatic conditions are such that exceptionally dry air can be guaranteed.

The somewhat unusual course is adopted of giving a short, separate chapter to the overhead travelling crane of the power station.

Digitized by Google

Chapter V., on the design and testing of power stations, is good, but a statement to which some exception can be taken is made on page 142, where the author says: "From about 1913, the tendency has been toward using outdoor type transformers, and placing them outside the power-house. This practice is more rational than housing them. . . ."

This can only refer to the step-up line transformers, but there is nothing in the electrical side of hydro-electric schemes to warrant any practice different from that usual with other high-tension transmission plants. Many instances of the successful use of small outdoor distribution transformers could be given, when a number of small isolated consumers has to be served over a scattered area. But this is very different from the use of large outdoor extra-high-tension transformers, through which the whole supply of the power house has to be given.

Wires, cables, insulators and power-line construction are discussed in Chapters VI., VII. and VIII. The relative advantages and disadvantages of copper and aluminium for overhead transmission conductors are clearly stated, and the use of aluminium cables with steel cores is favoured.

Some very practical information is given in Chapter VIII. on pole and tower lines. The author gives it as his opinion that "there are very few conditions which justify the use of steel towers, and a large percentage of the steel tower lines now in use have required an investment and consequent interest and depreciation charges, both of which are greatly in excess of the corresponding costs of a well-constructed, pole-supported line." Pole lines are no doubt quite suitable for many places, but local conditions, the lengths of the spans, the number and size of the conductors to be carried, &c., must all be taken into account before a definite conclusion can be safely reached.

A point sometimes overlooked when dealing with hydro-electric schemes is mentioned by the author at the end of Chapter VIII., where he states: "It is a financial fallacy to allot a specific value to all energy lost in the transmission line or used in station auxiliaries. Unless the station is fully loaded the cost of the lost (sic) current is practically nothing. . . If the water be plentiful and the total load within the generating capacity of the plant, energy losses do not represent any financial loss. Of course, when the commercial load overtakes either the station equipment or the water supply, the condition changes and the losses immediately have a money value equal to the selling price of the energy consumed."

The theory of electric circuits, the calculation of transmission lines with their deflection and mechanical stresses, and a short chapter on sub-stations complete Vol. II. of a work which can be highly recommended as evidently written for engineers by a man of large practical experience. There are a few obvious slips in the text, which will no doubt be remedied in the second edition. Some of these are the result of dividing the work into two volumes after it had been originally written in one. For example, there is a reference on page 8, Vol. II., to Chapter XX., when Chapter IX., Vol. II., is meant; on page 121 to Fig. 298, when Fig. 63, Vol. II., is meant; and on the same page to Fig. 295, when Fig. 60, Vol. II., is meant. It would, perhaps, have been better if the chapters, figures and tables had been numbered consecutively in the two volumes.

The indiscriminate use of the B. and S. gauge, the American wire gauge and circular mils in some of the tables is apt to be confusing. There can surely be no reason why the inch should not be used as the standard, both for diameters and cross-sectional areas of conductors.

It should be added that the binding, printing and illustrations are excellent throughout. J. H. RIDER.

HIGH-TENSION OVERHEAD TRANSMISSION LINES.

(*Concluded from p.* 233.)

In what follows we conclude our account of the discussion on the Paper read before the Institution of Electrical Engineers by Mr. G. V. Twiss on this subject. The Paper appeared in abstract in THE ELECTRICIAN of April 27th, May 4th and May 11th.

Mr. J. S. HIGHFIELD supported Mr. Trotter in his desire for working with security. On the whole it was for the benefit of the public and also the engineer. When the larg power systems had extended as they expected them to extend, the necessity of a secure supply would become increasingly important. If the security were increased the initial cost of the installation was higher, but the annual charges were less, and adding the interest and the annual charges together it would come to nearly an equal sum. The author liked the curiously arranged triangle of conductors. He thought it was admirable, but he also liked C1, which kept the cross arms as short as possible. The whole of the inside of steel poles should be coated with paint. The Cornwall Electric Power Co. had adopted a system by which the paint was blown suddenly through the pole, using one tank of paint and one of air. It was exceedingly satisfactory. A greater length of span could be obtained with steel poles than with wood. There was no difficulty in getting a 400 ft. span. He also thought it a mistake to test a line to any excessive pressure.

Mr. A. F. W. RICHARDS said there was nothing to show at what temperature the sags in the author's curves were ascertained. He assumed it was the temperature at which strong winds prevailed. How did the author arrive at the maximum figure of 132°F.? Was it the maximum obtained in the sun in England? He (Mr. Richards) generally took 22°, because it was an easy calculation to make, as they had to find the sag at 22° to satisfy the Board of Trade. Strictly speaking the sag due to the load ought to be added. He did not think the curves supported the author's statement that the larger the conductor [the] more economical was the span, except for steel poles. The contrary seemed to be the fact with regard to wood poles.

Mr. J. C. WIGHAM said the curves showed that even the United States regulations specified 400 ft. as the maximum span for a six-wi e circuit. That being so, what was the use of the enormous powers shown in the Paper? If the curves were correct, why had those heavy transmission lines with enormous spans been adopted so much abroad? The Post Office said the power lines must not come near them, but the Post Office wires caused the faults of all the electric light companies.

Mr. W. M. MORDEY asked the author or Mr. Jacob to clear up the vexed question of the difference between copper and aluminium as regarded the deposit of snow or ice. It was stated on excellent authority that snow did not remain on aluminium wires and that they did not get covered with a jacket of ice. With regard to the testing of insulators, with ordinary high-pressure tests and with the bridge test, very often nothing would happen. He had tried a method which might be of interest to the members. After testing insulators with the ordinary high-pressure and bridge tests he placed them in liquid in trays and put a little liquid in the hollow of the insulator and ran them for many hours with a little piece of copper wire connected to each cup and to a high-pressure line. About 1 in 10 got a blue coloration in the inside of the cup, showing that some current had passed through and that there was enough to colour the liquid with the copper salt. In that way he weeded out insulators which appeared by ordinary tests to be perfectly good.

Mr. JACOB said aluminium did not collect snow and ice to the extent of a copper wire, the reason put forward being that as the oxide skin on the surface was of a greasy nature the snow fell off.

The PRESIDENT explained that Mr. Vernier's recent Paper on "Wayleaves" and Mr. Twiss's Paper on "High-tension Overhead Transmission Lines" had been written by the desire of the Committee of the Institution dealing with the question of electricity supply, which was also being considered by a Board of Trade committee. It was felt that the first thing necessary was to find the proper outlet from the power-house—which was a question of wayleaves—and the second thing was transmission. He (the President) was an assistant of Mr. Ferranti 30 years ago, when he started using overhead wires. They did that because it was impossible owing to legislation to put them underground. Their franchise was then only 21 years. They found bare wires were safer than insulated wires. In addition to the Bond-street lighting they extended to the City and in the direction of Hampstead and down into Kensington. Mr. Ferranti was not satisfied with 2,500 volts; he put up lines to operate at 10,000 volts overhead. The scheme was shut down because of the passing of legislation which enabled them to have a franchise of 42 years. They beat the public authorities by pushing ahead with overhead wires, which induced them to grant the franchise necessary to enable the industry to go ahead.

The PRESIDENT then gave some particulars of an overhead line with which he had been concerned in South Wales. It was erected by the Powell Duffryn Steam Coal Co. from their power-house and colliery to overhead supply networks in the Aberdare and Rhymney Valleys—the former being 3,000 volts and the latter 10,000 and 3,000 volts. The four generating stations had plant capacity of 28,000 kw. and the output was 75 million units per annum. The four power-houses were run in parallel, two operating with steam plant and turbo-alternators and the others with gas and steam reciprocating engines. The line ran between the Middle Duffryn power station in the Aberdare Valley and the Britannia

Digitized by Google

Colliery, the central point of the company's Rhymney Valley undertaking, about 9 miles. The line was constructed for a working pressure of 30,000 volts, supplied through three 2,200 k.v.a. single-phase oil insulated water-cooled step-up transformers, designed for 30,000 volts operation and connected so as to give 3,000 volts mesh to 30,000 volts star and 30,000 volt star to 10,000 volt mesh. At present the line was working at 20,000 volts, the transformers being connected mesh to mesh, the ratio being adjusted by cutting out part of the neutral ends of the star winding. With the present mesh-to-mesh connections supplementary star transformers were used with the neutral earthed for operating the protective system, the line being constructed on the Merz-Hunter split phase system, the switchgear being actuated in the event of a line fault by balanced transformers connected in series with the split phase conductors. The line was controlled by switchgear with time limit overload relays, the transformers being connected direct to the transmission lines through isolating switches. The power factor and pressure when supplying from one end is controlled by motor operated static boosters. The lines are of six 0·073 sq. in. stranded conductors, each comprising 7/11 S.W.G. hard-drawn copper wires, arranged on normal spans with the phases 5 ft. apart vertically, the two splits of each phase being at 4 ft. horizontal centres. Pin type insulators on three-channel irons were used, and "Kay" type steel poles, with lattice masts in special locations; average span on straight runs 120 yards and maximum span 750 ft. A continuous earth wire 7/13 S.W.G. section hard-drawn copper was carried in flexible clips below the high-tension lines and connected the metal work of the entire system. The line was connected to the Britannia Colliery and Middle Duffryn power house by some 1,000 yards and 400 yards respectively of 0·1 sq. in. three-core split-phase 3,000-volt, paper insulated, lead covered, double wire, armoured cable, and a length of similar cable carried the line under the Glamorgan Canal, the armouring being connected to the earth wire. Each transmission pole had four galvanised iron earth plates, and additional earth plates were provided at each end of the line and on the section under the Canal. No lightning arresters were employed, the choking effect of the transformers and the capacity in the insulated cable at each end being relied on for damping down excess pressure waves.

Mr. E. S. BYNG (in a written communication) called attention to reinforced concrete poles which were now coming to the fore. The points to be considered in comparing the different methods of construction were :—(*a*) Cost of, and facilities for obtaining, materials, (*b*) cost of manufacture, (*c*) transport, (*d*) cost of erection, (*e*) maintenance, (*f*) life of poles and (*g*) insulation properties. In the case of wood poles the cost of timber was going up by leaps and bounds. The many advantages of ferro-concrete fo girders, beams, columns, &c., had been appreciated for some years, but the weight of concrete had hitherto practically prohibited this system from being utilised more generally for overhead transmission routes. In the latest development of ferro-concrete poles there were at least two or three manufacturers in this country who had adopted a hollow form of pole. The weight of concrete as compared with a solid pole up to about 45 ft. was thereby reduced to approximately one-third, and in poles of greater height this reduction would be even more. One of the chief points about ferro-concrete poles which he had inspected at Fulham was the density and uniformity of the concrete. This was obtained by a special method of manufacture consisting of an oscillatory-vibratory motion applied to the moulds whilst the poles are being manufactured, but before the "initial set" occurs. In a valuable Paper recently contributed by Mr. J. Orchison on "Telegraph Poles in New Zealand," it was stated that over 3,000 concrete poles had been recently erected in New Zealand and these had proved a great success, although one objection to their extended use was the question of transport. This was certainly a factor which has operated in the past against the use of ferro-concrete poles for power transmission work, where poles of considerable height were frequently required, but this difficulty had been overcome to some extent by the reinforcement being designed so that it can be put together and the structure made on site. The initial cost of ferro-concrete poles now compared favourably with that of any other type of construction, although this would not be of first importance if the annual charges were equated when working out the economics of the alternative proposals. In the case of the former the maintenance and depreciation charges would be practically nil, but in either wood tubular or lattice work poles these were quite an appreciable item, particularly in the case of the latter, where the frame-work had to be painted at frequent intervals in order to prevent corrosion, which would otherwise quickly occur.

Mr. TWISS, in reply to the discussion, said C2 in the "arrangement of conductors" diagram, was used for single circuit construction. There were only three wires, and there was no trouble with snow. Mr. Dickinson and Mr. Jacob referred to the relative quality of the work in this country and abroad. He could not quite agree with them. The Electric Power Commission of Ontario had factors of safety much less than in the United States, and their transmission lines were very reliable and did not come down very frequently. A certain amount of the American practice had got into bad odour because they went in for high voltages long before this country, which had profited by their mistakes. The Board of Trade regulations did not give an equal factor of safety on the small wires and in the large under the worst conditions, and it was under the worst conditions that the lines came down. If the factor of safety were decreased and the assumed loadings increased, a more comparable effect would be obtained, and it would probably reduce the cost of the transmission lines on the larger sizes, where it was most important. He did not suggest in the Paper that the Board of Trade restricted spans. He would like to see 300 ft. in preference to shorter spans where conditions justified it, but in many parts of the country there were prejudices against long spans, owing to the impression that they reduced the safety of the lines. The fact that the Board of Trade rules were used as precedents abroad was another reason why the rules should be carefully considered. He agreed with Mr. Dickinson that the mechanical tests of insulators should be limited. The number of discs required was dependent upon the location of the line. In some cases no number of discs would give adequate insulation. On the West Coast of Africa a line had to be run in duplicate, and one line used while the insulators of the other were being cleared of salt incrustation. Sir William Slingo mentioned spans of 180 ft. He (Mr. Twiss) made calculations recently for 60 ordinary telegraph wires and the economical span certainly showed less than 180 ft. He could quite understand that where the ice formed in a flat strip on the wire it would be less dangerous because the wind load and the swinging would be small. He had had no experience with ferro-concrete poles. They weighed about three times as much as wooden or steel poles, and shipping would be a serious item. Money could be saved by reducing the margin of safety to something with which the Board of Trade were at present satisfied. Now the question of conservation of coal was in the air he would like to see considerable advance made in the conservation of coal so far as it was in the power of electrical engineers by centralisation of power generation and by longer high-tension transmission lines. We should have equal security on small lines and large instead of large security on large lines and small security on small, as we had now. Mr. Highfield thought steel poles might be better than wood because they could be used for 400 ft. spans. The curves in the Paper showed that wood could be used on 400 ft. spans. The temperature for the curves of clearance was not worked out. The temperature would be taken into consideration in working out the sag. Mr. Wigham's calculation of economical span length confirmed his (the author's) curve. He had found that snow was more likely to collect on small than on large wires. A flake of snow would straddle the wire and the coating would be built up, but if the wire were larger the snow would strike it and rebound. He agreed that lightning arresters were not absolutely necessary, but sometimes they had to be put in to satisfy other people.

Erratum.—We regret that there were two mistakes in the report of Mr. Trotter's remarks in our last issue. In a note to us Mr. Trotter points out that in the fourth line the word "not" should be omitted. The statement is then in accord with the remark which Mr. Trotter interjected during Mr. Dickinson's observations, namely, that there is no limit whatever to high voltage in the Board of Trade regulations. The reference to the saving of copper relates only to short lines. The other error is in regard to wind pressure. The Board of Trade rule after the Tay Bridge was blown down was 50 lb. to the square foot. For the purposes of overhead wires this was brought down to 35 lb., and subsequently to 25 lb.

DISCUSSION AT BIRMINGHAM.

Dr. GISBERT KAPP said it was very satisfactory to find from the Paper that English engineers had been so successful in extra high-tension transmission lines, which subject had up to the present been generally considered to be the special province of American engineers. He thought the author's allusion to the so-called "cheap water power" in the beginning of the Paper required qualification, because if this popular belief were allowed to crystallise into a conviction it would cut the ground from such enterprises as were the subject of the Paper. As far as the cost of energy was influenced by capital outlay water power was by no means cheap. The average Italian hydro-electric works cost about £30 per kilowatt. Quite recently a Paper was presented to the Institution of Civil Engineers on the electricity works at Walsall, where the cost of a thermic works was given as a little under £8 per kilowatt. Whether the cost of energy was actually less in a hydraulic works than in a steam works depended on two things; the load factor and the utilisation of the by-products from the coal. If the recommendations recently brought before the Institution by Messrs. Paton and Cramp were carried out the cost of energy produced in a thermic works would under all circumstances be less than that produced by water power, and this country could compete with any country where there was abundant water power, so that the author's Paper would be found of great importance in the future development of home industries. In discussing the potential gradient in a string of insulators the author alluded to the effect of series and shunt capacity. It was interesting to note that the influence of shunt capacity had also been found to constitute a difficulty in the so-called Wurtz lightning arrester. It was well known that these appliances could not be used for very high voltages because the potential gradient between the first few cylinders close to the line was extremely steep and the addition of more cylinders at the earth end of the series did not materially flatten it. This was due to the shunt capacity. An Italian engineer, Mr. Moligniano, had overcome this difficulty by artificially increasing the series capacity between the cylinders so as to almost completely swamp the shunt capacity. By this means he obtained an almost straight line potential gradient, with the result that the Wurtz arrester could be used on lines of very high voltage. The author advocated a certain arrangement of wires. The speaker presumed that the advantage of so placing the wires was that in the event of an upper wire breaking it would fall clear of all the others, but he doubted whether one could rely on an absolutely vertical path of a broken wire. A wire broke generally under wind pressure and then, it seemed to the speaker, that the broken end would be blown sidewise and would foul the other wires whatever might be the geometrical disposition. Hence an arrangement, which would be electrically preferable might be adopted, such as the hexagonal disposition so frequently used in Switzerland. It had the advantage of shorter cross arms and less induetance.

Digitized by Google

Mr. A. Goldie Engholm said that although he had not had the time to go carefully into the details of the author's Paper he thought that it was very important that the cost of maintenance for overhead line transmission poles should be kept as low as possible. No doubt this cost would vary greatly with climatic conditions, but he would be pleased to learn if the author had any figures showing the cost of maintenance of the type of poles illustrated in the Paper. He had frequently found that sheradising any of the iron fittings and such like parts was better than galvanising, as very often the metal was eaten away underneath the galvanising, leaving only the outer skin of the galvanising, so that it was difficult by casual observation to detect such action. As it was well known that steel did not corrode when embedded in concrete, he would be pleased to learn if the author could express his opinion about the use of concrete poles. He thought one of the main features in connection with overhead line transmission should be that the cost of maintenance was kept as low as possible.

Dr. C. C. Garrard said this Paper dealt with a subject which would be of very greatly increased importance in this country in the near future. It had been imagined by some people that transmission lines, at very high voltages, were only necessary or desirable in connection with water powers. With a rational use of coal, however, it was possible that we could produce electricity at a total works cost (excluding distribution costs) of £2 per kilowatt year with a load factor of 60 per cent. This approached the best results attained by water-powers. Under these conditions extensive overhead transmission lines at high voltages would be very numerous. It followed from this that it was very desirable that the standardisation of British overhead equipment should be taken in hand by the Institution and the Engineering Standards Committee, in order that while maintaining the British reputation for high quality in this branch of engineering as in others, yet the development of the industry should not be hindered by the survival of obsolete official regulations. With regard to the testing of line insulators, Dr. Garrard directed attention to the method recently worked out in the States (*see* "Proceedings" American I.E.E. for January 1917), by which the actual resistance of high-tension insulators is measured. It was stated that by this means insulators having a slight degree of porosity and which would break down after several years' service, were eliminated before being put into use.

TEXTILE MILL ELECTRIFICATION.

There are few names which are so familiar to us as that of Dunlop, and the Dunlop tyre industry is one which is of particular interest from many points of view. It is a habit characteristically British that, having presented the world with a solution to a vital problem, we have contented ourselves with our achievement and left the development of our invention to the foreigner; but in the case of the pneumatic tyre nothing is more remote from the facts. Since the Dunlop tyre was invented in 1888 not only has the manufacture of the highest class pneumatic tyres been kept in this country, but, in addition, the Dunlop Company have left no stone unturned to promote the highest quality and reliability in their manufactures,

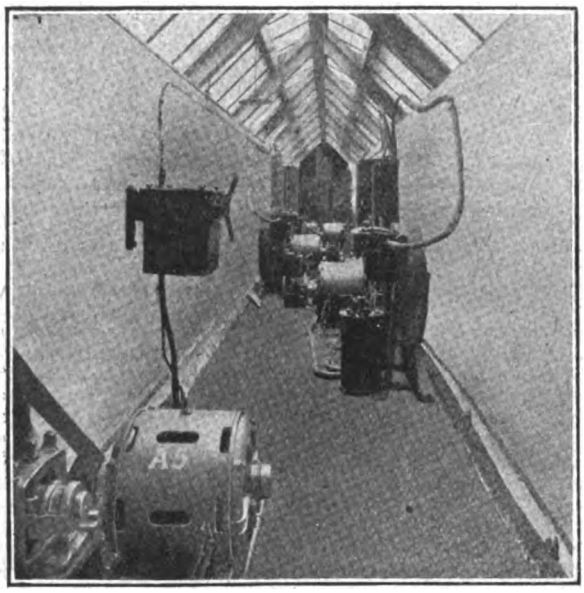


Fig. 1.—A Motor Corridor, showing Motors and Switchgear.

so that the Dunlop tyre has ever been in the van of progress. No better criterion of the progressive policy of the Company can be found than the latest of their ramifications, the D. R. cotton mills at Rochdale, where the company have laid down important works for manufacturing their motor tyre fabric direct from the cotton. The works are divided into two distinct parts, one devoted to the manufactures of the yarn from the cotton, and the other for the manufacture of the fabric from the yarn. The total area occupied by the premises is 33,000 sq. yds.

An inspection of these works keenly impresses the visitor with the efficient organisation, enabling the material to be dealt with rapidly right from its reception to its despatch. For the purpose of lighting and driving in this mill electricity has been exclusively adopted, there being an aggregate of 2,500 h.p. of Witton motors, and approximately 1,360 Osram lamps, with an average candle-power of 40. The total number of operatives is nearly 1,000. Electric power is derived from the mains of the Rochdale Corporation at a pressure of 6,000 volts, three phase, being transformed down and distributed throughout the works at a pressure of 400 volts for power and 200 for lighting. The question of the driving of textile mills is one which in the past has considerably exercised the minds of textile mill engineers. The vast majority are agreed upon the merits of electricity as against steam driving, but where agreement has not been so pronounced lies in the merits of individual against group driving. The management of the D. R. Cotton Mills has not favoured the completely individualised drive, and the mill has been laid out on the plan that isolated machines shall have their own drives, while where large groups of machines have to be driven in the same room the textile plant is separated into a number of small groups, each of which is driven by its own motor. The result has been to combine the merits of individual and group driving, taking advantage of the merits of each system, and a thoroughly efficient system of driving has been obtained.

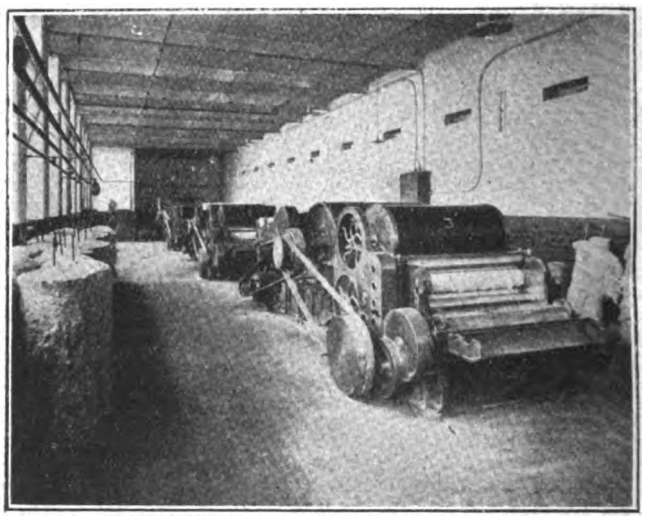


Fig. 2.—A Batch of Double Openers, Motor Driven.

Except in one or two special instances, where the presence of "fly" is more pronounced, the semi-enclosed type of induction motor has been adopted; but, at the same time, wherever possible, the various rooms in which groups of identical textile machines are installed, are operated from motors contained in special motor houses or corridors running parallel with the length of the rooms. A view of one of these motor corridors is appended, and it will be seen that the machines are started by auto-transformer starters or rotor-starters, as the circumstance may demand, and convey their power to the shafting through chain drives. In some instances, where the driving plant is remote of access from one of the corridors, special small cabins have been erected in the main rooms to contain the driving motors. The motors installed vary in size from 150 h.p. downwards. Every opportunity has been taken in these works for the reduction of labour costs by the utilisation of electric plant. When the raw cotton arrives, it is handled by a hoist driven by a Witton motor. When the finished fabric takes its departure it is deposited into the truck by a similar device.

The adoption of electric drive has enabled the excellent arrange-

Digitized by Google

ment of the mill plant to be shown to its best advantage. The individual machine stands compactly with its motor and starting panel, and can be operated independently of the rest of the plant.

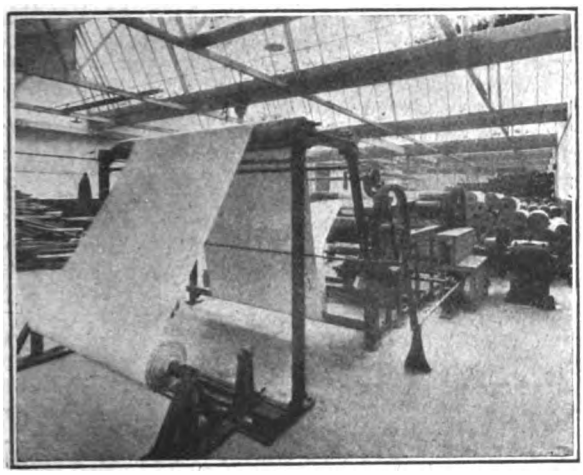


Fig. 3.—Fabric Stretching and Examining Machine.

If any repairs on the textile machinery need to be made, or if it be necessary to run an individual machine when the rest of the mill is

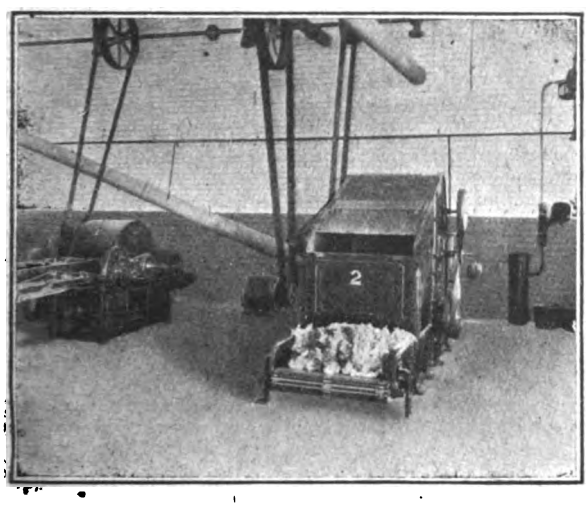


Fig. 4.—Bale Breaker.

shut down there is no question of detaining an engine-room staff. The man in charge of the work has but to operate the switch per-

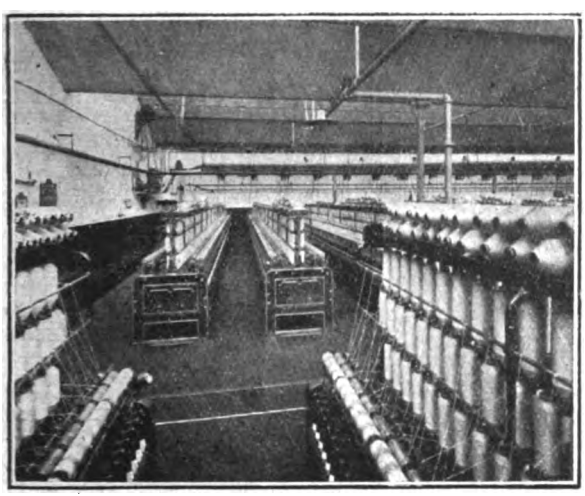


Fig. 5.—General View of Spinning Room, showing Humidifiers.

taining to the particular machine or group of machines he wishes to run. The spick-and-span cleanliness of the whole place cannot fail to attract attention. Even in those rooms where there is inevitably a considerable amount of "fly" created no more than a small accumulation is to be seen. Naturally, with the adoption of electric driving, the shafting and belting common to the steam-driven textile factory has been largely eliminated, which contributes considerably to the promotion of cleanliness. Particularising a few of the drives, the raw material on entering, and the finished fabric on leaving, is handled by 7 cwt. landing hoists driven by 6 H.P. "Witton" motors. These hoists are controlled from a point near to the door by operating handles. The hopper feeders are individually driven by 6 H.P. "Witton" motors. The broken cotton is swept to the subsequent process by a current of air passing through the pipes seen in the illustration, and produced by a fan driven by a 6 H.P. motor. The bale breakers, one of which is seen in Fig. 4, are electrically driven by 20 H.P. motors. Coming to the first of the corridors, this contains two 150 H.P., four 40 H.P. and two 20 H.P. motors, driving the various groups of carding machines, slubbing, intermediate, roving and ringspinning frames and so forth. Among the individual drives located in the main spinning room a typical example is shown in Fig. 5, which, in addition to giving an idea of the excellent general arrangements,

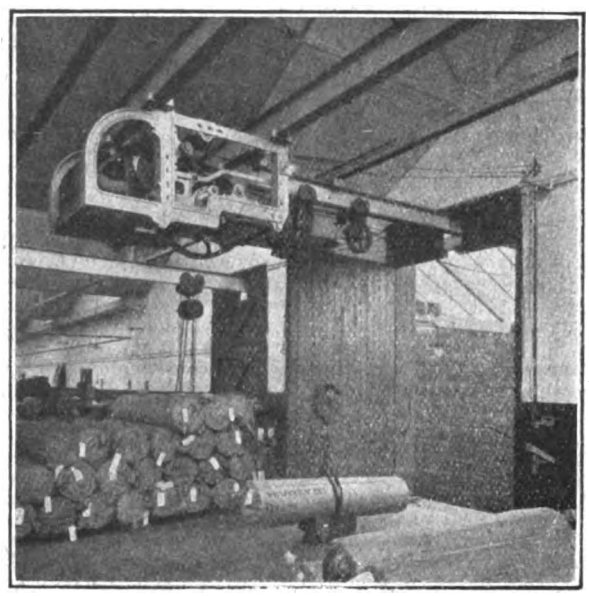


Fig. 6.—One of the Landing Hoists.

shows two 6 H.P. motors driving humidifiers. A further example of the individual drive is the fabric-stretching and examining machine depicted in Fig. 3, which in this instance is driven by a 20 H.P. motor.

Sufficient has been said to indicate the completeness of the arrangements for the production of a first-class article. With its 2,500 H.P. of "Witton" motors and its 1,360 Osram lamps, it is evident that this installation affords an excellent example of textile factory practice. No modern development has been neglected for the production of the best that is possible for this important item in the construction of the Dunlop motor tyre. The electrical plant, lamps, cables, &c., were supplied by the General Electric Co. (Ltd.), of Witton, Birmingham, through their local office at Victoria Bridge, Manchester.

Standardisation of Carbon Brushes.—In the "Electric Review and Western Electrician," Mr. E. H. Martindale refers to the difficult question of standardising carbon brushes. In the autumn of 1914 an investigation into the matter was initiated by the Industrial Power Committee of the American Institute of Electrical Engineers, and in May, 1915, it was followed up by the Electric Power Club and the Carbon Section of the Associated Manufacturers of Electrical Supplies. Standard dimensions (which apply both to carbon and plated brushes, except as regards thickness) have now been decided upon, and are presented by the author in tabular form. These standards are to be presented to the Electric Railway Engineering Association (U.S.A.) for consideration at an early date.

Digitized by Google

PROPOSED PARLIAMENTARY ACTION IN REGARD TO WAYLEAVES.

A Joint Committee of the Incorporated Association of Electric Power Companies and the Incorporated Municipal Electrical Association is drafting a Bill which it is hoped will be presented to Parliament at an early opportunity. In this Bill the question of wayleaves has engaged the attention of the committee, and the following details of the Bill are given by Mr. W. A. Chamen, chairman of the committee, in some communicated remarks on Mr. Vernier's recent Paper on "Wayleaves," read before the Institution of Electrical Engineers. The particulars here given are an abstract of remarks which will appear in the "Journal" of the Institution.

Clause 11 reads as follows:—

11. The undertakers may within their area of supply or any extension thereof under sec. 6 of the Electric Lighting Act, 1909, or otherwise construct, maintain, repair, alter and remove electric lines either over ground or under ground across, over or under private property or common lands, rivers, railways, canals, tramways, aerial ropeways, pipelines, water channels and the like, subject to the consent of the owners thereof, or without such consent (notwithstanding the provisions of sec. 7 of the Gasworks Clauses Act, 1847, as incorporated with the Electric Lighting Act, 1882, by sec. 12 thereof, and of sec. 10 proviso (*b*) of the schedule to the Electric Lighting (Clauses) Act, 1899), subject to the issue of a certificate of the Board of Trade declaring the construction of such lines to be desirable on ground of public utility and authorising their construction subject to terms and conditions as are hereinbefore provided. Any undertakers requiring to obtain such certificate shall make application therefor to the Board of Trade. Such application shall set out the purposes of the lines, the advantages of the routes proposed over any routes available by the exercise of their existing powers or that there are no such routes, and shall be accompanied by a map showing the route or alternative routes proposed to be followed, the easements required for access thereto, the lands and other properties concerned, a schedule of such lands and their owners and a certificate that copies of the map and notices of application have been served upon all such owners. Copies of any agreements which may have been made with any of the owners concerned in the construction of any part of such lines or of any consents given by such owners may be submitted with the application or at any time thereafter until the Board of Trade shall have decided to grant or withhold the certificate.

Upon the receipt of any such application the Board of Trade shall notify the owners concerned, other than those last above mentioned, and invite them to forward to the Board of Trade in writing within one calendar month, any observations which they may wish to offer upon the construction of the lines or the routes proposed so far as their own properties are concerned. The Board of Trade, if it sees fit, may thereafter hold a local inquiry or may decide to issue or withhold the certificate without such inquiry. The certificate issued shall be accompanied by a plan showing the route or routes approved by the Board of Trade with or without limits of deviation, but such routes or limits of deviation shall be confined to the properties scheduled by the undertakers in their application. The undertakers shall within six months of the receipt of the certificate serve upon all the owners concerned notices of their intention to construct such lines showing the proposed course thereof and of the easements for access thereto and at the same time serve notices to treat for the determination of the compensation to be paid where that has not been previously agreed upon.

The Board of Trade shall make regulations prescribing the scale of the maps, the forms of notice and observations, and the information to be submitted with applications and notices.

When the Board of Trade has decided to withhold the certificate, the undertakers shall not for 12 months or for such period as may be determined by the Board of Trade repeat their application and then only subject to such regulations as the Board of Trade may make.

The exercise of the powers conferred by this certificate issued by the Board of Trade shall be subject to the following provisions numbered (1) to (6), and failing agreement between the undertakers and any owner of any lands, &c., as to the matters set out in the provisions of this section the question shall be heard and determined by a single arbitrator to be appointed by the Board of Trade, and so far as possible all questions arising in respect of the line or lines authorised by any certificate of the Board of Trade shall be heard and determined by the same arbitrator sitting continuously.

(1) Payment by the undertakers to the owners of the property by way of lump sum or annual rent charge of such sums as may be agreed upon or awarded as compensation for the reduction in value of the lands by reason of the easements for the construction, maintenance and repair of the line and access thereto.

(2) Payment by the undertakers to the owners of such compensation as may be agreed upon or awarded for damage done in the course of construction, maintenance, repair and alteration of such lines at any time arising.

(3) In arranging whether any wayleaves shall be granted in perpetuity or for any term of years due regard shall be had to the liability of the undertakers to continuously maintain any supply of electricity once given by them.

(4) Alteration from time to time of the route followed by any line on, across, over or under any lands upon such terms and conditions as may be agreed upon or awarded, but so that the alteration shall not cause any interruption to the supply of electricity.

(5) In making any award it shall not be competent for the arbitrator to decide against the express wishes of any landowner or occupier that any electric line shall be run overhead across any ornamental park, garden or pleasure ground so as to spoil the amenity thereof.

(6) The Board of Trade may at any time revoke any certificates granted by them under this section upon such terms and conditions as they may determine, having due regard to the liability of the undertakers to continuously maintain the supply given by them.

It is not proposed under the Bill to proceed in any other way than through the present existing authority to whom all such matters are referred by the Electric Lighting Acts, namely, the Board of Trade, but if any other authority should be set up by Parliament for dealing with this question of wayleaves and/or any other questions at present dealt with by the Board of Trade, the transfer of this matter, along with any other such matters, to any other body, would, of course, be provided for in the Act appointing such new body. Experience seems to show that the bare fact of the existence of such powers as those set out in this draft clause would suffice in nine cases out of ten, if not, indeed, in 99 cases out of 100, to cause the property owner to make reasonable agreements without the actual powers contained in the clause having to be called into operation at all.

There is another point altogether, which has been referred to by the author, namely, that of the alleged right of veto by a local authority against the construction of any lines whatever overhead, even on private property. Mr. Chamen doubts if this alleged right of veto was ever intended by Parliament. As, however, the Board of Trade have maintained that sec. 10 (*b*) of the Schedule to the Clauses Act, 1899, does give an absolute veto to local authorities, without appeal in any shape or form, the Joint Committee have added the following section to the draft Bill:—

12. Notwithstanding the provisions of sec. 14 of the Electric Lighting Act, 1882, and of sec. 10 proviso (*b*) of the schedule to the Electric Lighting (Clauses) Act, 1899, the consent of the Local Authority shall not be required for the placing of any electric line above ground, excepting along, over, or across any street, and such consent for the placing of any electric line along, over or across any street shall not be unreasonably withheld. Any question whether such consent is unreasonably withheld shall be decided by the Board of Trade.

This section shall only apply to the works of authorised undertakers carried out by them, remaining their sole property and in regular use by them.

The effect of this is to take away all possibility of any claim by the local authority to have any power of veto over the construction of overhead lines on private property, and at the same time it provides that the consent of the local authority shall not be unreasonably withheld to the erection of any electric line above ground, along, over or across any street, and provides a right of appeal to the Board of Trade, to decide whether any refusal to give such consent by any local authority is unreasonably withheld or not.

CORRESPONDENCE.

A VIBRATION TENSION METER.

TO THE EDITORS OF THE ELECTRICIAN.

For some time I have used the principle of the vibration frequency meter to construct a tension meter for regulating aeroplanes. The problem of vibrating strings has often been raised in THE ELECTRICIAN, and I confess that the interesting communications of Dr. Fleming and others (THE ELECTRICIAN, Dec. 19, 1913, Feb. 6, 1914, &c.), have enabled me to devise a practical means of utilising the phenomena of resonance for measuring the tension of aeroplane cables and wires.

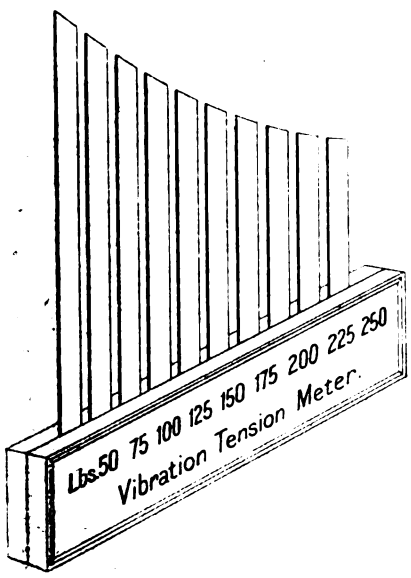
The vibration tension meter, which I have successfully adopted and is now largely used by aeroplane constructors, is made up of a series of small steel plates of various lengths and clamped at one extremity.

If one places the support of the tension meter in light contact with a wire which has been set in vibration, the plate, the natural period of which approaches that of the wire, will soon assume a distinct state of vibration.

Digitized by Google

The tension is equal to kn^2, k being a constant for any given wire, and can be measured directly. If the tension meter includes plates of frequencies from n to n' vibrations (n' being greater than kn), resonance will occur simultaneously with two or three plates.

This corresponds to the fact that a loaded wire can set in vibration plates whose periods of oscillation are n, $2n$, $3n$, &c., according to the frequencies of the harmonics of the vibrating wires. In order to measure the tension one must consider only the fundamental vibration of period n.



I have shown that, for the regulation of all modern biplanes, including the most recent types, a series of plates comprising frequencies from 20-40 per second is sufficient. All uncertainty due to multiple resonance is thus eliminated. The error due to the presence of the turnbuckles is about 5 per cent. in excess.

I have found it possible, in the course of destructive tests of new types of aeroplanes, to follow quickly the distribution of tension of all the wires and to determine irregularities which calculation did not predict. I have also been able to recognise all the elements (struts, cables and wires) which are capable of being influenced, during flight, by resonance with the motor, the fundamental frequency of which is of the order of 22-25 per second (1,300-1,500 revs. per minute).

CARLO MAURILIO LERICI,
Electrical and Aeronautical Engineer.

Turin, May 1917.

RATING OF INTERMITTENT MOTORS.

TO THE EDITORS OF THE ELECTRICIAN.

I fear that your correspondent Mr. B. Adair M. Boyce has misunderstood my note on the above subject in your issue of the 4th inst.

He says that the R.M.S. methods analysed will apply to direct-current series brake solenoids. It may interest him to know that the R.M.S. methods described are advocated and practised by most firms at home, and by many firms abroad, for determining the rating to be given to intermittent motors of large output. The example which was given was a "practical" one, in so far as it related to a winder in actual operation. Reference to your columns will show that a good deal of attention has been given to the theory of the subject.

H. H. BROUGHTON.

London, May 11.

IRONCLAD SWITCHBOARDS.

The "Ironsafe" switchboards by Berry, Skinner & Co., have already been described in these columns, and we, therefore, need only remind our readers of their general characteristics. These switchboards are made up particularly to comply with the Home Office regulations, and are built up in units. Each separate unit is interlocked, and a 'bus-bar chamber is provided where necessary with a locking bar and padlock, rendering the 'bus-bars accessible only to the responsible man in charge. All connections are under cover, but they are on the front of the board, so that this

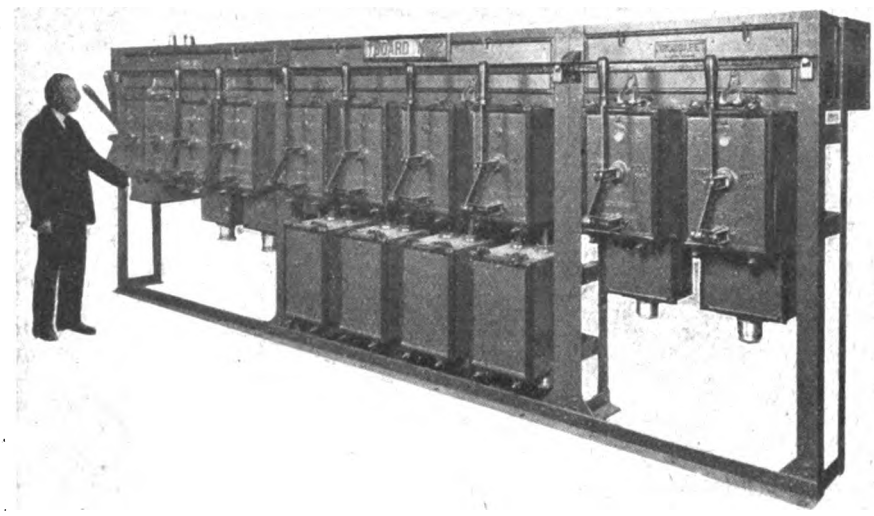


FIG. 1.—"IRONSAFE" SWITCHBOARD.

can be fixed directly against the wall. By this means much space can be saved. The whole board is practically watertight, dust proof and flame proof.

Fuses can be replaced in a few seconds in any unit, and by an inexperienced person if necessary, without the possibility of receiving

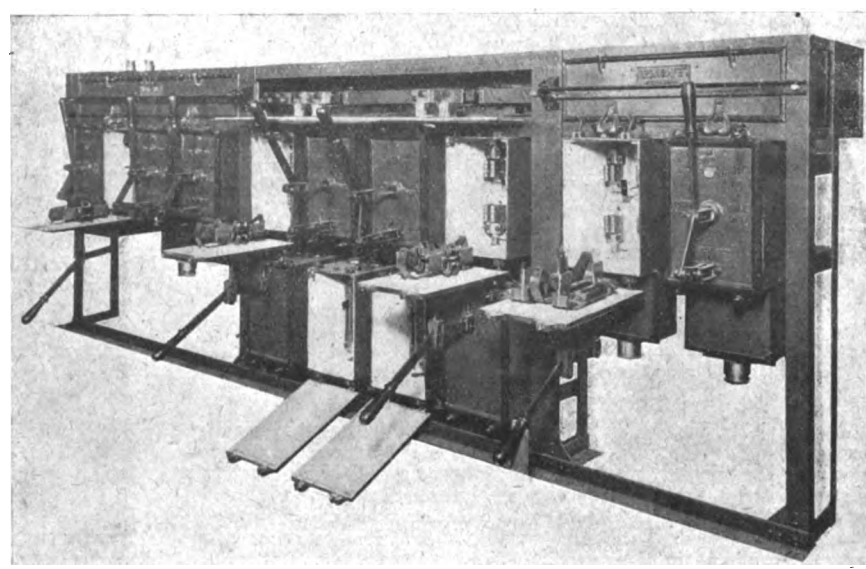


FIG. 2.—SWITCHBOARD PARTLY OPENED UP.

shock. The covers of switches can be opened only after first removing the switch to the off position. The adjoining illustrations show a switchboard, which is one of 10 that are being supplied to a large works. This board includes seven 1,500-ampere single-pole switches and two 400-ampere double-pole fuse switches. The four boxes placed underneath the switches in the centre of the board contain disconnecting links, and the chamber at the top of the framework encloses the heavy 'bus-bars.

In Fig. 2 part of the 'bus-bar chamber cover is removed, and certain of the switch covers are swung open. The overall height of this switchboard is approximately 5 ft., and the total length is 12 ft. 8 in. The largest switchboard supplied by Berry, Skinner & Co. for this contract was 25ft. in length.

Digitized by Google

PARLIAMENTARY INTELLIGENCE.

THE ADMIRALTY INVENTIONS BOARD.

In the House of Commons on Friday Col. CLAUDE LOWTHER asked whether, in view of the disfavour with which the Admiralty Inventions Board was regarded by inventors in every part of the country, many of whom refused to submit their inventions before it, he would appoint a fresh committee, whose duty should be to examine inventions directed solely against the submarine menace.

In reply, Mr. BONAR LAW said the Board of Invention and Research was composed of a number of eminent men of science, presided over by Admiral Lord Fisher of Kilverstone, and the large number of inventions submitted daily to the Board did not bear the contention. In addition to the Board of Invention and Research, there was a special division of the Admiralty War Staff whose sole function was to devise and perfect methods for dealing with enemy submarines.

In reply to a question by Mr. MACMASTER on Monday, Dr. MACNAMARA said that the Board of Invention and Research comprised (1) a central Committee, consisting of Lord Fisher (president), Sir Joseph Thomson, the Hon. Sir Charles Parsons, F.R.S., Sir George Beilby, F.R.S., and Vice-Admiral Sir Richard Peirse, with the heads of the technical departments of the Admiralty as ex officio associated members; (2) a Consulting Panel of 14 members—namely, Prof. H. B. Baker, F.R.S., Prof. Bragg, F.R.S., Prof. H. C. H. Carpenter, Dr. Dugald Clerk, F.R.S., Sir Wm. Crookes, F.R.S., Mr. W. Duddell, F.R.S., Prof. Frankland, F.R.S., Prof. Bertram Hopkinson, F.R.S., Sir Oliver Lodge, F.R.S., Sir Ernest Rutherford, F.R.S., Mr. Gerald Stoney, F.R.S., Prof. the Hon. R. J. Strutt, F.R.S., and Mr. Richard Threlfall, F.R.S. There were 12 sub-committees working under the Board and entrusted with different branches of research, each of which comprised one or more of the eminent scientists named, together with other experts. Mr. Threlfall and Dr. Dugald Clerk were the most recent additions to the consulting panel, and the constitution of the sub-committees was altered from time to time as found desirable.

Ashton-under-Lyne Corporation Bill.—This Bill, which authorises Ashton Corporation to purchase the tramway undertaking of the Oldham, Ashton & Hyde Electric Tramway (Ltd.), on giving six months' notice, has passed both Houses of Parliament and awaits the Royal Sanction.

Nottinghamshire & Derbyshire Tramways Bill.—This Bill, which authorises the purchase of the undertaking of the Ilkeston tramways, has been read a second time in the House of Commons.

Richmond (Surrey) Electricity Supply Bill.—The Richmond (Surrey) Electric Light & Power Co. (Ltd.) is applying for an Act making for their provision with reference to the supply of electricity in Richmond, and authorising increases or alterations in prices charged for electricity and meters, &c.

Trade Union (Amalgamation) Bill.—By this Bill, which has been read a second time and passed through the committee stage in the House of Commons, trade unions will be empowered to carry out a scheme of amalgamation, if supported by a majority of the members of each of the unions affected. At present, before such a scheme can be adopted, it must be supported by two-thirds of the members.

Company Directors.—On Tuesday the President of the Board of Trade (Sir Albert Stanley) introduced a Bill into the House of Commons to provide for the disclosure of certain particulars respecting the directors of companies. The Bill was read a first time.

LEGAL INTELLIGENCE.

Alleged Restraint of Trade.

Last week Mr. Justice Low delivered his reserved judgment in an action brought by Joseph Evans & Co. against Geo. Whitehouse & Co., and several other Birmingham firms manufacturing cased tubes. Plaintiffs claimed a declaration that they were entitled to 6·81 per cent. of the total of cased tubes sold by the whole of the members of the association, also accounts and inquiries, or alternatively £958. 1s. 7d. as an amount due under the rules of the association.

Plaintiffs were members of the Cased Tubes Association, the rules of which provided that prices should be regulated and a pool formed by members' contributions, out of which each member should be entitled to a certain proportion of the output of cased tubes sold by the whole of the members. By an agreement of June, 1913, plaintiffs' percentage was fixed at 6·81 per cent. Between March and November, 1915, plaintiffs' output had been less than 6·81 per cent. of the total output of the members of the association, and they were accordingly entitled to sums aggregating £958 odd under the agreement.

Defendants denied that plaintiffs' output had been less than 6·81 per cent., or that they were entitled to the money they claimed. They contended that nothing was due to plaintiffs, because they had not fulfilled the conditions required by the rules of the association, as they had not verified their monthly returns of output by statutory declaration; and they also pleaded that the action was not maintainable because the association's rules and the agreement were illegal and contrary to public policy as being in restraint of trade, and that the agreement was not enforceable because it came under the Trade Unions Act.

Mr. Justice Low said the point for decision really arose on the contention of defendants that the action was not maintainable on the ground that the rules of the association and the agreement were contrary to public policy as being in restraint of trade. The point under the Trade Unions Act was not pressed. The rules and agreement certainly appeared to his lordship most drastic, and the powers exercisable by the association under the rules for limitation to be almost unlimited. It was, however, quite contrary to experience that oppressive powers would not be exercised oppressively merely because inconvenience might or could result to the oppressor. It appeared to his lordship impossible to hold that the restraints on the persons who were parties to the agreement could be said to be justified by any circumstances with which he had been made acquainted. He was of opinion that having regard to any special circumstances which might exist the restraints of trade in that case were out of all reason. To enforce the money claim would be to assist that which was the sole object of the parties, to restrain the cased tubes trade in a wholly unreasonable and tyrannical manner. For that reason plaintiffs' claim upon the account stated failed also. In the result his judgment must be for defendants, with costs.

British Thomson-Houston Co. (Ltd.) v. Corona Lamp Works (Ltd.)

On Friday, Mr. Walter, K.C., who had a motion in this action before Mr. Justice Younger, stated that the matter was not one that could be satisfactorily dealt with on motion, and he has arranged with Mr. Kerly, K.C., who appeared on the other side, that there should be no order upon the motion, except that the costs should be costs in the cause, defendants undertaking until the trial to keep an account.

Wireless Telegraph Litigation.

A Court of Appeal in the United States has given a unanimous decision in favour of the Marconi Wireless Telegraph Co. of America in an action brought against the De Forest Telegraph & Telephone Co. for infringement of the Fleming valve patent, thus establishing that the Fleming patent was the master patent for valve receivers. The Fleming valve has contributed considerably to the surprising results obtained in long-distance wireless telegraphy and telephony, and has enabled wireless communication to be established over intervals of thousands of miles. The use of the valve has been principally responsible for such success as the Germans have obtained in wireless telegraphy both at home and abroad. In September, 1916, as the result of an action by the Marconi Company against the De Forest Company judgment was given in favour of the Marconi Company, but defendants appealed. One of the replies by the defendants to the action was that of filing a counterclaim for the alleged infringement of seven of their patents relating to similar devices. Both Courts have decided in favour of the Marconi Company, and in the decision now given the Appeal Court has stated that the Marconi Company do not infringe six of the De Forest Company's patents mentioned, and that the seventh De Forest patent is invalid.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"The Boy in Industry": Three Articles of Interest and Value to Employers, with a foreword by the Rt. Hon. Dr. ADDISON, M.P. (London: Ministry of Munitions.) Pp. 46. 3d.

"The Range of Electric Searchlight Projectors," by Jean Rey. Translated by J. H. JOHNSON, M.Inst.E.E. (London: Constable & Co., Ltd.) Pp. xiv.+152. 12s. 6d. net.

"Elementary Principles of Wireless Telegraphy." Part II. By R. D. Bangay. (London: The Wireless Press, Ltd.) Pp. viii.+241. 2s.

"Action Physiologiques et Dangers des Courants Electriques." By J. Rodet. (Paris: Gauthier,-Villars et Cie.) Pp. 87. 3fr. 25c.

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for the week:—

Officer for the week.—Platoon Commander Hughes Hallett.

Next for Duty.—Platoon Commander C. Campbell.

Monday, May 21st.—Technical for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling class.

Tuesday, May 22nd.—Lecture, 8.30, Company Commander Castell, "Knots and Lashings and Trestle Bridging." Physical drill and bayonet fighting, 7.30 to 8.30.

Wednesday, May 23rd.—Drill, No. 1 Company, Left Half Company, 6.15

Thursday, May 24th.—Drill, No. 2 Company, Left Half Company. Ambulance class by M.O., 6.30. Signalling class.

Friday, May 25th.—Technical for No. 2 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right half Company. Recruits' drill at 6.30 to 7.30.

Saturday, May 26th, and Sunday, May 27th.—See Special Orders.

Armlets.—Members are warned that armlets must be worn at all plain clothes parades.

Musketry.—For all Companies, see Notice at headquarters.

NOTE.—Unless otherwise indicated, all drills will take place at headquarters.

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

The British Trade Bank. The deed of settlement and the Royal Charter of incorporation of the British Trade Corpn. have been issued.

The share capital of the corporation is to be £10,000,000, but there is power to increase it. The corporation is not to commence business until at least £1,000,000 has been subscribed, and at least one-fourth of that sum paid up. The corporation must remain British in character and free from foreign control, and have its principal domicile and principal place of business in England, and the controlling board of directors in this country. The first directors were given in our last issue ; the term of the charter is 60 years, and the corporation is "to carry on the businesses of trading and banking in any part of the world," and its powers and objects, which are very wide, include the following :—

To act as agents for any Governments or authorities, or for any bankers, manufacturers, merchants, shippers, and others, and to carry on agency business of any description, including the power to act as attorneys and to give discharges and receipts.

To carry on business as contractors, merchants or traders on their own account.

To promote or finance or to assist in the promotion or financing of businesses and undertakings of any description, and to develop and prove the same, either through the instrumentality of syndicates or otherwise.

To enter into any partnership or other arrangements for sharing profits or on joint account.

To acquire and hold or dispose of any shares, stock, bonds, obligations, debentures, debenture stock, scrip or other securities or interests, &c.

To acquire and hold or dispose of any interest in any railways, tramways, ships, canals, docks, harbours, armament works, shipbuilding establishments, irrigation works, electrical works, gas works, water works, and, in addition, any carrying, transporting, trading, industrial, agricultural, financial or manufacturing works, concerns or businesses of any description, and to carry on the same.

To undertake and execute any trusts and to obtain, work or dispose of any concessions, charters, Acts of Parliament, or other legislative rights, monopolies, licences, patents, copyrights or other privileges or advantages.

To establish and maintain information and investigation bureaux, and to collect statistics, returns, particulars and information likely to prove useful for the consideration of business and financial propositions, and to undertake experimental and research work.

* * * *

Silician Sulphur. H.M. Government have decided to purchase from the Italian Government the quantity of Italian sulphur allotted to Great Britain, and a committee, of which Mr. H. S. Mingard of the Ministry of Munitions is secretary, has been appointed to deal with the matter.

The Committee has decided to offer imported sulphur in lots of not less than 5 tons for use in approved trades and industries and for the present the prices will be £23 per ton for flowers of sulphur, £23 for rolled brimstone and £12 for thirds, including delivery to purchaser's nearest railway station. A discount of 2½ per cent. will be allowed to recognised sulphur merchants and dealers, and applications for sulphur must be made on special forms, which may be secured from the Secretary, Sulphur Committee, Ministry of Munitions (Explosives Dept.), Storey's Gate, S.W.

* * * *

Trade Commissioners. It is reported that the Board of Trade will shortly appoint 12 additional trade commissioners to posts within the Empire. The intention of the Government is to extend the trade commissioner service of the Board, as already announced by Sir Albert Stanley, and following upon the resolution in favour of this course which was passed at the Imperial War Conference.

At present there are four commissioners—viz., in Canada, Australia, New Zealand and South Africa respectively, and there are also a number of trade correspondents (official and honorary) throughout the dominions, colonies and dependencies. At least one of the new commissioners will be appointed to India.

It is to be hoped that care will be taken to select good men for the new positions, and we should like to see five or six men appointed who have had engineering experience and training, including two or three well-equipped representatives of the electrical industry. The present commissioners are doing good work in stimulating trade between the mother country and the dominions, and the representatives of the latter at the War Conference urged strongly the immediate extension of the system in accordance with the recommendations of the Dominions Royal Commission. The "Manchester Guardian" states that in future the trade commissioners, with the co-operation of the dominion Governments, will work also for the promotion of inter-imperial trade ; that is to say, the British Commissioner in Canada, for instance, may, by arrangement with the Australian Government, act as the agent for Commonwealth trade there. An important part of the function of the commissioners is to report on the nature and extent of foreign competition with United Kingdom merchandise. The new officials will be sent out as soon as possible, so that they may make the best use of the opportunity which the war offers of substituting British for German trade influence.

* * * *

The Excess Profits Duty. The increase in the excess profits duty continues to exercise the minds of commercial men. At the meeting of the Council of the Hull Chamber of Commerce on Monday the Parliamentary Committee advocated the withdrawal of the proposal to add 20 per cent. to the duty, being of opinion that the tax would act prejudicially against trade and commerce both now and after the war, on account of the extra money being required to trade even on the old line owing to the greatly increased cost of materials and production.

Mr. J. H. Fisher considered that any public meeting or demonstration against the excess profits duty was undesirable and said it would be better to endeavour to get some concessions when the Finance Bill was brought forward. After discussion it was agreed to adopt this course.

* * * *

Commerce of the Empire. Though the resolutions passed at the Imperial War Conference related mainly to questions connected with the prosecution of the war, and many of them are necessarily of a confidential character, still some highly important commercial and technical problems were under discussion. Many of these matters have already been commented upon by us, but in view of their importance we give the principal resolutions passed at the Conference :—

Trade Representatives.—That the Imperial War Conference welcomes the proposed increase of the Board of Trade service of trade commissioners, and its extension throughout the British Empire, in accordance with the recommendations of the Dominions Royal Commission, and recommends that the Governments concerned should co-operate so as to make that service as useful as possible to the Empire as a whole, especially for the promotion of inter-Imperia trade.

Patents, &c.—The Imperial War Conference commends the proposals of the Board of Trade in the Memorandum on Patents and Trade Marks to the careful consideration of the constituent Governments of the Empire.

Naturalisation.—The Conference recognises the desirability and importance of securing uniformity of policy and action throughout the Empire with regard to naturalisation, and the proposals set out in the memorandum submitted by the Home Office were commended to the consideration of the respective Governments summoned to the Conference

Mineral Resources.—That it is desirable to establish in London an Imperial Mineral Resources Bureau, upon which should be represented Great Britain, the Dominions, India, and other parts of the Empire. The bureau should be charged with the duties of collection of information from the appropriate departments of the Governments concerned and other sources regarding the mineral resources and the metal requirements of the Empire, and of advising from time to time what action, if any, may appear desirable to enable such resources to be developed and made available to meet the metal requirements of the Empire, &c.

Double Income Tax.—The present system of double income taxation within the Empire calls for review in relation : (1) To firms in the United Kingdom doing business with the Overseas Dominions, India and the Colonies ; (2) to private individuals resident in the United Kingdom, who have capital invested elsewhere in the Empire, or who depend upon remittances from elsewhere within the Empire ; and (3) to its influence on the investment of capital to the United Kingdom, the Dominions and India, and to the effect of any change on the position of British capital invested abroad. The Conference, therefore, urges that the matter should be taken in hand immediately after the conclusion of the war.

Development, &c.—Having regard to the experience obtained in the present war, this conference records its opinion that the safety of the Empire and the necessary development of its component parts, require prompt and attentive consideration, as well as concerted action, with regard to the following matters : (1) The production of an adequate food supply, and arrangements for its transportation when and where required ; (2) the control of natural resources available within the Empire, especially those that are of an essential character for necessary national purposes, whether in peace or in war ; (3) the economical utilisation of such natural resources through processes of manufacture carried on within the Empire.

The time has arrived when all possible encouragement should be given to the development of Imperial resources. With these objects in view this Conference expresses itself in favour of : (1) The principle that each part of the Empire, having due regard to the interests of our Allies, shall give specially favourable treatment and facilities to the produce and manufactures of other parts of the Empire ; (2) arrangements by which intending emigrants from the United Kingdom may be induced to settle in countries under the British Flag.

D

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Aberdeen.—The Secretary for Scotland has consented to the borrowing by the Council of a further sum of £40,000 for the execution of capital works under the Aberdeen Electric Lighting Order, 1890, and the Aberdeen Corporation Electricity Act, 1907, raising the total sum authorised to be borrowed for that purpose to £450,000.

The sum now sanctioned is to be applied in providing a 5,000 kw. turbo-generator, together with engine room, building extension, sub-station buildings, a rotary converter and high-tension cable, &c.

Ayr.—The Council have received permission to borrow a further sum of £10,000 for extensions of the electricity supply undertaking.

Burton.—The Electricity Committee reported last week that the L.G. Board were recently asked to sanction a loan for extensions of the electricity works.

It was pointed out that the maximum boiler capacity had almost been reached, and it was most important that the Council should have an increase in the boiler power for next winter. The Board, however, refused the application, and the Electricity Committee were thrown back on finding some expedient to obtain the increased boiler capacity. It is proposed to put a fan in the flue leading to the old chimney at the south end of the electricity station. This will increase the draught and give a corresponding increase of steam. It is also proposed to use a higher grade of coal in the hope that this will give additional steaming power to the new boilers at a cost of only £400.

Rochdale.—The Council have approved the purchase of 1,250 sq. yds. of land adjoining the electricity works for extensions.

Last week the Council adopted a recommendation of the Electricity Committee to make an increase of 25 per cent. in the charge for electricity for lighting (in place of the existing 10 per cent.) over pre-war rates, and a further increase of 0·3d. per unit for power purposes. For power there is a special schedule for contract users, and a coal clause which increases or reduces the price 0·006d. per unit for each complete 3d. per ton rise or fall in the price of coal over 10s. or 12s. per ton. Consumers must guarantee to take a supply for five years with a payment of not less than 20 per cent. per annum on Corporation outlay on lines or cables, transformers, switchgear or converting plant.

Shipley.—The Urban Council has authorised an extension of the electric supply mains to a weaving shed, and supply is also to be given to a firm at Hurst Wood.

Wolverhampton.—The L.G. Board has sanctioned the borrowing of £2,410 to lay mains to supply manufacturers.

GENERAL.

Bristol.—The substitution of women for men employés has been carried to a considerable extent by the Bristol electricity department.

At present women employed include eight switchboard operators in training, nine cleaners at the generating station, seven meter readers, two women engaged in the sales department, 26 as clerks and stenographers, and one as a lubricating assistant, making, with the one female clerk employed prior to the war, a total of 54.

Electricity in Sewage Works.—At the recent meeting of Wigan Council the Sewage Disposal Committee reported that the insurance company had told them that the boilers at Pemberton were unsafe and should not be worked any longer.

The committee think that as soon as the war is over it would be advisable to try if it were possible to put down an electrical plant. The Borough Engineer had seen the Electrical Engineer and between them they had drawn up a scheme which it was submitted would effect a very big saving indeed. They unanimously recommended that that course be adopted and that an electrical installation be put up in place of renewing the old boilers.

Ipswich.—Ald Paul called attention to the supply of electric power at the last meeting of the Council, and asked if the electric supply station could not supply more current.

In reply, Mr. E. C. Ransome said it was quite correct that the Electric Committee had contracted for the full output of power. They had endeavoured to get permission from the L.G. Board to put in more plant, but had failed. It was impossible to accept any more large contracts, but small supplies would still be considered, and, if possible, a supply would be given in these cases.

Manchester.—The Finance Committee reported to the Council on Wednesday that it would be necessary to make an increase in the rate.

Several members endeavoured to avoid the increase by suggesting that the trading departments should contribute more than they have declared themselves able to do. It was suggested that the Tramways Committee should give £75,000 instead of the £50,000 they have offered, and the Gas Committee (who propose to raise the price of gas by 6d per 1,000) should contribute £25,000, although the Committee had already stated that they cannot this year afford to give anything in relief of rates. It was also suggested that the Electricity Committee might be able to raise their promised contribution from £17,570 to £25,000, or £5,000 below the sum contributed last year. For several years the tramways contribution has been £100,000, and that of the gas £50,000.

HYDRO-ELECTRIC NOTES.

Hydro-Electric Undertakings in Italy.—At the meeting of the Banca Commerciale Italiana on March 28 the President (Senator Luigi Canzi) said that their industries had been almost wholly absorbed by the exigencies of the war. They had shown wonderful activity, and gratifying results had been obtained. Undertakings for the generation and distribution of hydro-electric power had shown good and, in some instances, excellent results. There was a general tendency to increase the capacity of existing plants and to search after new sources of energy.

The directors had always realised the vital importance of that industry from the point of view of economic independence and national prosperity, and they might congratulate themselves on the extensive and cordial support they which had always lent to it. It was as yet hardly possible to make any forecast respecting the financial and economic consequences which the war would have on the internal affairs of the individual belligerents and on international relations. As far as Italy was concerned, however, they felt that the resistance which the country was displaying, the improved exploitation of their national resources, and confidence in their own strength would, once victory had been attained, help them to find their way amidst the many problems on which their future industrial development would depend.

Morocco Water Power.—A consortium, comprising the French companies and firms of Schneider (Creuzot), Pavillier, Giros and Loucheur, Compagnie Marocaine, Compagnie Générale, and the P.L.M. and Orleans Railway Companies, has been formed to exploit the water power of Morocco. The consortium proposes to utilise the falls of the Oum-er-Rebia river and probably later the river heads in the Atlas Mountains.

ELECTRIC TRACTION.

Dearne Valley Light Railway.—The clerk to the Dearne Valley Light Railway Board (Mr. J. L. Hawksworth) has issued a statement showing that the expenses of promoting the scheme to date are £11,225. This sum will be borne by the promoting authorities in the following proportions:—

Wombwell Urban Council, six-fifteenths; Wath Urban Council, four-fifteenths, Bolton Urban Council three-fifteenths, and Thurnscoe Urban Council two-fifteenths.

The order was obtained in 1915, but the board have not attempted to proceed with the enterprise during the war.

Glasgow.—The Tramways Committee recommend, in respect of the present increased cost of living, a bonus of 4s. per week to married male employees on a weekly wage, and to male employees on a weekly wage who are the sole support of households, with an additional bonus of 1s. in respect of each dependant under 14 years of age.

L.C.C. Tramways.—On Tuesday the Highways Committee reported on the result of the arbitration in connection with the purchase of the portion in London of the undertaking of the London United Tramways.

At the time of the result being published the Committee stated that there were certain disputed items in the award as to which further proceedings might be necessary; but it is now announced that, as the result of negotiations, terms have been agreed which will, the Committee think, provide for a satisfactory settlement both as regards the purchase and the working of the tramways. The lines affected, which are in the borough of Hammersmith, are about 5½ route miles in length, and are worked on the overhead trolley system. They include the London termini at Hammersmith-broadway, and at Shepherd's Bush-green of the system of tramways worked by the company, which extends to Hampton Court, Hounslow and other points in the county of Middlesex.

The arrangements proposed include provision for running arrangements between the Council and the company. It is proposed that the L.C.C. should pay £235,000 for the lines, and in addition £12,000 towards the

Digitized by Google

company's costs of the arbitration and subsequent proceedings. The Chiswick power station, including the whole of the plant, will be transferred to the Council. The Committee think that, having very carefully considered the matter in all its bearings, it will be to the interest of the Council to agree to the arrangements proposed.

The Finance Committee report that the capital expenditure involved will be as follows: Purchase price, £235,000; company's costs to be paid by Council, £12,000; Council's costs, £10,000; reconstruction of part of the purchaseable lines, £63,899; total, £320,899. In addition, further expenditure of some thousands of pounds will be necessary for junction lines, &c., necessary to give effect to the proposed through running arrangements. It is expected that this will be recouped by the increased traffic due to through running arrangements. It is estimated that, on the basis of an annual mileage of 1,200,000, the balance of receipts over working expenses (including renewals, but excluding power, which will be supplied by the company free of cost) will amount to £22,917 a year. The total debt charges in the first year will be about £26,870, decreasing annually by about £545.

The report was adopted.

Tram Rail Famine.—Last week a proposal was made by the Blackburn Electricity and Tramways Committee to discontinue the running of tramcars between Witton Stocks and Cherry Tree, and that the rails on such track be taken up so as to replace the worn-out rails on the Preston-road route.

The Chairman of the Committee (Ald Thompson), however, agreed to take back the matter as considerable opposition had been aroused.

Councillor HIGHAM said the recommendation to the committee by the manager and the chairman and vice-chairman was that the committee should visit the various tram routes, and give their opinion as to what course should be adopted. After they had heard the explanation as to why the tram rails were required, however, the committee came to the conclusion that there was no necessity to visit the routes, as there was no alternative before them. Although they were referring that matter back he was bound to say that he saw no hope whatever for continuing the tramway service unless the Witton route or some other route was stopped, and the rails taken up. They could not get rails from anywhere, as the Government would not allow the rolling of tram rails at present. Various tramway authorities in the country had endeavoured to obtain rails, but without success. The nearest approach had been that of Leeds, who obtained a tender from America at £22 a ton, with problematical delivery in 18 months' time.

Tramway and Omnibus Strikes.—Owing to a strike, the Borough of Keighley is without a tramway service, both the rail and railless car services being completely stopped.

Owing to a dispute between the London General Omnibus Co. and its employés as to the recognition of the union and other causes, there has been an almost total stoppage of the motor omnibus service in London this week, the result being that the electric tramways and underground electric railways have had to deal with considerable extra traffic. On Tuesday, Mr. Blain, operating manager of the L.G.O. Co., said that company and Messrs. Tilling had about 100 'buses running. No advances had been made by the men or the companies.

Tramway Employees' Wages.—Newcastle Corporation tramway employees have received an advance of 5s. per week.

Recently an advance of 3s. a week was given to Nottingham Corporation tramway employés, but an agitation has been started for a larger allowance, demanding a reference of the question to the Industrial Commissioners.

Women Tramcar Drivers.—In the report of the Amalgamated Association of Tramway and Vehicle Workers it is stated that "women tramcar drivers are a menace to male drivers, now and in future, and therefore their employment necessitates strenuous opposition."

At the annual conference at Leicester on Monday several delegates criticised the executive's action with reference to permitting employment of women drivers at Cardiff, Blackburn and other towns.

In reply, the president said the position taken up by the Board of Trade and the Ministry of Munitions was that there could be no interference unless it was proved that women drivers were a danger to the public.

The conference adopted a resolution insisting on the employment of discharged soldiers in place of women.

TELEGRAPHY AND TELEPHONY.

P.O. Telegraph and Telephone Service.—At the recent conference of the Telegraph Clerks' Conference the following resolutions were passed:—

One declaring that the apparent policy of the department to place the telegraph service in the background in favour of the development of the telephones was opposed to the best interests of the nation.

One protesting against the economical policy of the department during recent years, resulting in the serious deterioration of the telegraph service, whereby public telegrams are delayed and exposed to error, and demanding a return to conditions that would ensure a telegraph service combining speed with accuracy at once creditable to the staff and satisfactory to the public.

Resolutions were also carried urging that the scale of pay and conditions of service of men and women telephonists be raised to that of telegraphists, and instructing the incoming Executive Committee to take every possible step to bring the telephone administration into line with at least that of other branches of the Post Office service.

U.S.A.-Argentina Wireless Telegraphy.—The "Review of th River Plate" says the representative of a United States company (the Federal Holdings Co. it is believed), which holds a concession from the Argentine Government for the installation of a high-power wireless station to communicate directly between Argentina and Arlington, Virginia (U.S.A.), has informed the Ministry of Marine that certain modifications in the original project will be made. The power of the station is to be greater than was at first proposed, and instead of the three towers of the original plan, one single tower 300 metres in height is to be erected. Work upon the Argentine station is to be started shortly.

FOREIGN NOTES.

Italian, French and Spanish Commerce.—It is reported that the Unione Industriale Italo-Francese has been formed in Rome to promote a more intimate and effective economic relationship between the two countries.

The capital of the combination is for the present limited to 10,000,000 lire (about £400,000), with power to increase it to 20,000,000 lire. The Council of Administration is composed of 18 members, half French and half Italian. The headquarters are at Rome and branches may be opened in Paris and the chief commercial centres of France and Italy. Over 40 of the most prominent metallurgical, electrical, silk, tanning and other industrial firms of the two countries have already joined the Unione.

An Italo-Spanish Committee has been inaugurated in Rome to develop commercial relations between Italy and Spain, with particular reference to after-war conditions. At a meeting of this Committee in Rome it was announced that a Spanish mission composed especially of commercial and industrial experts, will visit the principal towns of Italy from about the middle of May onwards to study the possibilities of Italo-Spanish trade with a view to the conclusion of agreements for the period following the conclusion of peace. It is proposed to publish a journal in Italian and Spanish with a view to maintaining and improving the good relations of the two countries and also to increasing the solidarity of the Latin races in South America, and it is reported that a Brazilian Chamber of Commerce is likely to be formed at Genoa.

Japanese Railways and Telegraphs.—At March 31, 1915, the total mileage of railways open to traffic was 7,766, of which 5,690 miles were represented by the Imperial Government Railways, 1,387 miles by privately-worked railways and light railways, and 689 miles by the South Manchuria Railway.

The "Railway News" states that the mileage of private tramways open to traffic aggregated 1,196 miles, comprising 629 miles of electric, 195 miles of steam, 61 miles of gas, 243 miles of horse-drawn and 68 miles of the rikisha (man-drawn) tramways.

The number of stations open to telegraph service was 1,530, of which 905 were equipped for the acceptance of public messages, while the number of messages dealt with amounted to 48,276,062, including 7,009,571 public telegrams. The length of electric communication lines extended 6,219 miles, and communication wires 73,935 miles, with 2,134 sets of telegraph, 10,529 sets of telephone and 3,360 sets of block instruments.

The total length of power cables was 388 miles and the wire length 1,466 miles, while there were 72 prime motors developing 24,633 H.P., 76 generators representing 16,499 kw. The motor stock comprised 523 motors (7,016 kw.) for power supply, 422 (29,692 H.P.) on 124 electric tramways, 24 (7,920 H.P.) on 12 electric locomotives. The electric lighting apparatus comprised 65,220 glow lamps (3,257 kw.) and 511 arc lamps (293 kw.), besides 30,869 glow lamps fitted in the carriages. The current generated was equal to 15,046,519 units and that transformed to 7,952,714 units. The mileage travelled by the electric tramcars totalled 5,389,347, with 5,955,819 units consumed for running purposes, and the electric locomotive mileage 136,409 miles, with 2,549,124 units of current consumed.

Madrid Underground Electric Railway.—The contract for the earth and masonry works of the first line of the underground electric railway system in Madrid has been given to a Spanish firm.

Shanghai Municipal Electricity Works.—The accounts of the municipal electric supply undertaking for the year ended Dec. 31, 1916, show total capital outlay £935,905.

Revenue was £264,323 and gross profit (after allowing £43,178 for depreciation) £83,295, and after providing for interest, special charges, writing off stores, bad debts, depreciation of plant, &c., the balance carried to appropriation account was £47,318, of which £4,967 was contributed to general funds and the remainder carried forward. Plant capacity is 19,600 kw. (no alteration since last year), the capital cost per kilowatt being £47. 15s., and the maximum load was 19,167 kw. (14,400 kw.). Income was 1·02d. and works costs were 0·531d. per unit sold.

In his report, the engineer and manager (Mr. T. H. U. Aldridge) states that notwithstanding shortage of plant and underground cables, there was a large expansion of business. Reverting to his remarks in last year's report on the defects of the two German-built 2,000 kw. turbo-alternators, he says this year another tale of disaster concerning one of the 5,000 kw. A.E.G. machines could be told. For a period during the winter of 1916 the full supply of electricity could not always be kept up and some of the more recently connected large power users were put on restricted supply. Loss was suffered by the breakdown of the No. 3 A.E.G. alternator at Riverside, because while the machine was out of

Digitized by Google

commission less efficient machines had to be run, with the result that the coal cost rose during that period. Units generated at Riverside and Fearon-road were respectively 69,796,698 (increase 14,951,283) and 7,763,986 units (increase 317,958). Mr. Aldridge emphasises the acuteness of the demand for additional plant by stating that the percentage of spares is only 2·2 per cent. The units sold were 62,160,796 (against 49,787,397); the load factor was 38·2 per cent., compared with 40·8 per cent. in previous year. Heating and cooking units (899,585, against 679,704) showed 32 per cent. increase in spite of the restriction of the radiators on hire to the same number as the previous year, owing to shortage of generating plant. Transformers installed aggregate 20,571 kw. (net increase 2,286 kw.). For public lighting the remaining enclosed and flame arcs were replaced by nitrogen field half-watt metal filament lamps. Fines for lamps out have fallen by 60 per cent. There are 1,583 m.f. street lamps connected, besides 220 (increase 121) in private roads, &c., and also an increasing number of installations for lighting alleyways for which the landlord supplies the wiring, &c. House connections are 21,859 (net increase 3,755), and total connections, including fans, radiators and cookers, but not street lamps or motors, are equivalent to 694,833 (increase 73,755) 30-watt lamps. Motors connected are equal to 20,340 H.P. (net increase 5,790 H.P.).

The estimated profit for 1917 is £38,725, interest allowed for being £48,250 and depreciation £50,202, the estimated profit being reduced by the fact that the price of coal has risen 50 per cent. above last year's prices. Only 2·13 miles more of the 22,000-volt split conductor underground cables remained to be laid to complete the four trunk mains connecting Riverside with Fearon-road. The G.E.C. 10,000-kw. turbo-alternator arrived in good time, and a large temporary structure had to be erected over the turbine room, there having been considerable delay in getting the steelwork from the United States. It has been extremely difficult to get the steel tubes for the boilers. The charges for current for light, heat and power (other than bulk supplies with special provisions in contracts) were increased by 15 per cent. at the beginning of 1917, but there has been no falling off in the demands. New cotton mills and other factories requiring power are being built.

In a note accompanying the report Mr. Aldridge says some people in Shanghai, in common with those in English municipalities, have doubted the wisdom of building up a large power supply business and selling cheap units, but the result of the last few years' working at Shanghai has conclusively shown that the bigger the output of these power units the greater the prosperity of the undertaking. The year's net profit (£48,250), after meeting interest charges, special depreciation on the old Fearon-road. station (the steam generating plant in which will be scrapped in a few years), reserve for bad and doubtful debts, brokerage and other special charges (in all £47,318), and after writing off £43,178 for depreciation, was equal to 8·9 per cent. on the capital outlay.

MISCELLANEOUS.

An Electrically-operated Machine Gun.—It is reported that a new machine gun has been invented in Switzerland. The mechanism, which is operated by electricity, is stated to be capable of firing far more projectiles in a given time than any existing machine gun, and to fire without any detonation.

Board of Trade Electrical Power Committee.—The Council of the Incorporated Municipal Electrical Association has passed a resolution protesting against the inadequate representation of municipal electrical industries on this Committee.

Amongst the local authorities who have passed similar resolutions are the Corporations of Bristol, Bradford and Sunderland.

Inquests.—An inquest was held at Lanner last week on two youths named Wm. H. Mugford and Nelson Geach who were killed on the 3rd inst.

Evidence was given by a miner named Harris, who said that the youths suggested going up an electric pole. He advised they had better not do that, but they persisted. He saw them commence to climb the pole, and then walked away. Returning a little later he saw Mugford on the middle bar, and it looked as if his foot was on fire. Geach was on the top of the pole lying across it. Witness called to the lads, but neither answered. He called a Mr. Read and at that moment Mugford's body fell to the ground. There were wire protections around the poles and notices were posted warning the public as to the danger of interfering with the poles. It was stated on the notices that the strength of the current along the wire was 10,000 volts.

It was remarked by a juror that Geach, thinking to fit himself for the Navy, had been climbing poles. He had mastered telegraph poles and then thought to try an electric standard.

Thos. Read, farmer, stated that he saw the youths climbing the pole, and he shouted, asking them if they were not aware of the danger. He believed they heard him, but took no notice.

Mr. L. A. Hards, manager of the Cornwall Electric Power Co., said that one of the lads probably touched the wire and, in his convulsion, caught hold of the other lad, who was also killed. There was no cross connection between the wires. No one should ever touch a person in contact with a wire carrying current at 10,000 volts. The wires carrying the current went to Tresavean and were controlled from the Carn Brea section. The wires ran through from there to Carnon Valley. The current was supplied to Carnon Downs to keep some machinery there in order. He pointed out that even if the current were cut off from those wires they were still dangerous to touch, and when a man touched such a wire he would get such a shock as would knock him off the pole. Although the energy would not be enough to kill him, he would receive a severe shock. People had been killed with current at 200 volts; it was possible for a man to be killed by contact with the tramway wires. The poles carrying the wires were protected andt most people understood the danger.

The Foreman said that 90 per cent. of the people thought the current was cut off from Tresavean to Carnon.

Mr. Hards said it was dangerous to touch the wire whether the power was on or not. The poles carrying the wire were 45 ft. high; 13 ft. from the ground were strands of barbed wire around the pole for a distance of 18 inches, and on a certain number of poles danger notices were fixed.

The Coroner said the lads, knowing the danger, must have been arrant fools to climb the pole.

The jury returned a verdict of "Accidental death," and expressed sympathy with the bereaved families.

On Tuesday an inquest was held at Dudley or Joseph C. Beaumont, who was killed at a local factory.

Deceased had been employed at the factory since January last, and on Saturday morning he went to one of the blocks to put out unnecessary lights. Afterwards he invited a change hand and a tool-setter to accompany him to the transformer house, the door of which he unlocked. After they had entered the building deceased mentioned that current of 5,500 volts was passing through a high-tension switch. He went to the cubicle containing the switch, opened the door and directly afterwards it was noticed that his right sleeve was smouldering and he was in a contorted position. Directly afterwards deceased dropped away from the cubicle and was found to be dead.

Evidence was given that there was no reason for deceased to have gone near the cubicle, and he acted wrongly in taking two men with him. The marks on the cubicle showed that deceased must have touched a copper wire when the side of his arm and left leg were touching the case, thus making the contact and causing the whole of the current to pass through his body. He made what was a dead earth, which caused switches to trip out at the power station at Smethwick, Oldbury and at the factory. The case and the copper wire were "earthed" in accordance with the regulations of the Board of Trade, and additional precautions against accident had been adopted.

A verdict of "Accidental death" was returned.

"Printers' Pie, 1917."—We are pleased to notice that that ever-welcome annual, "Printers' Pie," made its appearance on the 14th inst., and, judging by the list of eminent authors and artists who have contributed to its pages, it will undoubtedly come as a cheery gleam to those on active service, in hospitals and camps, or at home.

There are stories by A. S. Barrow, Lieut.-Col. Newnham-Davis, Harry Graham, Wm. Le Queux, Mostyn T. Pigott, W. Pett Ridge, Reg. Rigby, Geo. R. Sims and J. D. Symon. Drawings are contributed by a number of distinguished artists.

"Printers' Pie" is published by the Sphere and Tatler (Ltd.), and obtainable at all booksellers and bookstalls at 1s. net. It is indeed wonderful value at this price.

Prohibited and Restricted Exports.—His Majesty in Council issued a Proclamation on May 10 consolidating previous Proclamations and Orders as to prohibited and restricted exports.

Articles marked A are prohibited to all destinations, those marked B to all ports and destinations abroad, other than ports and destinations in British Possessions and Protectorates; and those marked C to all destinations in foreign countries in Europe and on the Mediterranean and Black Seas, other than France and French Possessions, Russia, Italy and Italian Possessions, Spain and Portugal, and all ports in any such foreign countries, and to all Russian Baltic ports.

The amended schedule includes: A, aeroplane engines and parts; A, aluminium powder, aluminium alloys and manufacture of aluminiums; B, asbestos and articles manufactured wholly or partly thereof; A, ball and roller bearings; C, woven hair belting; C, liquid or solid bitumen; A, boilers and boiler tubes; A, bronze powder; B, insulated cables; B, cadmium, alloys of cadmium and cadmium ore; A, Brazilian carbon, carbons suitable for searchlights, malleable hæmatite iron castings, celluloid, cerium and its alloys (except ferro-cerium), and all metallic acetates; B, aluminium oxides and mixtures containing same; C, salts of aluminium (except aluminium nitrate and sulphate, alumino-ferric and ammonium alum); B, aluminium sulphate, alumino-ferric; C, compounds of antimony (except sulphides and oxides of antimony); B, sulphides and oxides of antimony; B, barium peroxide and sulphate; B, oxides and salts of cerium; B, compounds of chromium (except chromium acetate, chlorine and nitrate), and mixtures containing such compounds; A, chromium acetate, chlorate and nitrate; A, collodion; A, copper acetate; C, compounds of copper (except acetate, iodide, nitrate, sulphate and suboxide), and mixtures containing same; B, copper iodide; A, copper nitrate; B, suboxide of copper and mixtures containing same; B, copper sulphate; C, iridium compounds; C, oxides of iron and iron sulphates; A, lead compounds and mixtures containing same; C, manganese compounds not otherwise prohibited; B, mercury compounds and preparations (except nitrates) and mixtures containing same; A, mercury nitrate; A, nickel nitrate; B, nike oxides and salts (except nickel nitrate), and mixtures containing same; A, all metallic nitrates; C, chromium compounds; C, palladium compounds; A, strontium compounds and mixtures containing same; C, metallic sulphides not otherwise prohibited; B, oxides and salts of thorium; B, chlorides of tin; C, compounds of tin chlorides and oxide; B, oxide of tin and mixtures containing same; A, titanium com-

Digitized by Google

pounds ; A, salts of platinum ; B, tungsten compounds ; C, uranium compounds ; B, zinc chloride and sulphate and mixtures containing same ; A, zinc oxide ; B, zinc sulphide ; A, zirconium compounds ; A, copper ore, regulus, matte, nitrate and precipitate ; A, copper refined or unrefined, including brass, bronze and yellow metal, and all alloys of copper ; C, electrical apparatus and plant not otherwise prohibited ; B, electric lamps (except carbon filament lamps, arc lamps for street lighting and pocket electric lamps and parts) ; C, pocket electric lamps and parts ; A, electrodes, carbons for electrical purposes ; B, ferro-cerium ; B, ferro-chrome, ferro-manganese ; A, ferro-molybdenum ; B, ferro-nickel, ferro-titanium ; A, ferro-tungsten ; B, ferro-vanadium, silicon, spiegel, spiegeleisen ; A, ferro-silicon ; B, portable forges ; A, fuel economisers constructed of c.i. pipes ; C, compounds for electrical insulation ; C, leatheroid, oiled cloth and tape, vulcanised fibre ; C, zinc barium pigments made from zinc salts and barium sulphate (except zinc oxide) ; C, iridium and its alloys ; A, iron and iron articles containing chrome, cobalt, molybdenum, nickel, tungsten or vanadium ; A, iron angles, bars, billets, ingots or pigs, pipes (wrought), plates, scrap, tubes, &c. ; B, lead ore ; A, lead, lead alloys, and manufactures of lead or lead alloys ; C, metal working machinery and parts ; A, magnetos and parts ; B, manganese and manganese ore ; B, mica ; A, mercury ; B, molybdenum and molybdenite ; A, platinum, alloys of platinum and manufactures containing same ; C, railway material (except carriages, locomotives and wagons and their parts, steel rails and sleepers) ; A, railway rails, sleepers, springs and other constructional material, wheels, axles and tyres ; B, searchlights and parts ; A, engines for use on board ship, including Diesel and other internal combustion engines and parts, machinery for steamships, and parts, ships' telegraphs and parts ; B, sparking plugs ; A, spelter and spelter dross ; A, steel and steel articles containing nickel or vanadium, steel containing tungsten or molybdenum and tools or other articles made from such steel, steel bars, rounds and other sections and shapes steel structural material, ingots, plates, &c. ; B, submarine sound-signalling apparatus ; A, telegraphs, including wireless and telephones and instruments and material therefor ; A, titanium alloys and titanium ores ; A, tungsten (except tungsten filaments for electric lamps ; B, tungsten filaments for electric lamps ; B, tungsten ores ; A, uranium alloys, alloys of uranium and uranium ores ; C, gas, steam and water valves ; B, vanadium ; B, insulated wires ; B, X-ray apparatus ; B, zinc ore ; A, zinc alloys, manufactures of zinc and zinc dust ; A, zirconium and its alloys ; B, zirconium minerals.

Prohibited Imports.—The importation of manufactures of rubber is prohibited as from May 10.

Railway Rates.—The Board of Trade has placed "strips, iron or steel, packed" in Class C of the schedule of maximum rates and charges fixed under the Railway and Canal Traffic Act.

Trading With the Enemy.—The "London Gazette" of May 11 contains additions and alterations to removals from the statutory list of firms and persons with whom trading by firms and persons in the United Kingdom is prohibited.

Among the names removed from the list is : *Brazil* :—Figner, Friedrich (casa Edison), (Rio de Janeiro).

Tribunal Case.—At Barnstaple last week the military applied for the withdrawal of the exemption of Malcolm Y. Andrew, 18, B1, premium pupil to the electrical engineer and manager of Barnstaple Corporation.

Mr. J. W. HADFIELD said the conditions imposed by the tribunal when the exemption was granted were being observed. He had been training the man for 18 months.

Ald. H. BARRETT, chairman of the Electric Light Committee, said if the military would supply them with a competent substitute the man could go, but Mr. Hadfield could not devote the necessary time to train anyone to take Andrew's place.

Mr. WOODCOCK (Military representative) said it was not for the military to supply a substitute. He knew of one switchboard attendant who had applied to the Labour Exchange for a post, but they had none for him.

Mr. HADFIELD believed the man he understood to be referred to, picked up his knowledge of electricity and would require capable supervision, which he had not the time to devote.

The application was dismissed, but Mr. Woodcock gave notice of appeal.

Unemployment Insurance.—The Umpire has given the following decisions :—

Contributions are payable in the case of workmen engaged in the manufacture of electrical cooking and heating apparatus ; but contributions are not payable in respect of workmen (other than those engaged in saw-milling or machine wood work) engaged in the work of handling, preparing and creosoting telegraph poles and other timber.

Wage Awards.—Owing to several non-federated firms not complying with the national wage award made recently to the engineering, foundry and shipbuilding trades, the Ministry of Munitions has circularised trade unions, notifying them that steps are being taken to obtain statutory powers to enable the Ministry to make the award compulsory. At present non-federated firms cannot be compelled to pay the award. The compulsory recognition of wage awards made in future by the Committee on Production will probably allay much of the irritation which has arisen through delay in their general application.

Wiremen's Wages.—Requests have been made by wiremen and wiremen's mates in the electrical section of the London County Council's tramway department for an increase of 2¾d. and 2d. an hour respectively in their rates of pay ; and by men employed at Greenwich generating station that their war bonus shall be increased to 12s. a week as from April 1 last, have been referred to the Electrical Conciliation Board.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during April, 1917, and (*b*) the aggregate figures from Jan. 1 to April 30, with increase or decrease compared with corresponding periods of 1916 :—

Electrical machinery, (*a*) £129,808 (increase £22,284), (*b*) £490,516 (increase £118,789) ; including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £14,023 (increase £1,716), (*b*) £76,225 (increase £18,878) ; and electrical machinery unenumerated, (*a*) £115,785 (increase £20,568), (*b*) £414,291 (increase £99,911) ; telegraph and telephone cables other than submarine, (*a*) £1,122 (decrease £7,926), (*b*) £43,852 (increase £12,115) ; telegraph and telephone apparatus, (*a*) £2,585 (decrease £41,987), (*b*) £11,572 (decrease £79,989) ; other electrical wires and cables, rubber insulated, (*a*) £1,242 (decrease £3,370), (*b*) £22,833 (decrease £11,624) ; with other insulations, (*a*) £1,024 (decrease £676), (*b*) £3,672 (increase £668) ; carbons, (*a*) £9,128 (increase £2,386), (*b*) £31,804 (decrease £1,499) ; glow lamps, (*a*) £4,674 (decrease £32,478), (*b*) £59,590 (decrease £26,823) ; arc lamps and electric searchlights, (*a*) nil, (*b*) £38 (increase £38) ; parts of arc lamps and searchlights (other than carbons), (*a*) £10,345 (increase £5,157), (*b*) £37,482 (increase £12,395) ; primary and secondary batteries, (*a*) £27,071 (increase £9,924), (*b*) £129,374 (increase £59,083) ; meters and measuring instruments, (*a*) £596 (decrease £2,790), (*b*) £9,107 (decrease £3,219) ; switchboards, (*a*) nil (decrease £5), (*b*) nil (decrease £253) ; electrical goods and apparatus unenumerated, (*a*) £48,090 (increase £29,167), (*b*) £175,639 (increase £84,691). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £106,177 (decrease £42,398), (*b*) £524,963 (increase £45,583).

Exports.—The exports of electrical machinery, material, &c. (*a*) during April, 1917, and (*b*) from Jan. 1 to April 30, with increase or decrease compared with corresponding periods of 1916 were as follows :—

Electrical machinery, (*a*) £87,809 (increase £6,333), (*b*) £490,036 (increase £100,303) ; including railway and tramway motors, (*a*) £360 (decrease £970), (*b*) £10,643 (decrease £2,604) ; other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £43,320 (increase £4,082), (*b*) £271,552 (increase £64,086) ; and electrical machinery unenumerated, (*a*) £44,129 (increase £3,221), (*b*) £207,841 (increase £38,820) ; telegraph and telephone cables, submarine (*a*) £23,955 (increase £7,223), (*b*) £95,979 (increase £10,577) ; other than submarine, (*a*) £77,554 (increase £34,794), (*b*) £298,869 (increase £96,953) ; telegraph and telephone apparatus, (*a*) £12,254 (decrease £10,681), (*b*) £69,828 (decrease £23,029) ; other electrical wires and cables, rubber insulated, (*a*) £6,941 (decrease £23,664), (*b*) £109,777 (decrease £32,349) ; with other insulation, (*a*) £11,462 (decrease £47,271), (*b*) £133,502 (decrease £100,918) ; carbons, (*a*) £1,312 (increase £44), (*b*) £8,486 (increase £4,956) ; glow lamps, (*a*) £8,843 (decrease £2,095), (*b*) £49,501 (decrease £218) ; arc lamps and searchlights, (*a*) £10 (decrease £700), (*b*) £10,548 (increase £5,697) ; parts of arc lamps and searchlights (other than carbons), (*a*) £4,581 (increase £2,929), (*b*) £15,919 (increase £11,312) ; primary and secondary batteries, (*a*) £10,611 (decrease £10,486), (*b*) £63,340 (decrease £15,739) ; meters and measuring implements, (*a*) £6,349 (decrease £8,254), (*b*) £45,193 (decrease £14,053) ; transformers, (*a*) £2,471 (decrease £1,606), (*b*) £22,747 (increase £4,844) ; switchboards, (*a*) £1,788 (decrease £4,555), (*b*) £10,266 (decrease £11,305) ; electrical goods and apparatus unenumerated, (*a*) £52,574 (increase £11,756), (*b*) £232,545 (increase £50,348). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £220,705 (decrease £52,569, (*b*) £1,166,500 (decrease £13,518).

EDUCATIONAL.

Armstrong College, Newcastle-on-Tyne.—The Council have accepted the offer of the Ebbw Vale Steel, Iron & Coal Co. of three exhibitions of £60 per annum for students in the mining department.

New Technical School.—The Dudley Education Committee has requested the Town Council to purchase land in the Ednam-road for the erection of a new technical school, which is to be provided jointly by Dudley Town and Staffordshire County Councils.

Engineering Apprentices' Education.—Glasgow School Board recently received an offer from Messrs. Barr & Stroud to co-operate in the education of their future apprentices by means of scholarships, and the offer has been referred to a Special Committee for report.

The firm stated that they were of opinion it would be to the advantage of apprentices that they should stay at the day schools until they were at least 15 years old, and provided the year spent at school from 14 to 15 was devoted to subjects specially suitable for and interesting to engineering apprentices, they had resolved to institute 10 scholarships of £10 each tenable for one year ; they would be awarded to boys of 14 years recommended by the headmaster of certain selected schools ; they would be tenable at a school in which a course of instruction in mathematics and practical physics suitable for engineer apprentices could be followed ; the boys, before taking up the scholarship, would sign an agreement to serve five years' apprenticeship with the firm to the trade of instrument-making or of engineering.

Digitized by Google

TENDERS INVITED AND ACCEPTED.

Electrical and General Stores.

MANCHESTER Electricity Committee require tenders by 10 a.m. May 25 for 12 months' supply of Various Stores.

Mechanical Stoker.

WARRINGTON Electricity and Tramways Committee require tenders by noon May 22 for an Underfeed Type Mechanical Stoker. Specification, &c., from the Borough Electrical and Tramways Engineer.

Electric Lamps.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. May 23 for supply of 8,250 Incandescent Electric Lamps during the year ending June 30, 1918. Specification, &c., from the Commissioner's Offices, Spencer-street, Melbourne.

Telephone Operators' Chair Fittings.

The COMMISSIONERS OF H.M. WORKS, &c., require tenders by 11 a.m. May 18 for the supply of Telephone Operators' Chair Fittings. Forms of tender, &c., from the Controller of Supplies, King Charles-street, Westminster, S.W. 1.

BARROW-IN-FURNESS.—The following tenders have been accepted by the Corporation :—

British Thomson-Houston Co., 250 kw. rotary converter, £1,165; Stirling Boiler Co., water-tube boiler, £4,221; British Insulated & Helsby Cables, wire, joint-boxes and cutouts; A. F. Goodwin & Co., fuse wire, &c.; General Elec. Co., switches and lampholders; A. P. Lundberg & Sons, adapter and pin plugs; Chamberlain & Hookham, meters; Ferranti (Ltd.), meters and meter boards; Drake & Gorham, tantalum lamps, &c.; Doulton & Co., pipes and troughs; L. Andrew & Co., Para strip, &c.; Dussek Bitumen Co., insulating compound, &c.; Vacuum Oil Co., oils; H. G. Mable & Son, shellac, varnish, &c.

LONDON COUNTY COUNCIL.—Only one tender was received for the supply of six auto-transformers required in connection with the proposed supply of power in the Woolwich district—viz., from the British Electric Transformer Co., at £596. 9s., and this has been accepted.

SOUTHEND.—The Council has accepted the tender of the Worthington Pump Co. for a centrifugal pump at the electricity works at £53. 10s., also the tender of John Sadd & Sons, at £47. 14s. 6d., for meter boards.

BATTERSEA (LONDON).—The following tenders have been accepted by the Borough Council :—

Reason Mfg. Co., electrolytic meters; Pryke & Palmer, ironmongery &c.; Jensen & Nicholson, varnish, &c.; Doulton & Co., stoneware pipes; Dussek Bitumen Co., box compound and bitumen composition.

FARNBOROUGH.—The Council has accepted the tender of the Pulsometer Engineering Co. (at £112. 10s.) for an electric motor and pump for the sewage works.

LEEDS.—The Electricity Committee has accepted the tenders of the British Thomson-Houston Co. for lamps and h.t. switchgear, Tramway Supplies (Ltd.) for h.t. switchgear, and J. Henry (Ltd.) for castings.

SOUTH SHIELDS.—The Corporation have accepted the tender of the British Westinghouse Co. for extensions and alterations to the 1,500 kw. turbine, at £940.

WOLVERHAMPTON.—The Council has accepted the tender of the Staveley Iron & Coal Co. for c.i. condenser pipes at £825.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments :—

Postmaster-General's Dept., Melbourne.—British General Electric Co., 1,000 condensers 1s. 10d. each, 20 strips keys 12s. 9d. strip, 100 microphones 5s. 9d. each, 2,000 caps for supervisory lamp 5d. each, 100 strips, jacks, 10s. 8d. strip, 120 strips ditto 8s. 6d. strip, 200 supervisory lamps 10d. each, 300 line lamps 10d. each, 100 ditto 1s. each, 100 nuts 2d. each; Warburton Franki, 5,000 dry cells, 1s. 11d. each.

Postmaster-General's Dept., Sydney.—Western Electric Co., 50 carbon blocks 2s. each, 10 coils £2 each, 50 condensers 11s. each, 4,500 ditto 2s. 5d. each, 3,500 cords 1s. 10d. each, 150 diaphragms 9d. each, 1,800 line lamps 6½d. each, 40 resistances 1s. 5d. each, 1,120 lb. solder 1s. 8d. per lb.; Jas. Paton & Co., 300 carbon blocks 1s. 2d. each, 120 microphone chambers 2s. 4d. each, 75 ditto 2s. 3d. each, 1,000 diaphragms 8d. each, 1,200 ditto 7d. each, 500 ditto 5d. each, 200 indicators 4s. 2d. each, 25 strips jacks 17s. per strip, 1,000 lugs ½d. each, 5,000 plugs 1s. 6d. each, 4,500 ditto 1s. 1d. each; Lawrence & Hanson Co., 50 condensers 6s. 2d. each, 600 cords 3s. 1d. each, 6,000 ditto 1s. 8½d. each, 2,000 ditto 2s. 2½d. each, 1,000 earpieces 5½d. each, 750,000 staples 4s. 11½d. per 1,000; Oliver Mfg. Co., 10,000 fuses 3½d. each, 1,000 ditto 9d. each, 300 switches 6s. 10d. each; British General Electric Co., 150 bells sets, £2. 16s. each; India Rubber Gutta Percha & Telegraph Works Co., 7,500 copper binders 5s. 8d. per 100, 5,000 ditto 6s. 4d. per 100, 9,000 ditto 10s. per 100, 8,000 ditto 12s. 9d. per 100, 2,500 ditto 15s. per 100, 5,000 copper tapes 4s. 6d. per 100, 15,000 ditto 7s. per 100, 5,000 ditto 12s. 6d. per 100, 3,000 ditto 15s. 6d. per 100.

Postmaster-General's Dept., Brisbane.—Western Electric Co., 400 lamps 6½d. each, 150 arresters 5s. each, 30 sounders 10s. 10d. each, 200 cords 1s. 9d. each, 200 ditto 1s. 11d. each, 100 ditto 3s. 8d. each, 28 strips jacks 8s. 6d. per strip, 45 ditto 9s. 6d. per strip, 50 keys 3s. 6d. each, 60 ditto 9s. 6d. each, 850 plugs 5s. per 100, 5 relays 7s. 6d. each, 40 ditto 13s. 3d. each, 20 ditto 9s. 9d. each, 2 ditto 7s. 6d. each, 20 ditto 10s. 3d. each, 50 ditto 10s. 6d. each, 5 ditto 17s. each, 20 ditto 35s. each, 95 resistances 1s. 5d. each, 100 calautograph ribbons 4s. 9d. each, 20 strips lamp sockets, strips of 10, 9s. per strip, 80 terminal strips 4s. 6d. each; British Insulated & Helsby Cables, 11 miles wire £22. 17s. per mile, 20 miles ditto £7 per mile, 6 artificial lines £20 each, 2 relays £7 each, 5 lever switches 14s. each, 100 cords 2s. each, 250 ditto 2s. 7d. each; India Rubber, Gutta Percha & Telegraph Works Co., 1 Wheatstone automatic receiver 13s. 3d., 2 recording armatures 70s. each, 6 spindle and gear wheels 17s. 3d. each, 2 polechanger blocks £7. 10s. each, 3 jewelled pivot springs for transmitter 13s. 3d. each, 6 star wheels for tape feed 9s. 3d. each, 3 tape guide plates 21s. 6d. each, 1 chain for driving motor weight; Jas. Paton & Co., 25 indicators 4s. 4d. each, 150 plugs 1s. 8d. each, 4,500 ditto 1s. 2d. each, 2,500 ditto 1s. 6d. each, 200 ditto 1s. 5d. each 60 electrical registers 32s. each, 10 relays 5s. 8d. each, 275 terminal strips 6s. 10d. each; Noyes Bros., 40 miles wire £36. 10s. per mile; Electric Supplies & Engineering Co., 2 ammeters £8. 10s. each, 2 voltmeters £8 each; H. Rowe & Co., 1 megger £33. 12s., 2 meggers £8. 18s. each.

Postmaster-General's Dept., Adelaide.—Lawrence & Hanson Co., 5,000 cords 7½d. each, 300 ditto 1s. 2d. each, 150 ditto 2s. 10½d. each, 300 ditto 2s. 8d. each; British General Electric Co., 200 telephones, with generator, for extension stations, 53s. each; Western Elec. Co., 50 telephonemeters £2. 7s. 10d. each, 10 repeating coils 8s. 9d. each; India Rubber, Gutta Percha & Telegraph Works Co., 500 fuses 5½d. each; Callender's Cable & Construction Co., 10 miles' wire £22. 15s. per mile, 30 miles ditto £33. 10s. per mile, 30 miles ditto £23. 15s. per mile, 5 miles ditto £11. 5s. per mile, 8 miles ditto £13. 15s. per mile; Gray Bros., 8,000 spindles 1s. 3½d. each

APPOINTMENTS VACANT AND FILLED.

An experienced electrician is wanted for docks and railway. *See advertisement.*

Mr. J. T. Fayle, of Leyton, has been appointed traffic superintendent of the Southend tramway system.

BUSINESS ITEMS.

On the 21st inst. Messrs. W. T. Henley's Telegraph Works Co., Ltd. will remove their Birmingham branch offices and stock rooms to Broad-street chambers. The new premises will afford facilities for carrying much larger stocks of electric wires and cables, flexible cords, jointing materials, boxes, tapes, &c., to meet War demands for urgent delivery. The new telephone number is Midland 790, but the telegraphic address remains "Henletel, Birmingham."

For reasons of health Mr. A. E. G. Braithwaite has retired from the firm of Messrs. Braithwaite & Kirk, engineers, of 117, Victoria-street, London, S.W., and West Bromwich, Birmingham, &c. The remaining partners (Messrs. J. H. Humphreys and A. Anderson) have taken over the business and are continuing it under the title of Braithwaite & Co., who will receive all debts due to and discharge all liabilities by the late firm.

Fred Collins and Chas. Edward Price, electricians and electrical engineers, 35, Moorfields, Liverpool, and 28A, Market-street, Hoylake, have dissolved partnership. Debts by or to the Liverpool branch will be paid or received by Mr. Collins, and those in respect of the Hoylake branch by Mr. Price.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of June 14. *Further particulars are set out in an advertisement.*

Amendment of Patent Specification.—It is announced that Mr. C. O. Bastian is seeking leave to amend the specification of Letters Patent No. 12,867/1914, granted to him for "Improvements in or relating to electrical resistances." Particulars are given in the "Illustrated Official Journal (Patents)" of May 9, and notices of opposition must be given within a month from that date.

CATALOGUES, &c.

Switchgear.—We have received from the British Westinghouse Electric & Mfg. Co., Trafford Park, Manchester, a group of ten well prepared, nicely illustrated leaflets which show a series of the company's switchgear installations. Each leaflet gives a clear illustration of some piece of switch equipment or switchgear supplied by the company, together with brief particulars of its construction and operation.

Wiring Hints for Western Electric Inter-phones.—A booklet has been issued by the Western Electric Co., Ltd., under the above title, giving some useful hints of "Inter-phone" connections.

After dealing with typical equipment, the fitting of wall and table sets, the location of batteries, &c., the installation and wiring is explained, the use of cable terminals and the waxing and forming of the cable being illustrated by appropriate diagrams. A wiring diagram for a complete 7-line system is presented. Some brief directions for finding and clearing faults are given. Finally there is a concise explanation of the working of the sets.

LIQUIDATIONS, &c.

Meetings of creditors and contributories of the Australian Metal Co. (Ltd.), 14, George-street, London, E.C., will be held on Oct. 23 at 33, Carey-street, London, W.C.

Claims against the Harman Electric Co. (Ltd.) are to be sent by June 30 to the liquidator, Mr. P. F. Huddleston, 72, Finsbury-pavement, London, E.C.

Digitized by Google

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Adelaide (S. Australia.)—The accounts of the Municipal Tramways Trust for the two years ended July 31 last have been issued :—

Total capital expenditure £2,279,930 and total appropriation (including reserve, interest and sinking fund) £691,005. The following figures relate respectively to the four half-years ended (*a*) Jan., 1915, (*b*) July, 1915, (*c*) Jan., 1916, and (*d*) July, 1916 : Revenue (*a*) £157,149 =15·02d. per car-mile, (*b*) £153,283 = 15·25d., (*c*) £160,463=16d., (*d*) £163,789=16·73d. Total costs, including operating expenses, reserve, interest and sinking fund (*a*) £62,431, (*b*) £62,390, (*c*) £64,579, (*d*) £64,696. Total working expenses were (*a*) 9·22d., (*b*) 9·45d., (*c*) 9·68d., (*d*) 10·05d. per car-mile. Excess of receipts over working expenses was (*a*) £60,261, (*b*) £58,129, (*c*) £63,019, (*d*) £64,750. Car-miles run were (*a*) 2,509,185, (*b*) 2,405,172, (*c*) 2,390,519, (*d*) 2,328,524.

Blackburn.—The gross capital expenditure of the tramways department at March 25 was £336,258, the amount repaid being £111,962.

Revenue was £67,434 (compared with £68,410 in previous year), working expenses were £50,156 (£46,964) and gross profit was £17,277 (£21,446). Interest required £3,002, sinking fund instalments £10,002, public works loan repayments £6,022, and income tax £670, leaving a net deficit of £2,439 (compared with a profit of £1,756). Receipts per car-mile were 14·44d. (against 14·12d.) and working expenses (including power) were 10·86d. ; passengers carried were 11,862,343 (12,246,151) and car-miles run 1,052,078 (1,091,050). In his report, Mr. J. H. Cowell (general manager) states that the units consumed increased from 1·53 to 1·64 per car-mile, due to changes of drivers. Current cost 2·48d. (against 2·13d.) per car-mile, due to increased consumption per car-mile and to the increase of current. There are 12 women drivers and 42 women conductors. £2,983 was paid to dependents of men serving with H.M. Forces.

Durban (Natal).—The accounts of the electric supply department for the year ended July 31, 1916, show that the net capital liability is £400,000 (no increase).

Revenue was £116,008 (compared with £104,554 in previous year) working expenses were £54,976 (£48,522), capital charges, interest and sinking fund required £20,231 (£19,160), and £12,000 (£12,778) was placed to depreciation and renewals, and £17,936 (£17,336) contributed to borough funds, leaving a surplus of £10,864 (£3,418) The total amount contributed to borough funds is now £198,537. Units sold were 20,025,906 (17,659,922). Consumers increased from 7,230 to 7,717.

The borough electrical engineer, Mr. John Roberts, says in his report the supply for motive power is the branch of the business showing the greatest development, the units sold for power purposes being 7,092,749 (against 5,680,174), exclusive of tramway and Government supplies. A fair proportion of this power supply is used outside the borough, and Mr. Roberts is in favour of encouraging such demands and making the district attractive to those desiring to establish industries. A turbine has been put down at the works running at 3,000 revs. per min. and driving a three-phase alternator at the same speed, as well as a 1,000 kw. d.c. generator through gearing. Mr. Roberts believes this to be the first turbine driving a generator through gearing installed in South Africa, and it has run most successfully. A new British Westinghouse condenser fitted with a rotary air pump has also been purchased. Average receipts were 1·37d. per unit, and total expenses, including capital charges, were 1·03d.

Leeds.—The statement of income and expenditure on the Corporation tramways for the year ended March 31 shows that the income was £515,806 (compared with £475,505 in previous year), and that general repairs and maintenance cost £53,290 (against £42,786). Power expenses were £37,560 (£33,766), less power used at depots, &c., £2,462 (£1,751), war bonus required £10,765 (£5,511), and balance carried to net revenue account was £254,320 (£239,278).

To this sum was added £2,378 (£4,413) bank interest, and £7,377 (£5,867) dividends on investments. Interest on Sovereign-street and Burmantofts property required £3,343 (£3,218), interest on capital £49,776 (£49,444), income tax £17,846 (£15,349), rent of lines, &c., of Morley tramways £3,018 (£3,071), and war allowances to dependents £12,890 (£13,270), leaving net revenue £177,200 (£165,204). Out of this, redemption fund required £64,204 (£72,488), contributions to cost of Act £445 (£703), renewals of permanent way £30,000 (£3,146), revenue contribution to capital outlay £2,373 (nil), and reserve for third-party risks £746 (£2,044), the net surplus being £79,431 (£71,821).

Marylebone (London).—The revenue statement of the electricity undertaking for the December quarter gives the following particulars :—

Units sold 5,341,237 (an increase of 358,783 over the December quarter of 1915), income from consumers £63,252 (increase £2,783), gross revenue £72,918 (compared with £69,991), expenditure £25,383 (against £21,636), total costs (other than capital charges) were 1·141d. (against 1·042d.) per unit sold. Coal cost increased 14 per cent., and repairs were abnormally high. The sales and publicity department showed a credit balance of £571 (£343) for the quarter. The credit balance for the June, 1916, quarter was £17,945 (against £15,872 for corresponding quarter of 1915), for the September quarter £14,504 (£14,637), and for the December quarter £43,272 (£44,167), total for nine months £75,721 (£74,677).

The estimates for the year ending March, 1918, put the income at £226,270, and the credit balance, after meeting all expenses and capital charges, at £1,821.

Reading.—The accounts of the tramways department for the past year show a net profit of £7,268 (compared with £7,485 in the previous year), and £4,000 of this is to be devoted to relief of rates.

Receipts were £45,404 (against £41,659), gross profit was £20,185 (£19,750), exclusive of £6 bank interest. Interest on capital required £6,677 (£6,690), sinking fund £5,061 (£5,061), and income tax £1,185 (£560), leaving the net profit above mentioned. Army service allowances absorbed £1,544 (£1,253). Traffic receipts were 11·48d. (10·40d.) per car-mile. Wages increased by £1,545 and total working expenses by £3,309, coal alone accounting for £1,207 increase. Passengers carried were 10,919,533 (9,953,906) and car-miles run 912,258 (924,656). 140,775 (138,881) parcels were carried.

Rochdale.—At the last meeting of the Gas and Electricity Committee it was reported that there was a deficit on the past year's working of the electricity department, while the gas profit was also down by £11,358.

The total income of the electricty department was £62,035 (increase £10,727), and working expenses were £54,574 (increase £24,190). Coal, coke and removal of ashes cost £32,594 (increase £13,894), repairs and maintenance of works and plant £9,450 (increase £6,974), and wages increased £1,243, the total of generation costs being over £47,000, or nearly £22,700 more than in the previous year. Gross profit was £7,461, interest and sinking fund charges amounted to £20,464 (against £17,686), and after paying half wages to men on active service and war bonus £767 (against £704) there was a net deficit of £13,430. Last year there was a surplus of £2,537. Gross capital expenditure is £241,721. Reserve fund amounts to £7,395 (increase £2,537), depreciation fund to £12,703 (increase £2,417) and sinking fund to £44,316 (increase £9,302). Loans repaid amount to £22,119. Units generated were 16,500,000 and sold 14,809,985. £7,395 is to be taken from the reserve fund towards meeting the deficit and that the remainder (£6,035) is to be carried forward as a debit balance.

COMPANIES' MEETINGS AND REPORTS.

West India & Panama Telegraph Co. (Ltd.)

The 80th ordinary general meeting was held on Wednesday, Sir ALEXANDER FREEMAN KING, K.C.B. (chairman of the company), presiding.

The SECRETARY (Mr. J. Winser) having read the notice convening the meeting, the minutes of the ordinary general meeting held on Nov. 15, 1916, and the report of the auditors,

The CHAIRMAN said : You will have no doubt noticed that the amount to the credit of revenue during the half-year in question shows an increase as compared with the corresponding period. It is true the expenses also show considerable increase, but on balance we are about £6,000 to the good, and we are thus able to recommend the payment of a dividend on the ordinary shares, which we were not able to do last year. Owing to circumstances which we hardly dare hope will be of a permanent nature, our traffic receipts show an improvement, not only in the period with which we are now dealing, but during the current half-year. I will not essay to make a forecast of the future of our Company. We can only hope for the best. But while congratulating ourselves on the increase in traffic receipts we must not forget the growth of expenses. The cost of labour and of materials has, as you are aware, increased considerably, and will, I fear, continue to increase for a time. You will no doubt have noticed that £4,000 has been placed to reserve. As regards that, I may perhaps say that it is now more than two years since it has been found possible to take a similar prudent step, and I think you will all agree that your directors have acted rightly in seizing this opportunity to strengthen our financial position. When I addressed you in November last I told you that our mortgage debentures fell due for payment on Dec. 31 last, and that it was our intention shortly to issue a circular inviting the holders to renew them for a period of 10 years. The then state of the Money Market was not propitious for such an operation, certainly not for a renewal at par ; and I mentioned that it would be necessary to offer some inducement in the form of a cash payment. After careful consideration, the Board decided to offer the debentures for renewal at £93 per £100 bond, to continue to bear interest at 5 per cent., the term of renewal to be for 10 years—namely, to Dec. 31, 1926. A certain number

Digitized by Google

of bonds were renewed under an arrangement with our bankers on the understanding that when the market was more favourable we should ask our shareholders and others to buy them from the bank at the same reduced rate of £93 per £100 bond. I mention this to prepare you for the receipt later on of a circular dealing with this matter. You are already aware that it is considered desirable to hold our shareholders' meeting annually instead of half-yearly, and consequently a resolution will be submitted altering the Articles of Association in accordance with the terms of the notice calling this meeting. I will now move that the report and accounts as submitted be adopted.

Mr. H. W. BIRKS seconded the resolution, which was unanimously adopted.

Sir Alexander King, K.C.B., was then elected a director, and Messrs. Deloitte, Plender, Griffiths & Co. were reappointed auditors.

A resolution altering the Articles of Association was subsequently adopted, and a vote of thanks to the chairman and staff terminated the proceedings.

BRITISH WESTINGHOUSE ELECTRIC & MFG. &C. (LTD.)—It is announced that arrangements are being made for carrying into effect an agreement made by this company for transferring to this country the control hitherto exercised by the Westinghouse Electric & Mfg. Co. (of Pittsburg, U.S.A.) and its connections, over the majority of the preference and ordinary shares of the company. The agreement takes the form of an option exercisable on or before June 1 next to purchase the whole of their preference and ordinary shares, together with their debenture stock, of which they hold a majority. The agreement provides that a holding company shall be formed in Great Britian to buy the shares and debenture stock held in the United States, and that this holding company shall issue to the American sellers in payment, approximately, £1,250,000 5 per cent. first lien bonds redeemable in 10 years, creating a first charge upon all property of the holding company. The holding company is to have a capital of £500,000, divided into £300,000 6 per cent. preference shares of £1 each and 200,000 ordinary shares of £1 each. It is at present proposed to issue only 200,000 preference shares and 100,000 ordinary shares, one-half of the latter to be allotted to the American vendors in part payment of the purchase consideration.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—During the past year 23,575,211 units of electrical energy were sold, compared with 21,081,928 units in 1915. The number of houses connected at Dec. 31 was 9,461, against 8,768. The profits amount to £167,371, which, with balance from 1915 and interest received on money at deposit, makes a total of £199,847. After deducting the interim dividend of 3½ per cent. (actual) paid on the ordinary shares in November, the dividends paid and accrued on the preference shares, &c., there remains £138,351. The directors recommend that £40,254 be placed to credit of depreciation and renewals account, that £2,500 be added to reserve fund, and that a final dividend be paid on the ordinary shares for the second half-year at the rate of 6 per cent., actual, making 9½ per cent. for the year, which will leave £65,150 to be carried forward, after providing for the directors' extra remuneration of £2,500, but subject to excess profits duty. The expenditure on capital account last year amounted to £91,058, the total outlay now being £1,406 938. 9s. 7d. The demand for electrical energy continues to increase steadily. Under the terms of its license, the company is bound to meet any demands for supply of current that may be made, but on account of the difficulty in procuring additional plant it has been found necessary to publish a notice that the company regrets its inability to accept applications in excess of the capacity of the available plant.

CITY OF SANTOS IMPROVEMENTS CO. (LTD.)—At the recent meeting the managing director (Mr. H. K. Heyland) stated that the number of passengers carried on the tramways showed a satisfactory increase of just over half a million. A small proportion of the increase was due to the additional three-quarters of a mile of line converted from mule to electric traction, thus completing the conversion of all lines. The consumption of energy for electric light and power continued to show a steady increase. There had been a decrease in the number of private gas consumers, but those, no doubt, had switched over to electric light, so that what they lost on the one hand they partly recouped on the other. As all their undertakings were being worked under such abnormal conditions it would be useless to make any detailed comparison with previous years, but under the circumstances the results were most gratifying.

CLEVEDON, PORTISHEAD & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The chairman (Mr. H. B. Napier) stated at the recent meeting that there had been a satisfactory growth of the undertaking, and in spite of the very difficult conditions prevailing the gross revenue was more than double that of the previous year. The number of consumers connected to the mains in Portishead had been increased from 179 to 193, and the sub-station at Bower Ashton was supplying power to the South Liberty Colliery and the Ashton Vale Brick Works. The extension of mains through long Ashton village was duly authorised last year and was almost completed, a number of consumers having recently been connected up. The total receipts were £3,955, compared with £1,737 last year, and, notwithstanding the increased costs for fuel and other expenses, the gross profit was £884, compared with £696.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—The report for the past year states that operations in Kalgoorlie have been continuously maintained, and all important customers are still taking current, though in some cases in less quantity than formerly. The continuation of the war has accentuated the shortage of labour, causing difficulties, including a further increase in the cost of supplies and in taxation. These unfavourable factors have caused a decrease of the gross profit for the year of £4,167 and (owing to heavier taxation) in the net profit of £4,926. Notwithstanding the reduced profit, the dividend at the rate of 4 per cent. per annum has been paid to the holders of the preference shares, £7,000 has been added to the debenture redemption fund, and £2,000 depreciation has been written off, the balance (£1,007) being carried forward.

KIDDERMINSTER & DISTRICT ELECTRIC LIGHTING & TRACTION CO. (LTD.)—The report for 1916 states that the amount expended on capital account was £1,100, making the capital expenditure at Dec. 31 last on buildings and plant, &c., for electric supply £57,380. The net receipts of the lighting undertaking were £2,900. A sum of £2,782 was received for dividends on investments and £1,457 brought forward, making £7,141. After deducting administration and general expenses, interest on temporary loans and debenture stock, and providing £500 for renewals, there remains £2,499. The directors propose to place £500 to reserve and to carry forward £499. The profit on the tramways, after providing for renewals, is £2,658, which, added to £100 brought forward, leaves £2,758. £500 has been placed to reserve, and a dividend at rate of 3½ per cent. has been paid on 5,720 shares, leaving £256 to be carried forward.

KIDDERMINSTER & STOURPORT ELECTRIC TRAMWAY CO. (LTD.)—The profit on the past year's working (after providing for renewals) is £2,658, which, added to £99 brought forward, makes £2,758. A sum of £500 has been applied to reserve, and it is proposed to pay a dividend at the rate of 3½ per cent. (£2,002), leaving £256 to be carried forward.

LEWES & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The revenue for 1916 amounted to £3,338, and expenses to £2,078. After providing for debenture interest and adding interest (£72) and £303 brought forward, there remains £1,196. The directors propose to place £600 to renewals fund and to carry forward £595.

PEEL-CONNER TELEPHONE WORKS (LTD.)—The profit and loss account for the year ended March 31 shows a net profit of £16,238, out of which there has been placed to reserve for depreciation £2,000, leaving £14,238. With amount brought forward (£3,950) the balance available for dividend is £18,188. An interim dividend was paid in November upon the preference shares, absorbing £2,500, and the directors recommend that dividends be now paid as follows: On preference shares (balance) £2,500, and 2s. per share on the ordinary shares (£8,000), leaving to be carried forward a balance of £5,188. The result for the past year does not compare favourably with previous years, owing to the fact that the works have been mainly engaged on munition work of a varied nature, with the result that a number of the departments have at times not been fully employed. This condition of affairs is likely to continue until the company can resume the manufacture of its normal productions.

SHANGHAI ELECTRIC CONSTRUCTION CO. (LTD.)—The profit during 1916 was £48,123, compared with £31,083 for 1915, and with £1,386 brought forward the total was £49,509. There has been transferred to reserve for renewals £10,000, and £5,000 applied in reduction of preliminary expenses, and the interim dividend of 4 per cent. left £21,709. The directors recommend a final dividend of 6 per cent. (less tax), making 10 per cent. for year, leaving to be carried forward £2,509. The loss by exchange on subsidiary coinage in 1916 was £38,751, which is equal to 12·11 per cent. on the capital. The traffics and net receipts for the first four months of 1917 show an improvement upon those for the corresponding period in any previous year. Fifteen trailer cars have been added to the rolling stock, making a total of 70. Including the seven rail-less cars, the number of passenger vehicles is 167, against 65 when the tramway was opened.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—The report for 1916 states that the business of the company shows an increase during the year, the units sold amounting to 30,058,461, compared with 28,967,656 in 1915, an increase of 1,090,805 units. After payment of all working expenses and interest on prior lien debenture stock, and making provision for depreciation of new plant, the surplus was £8,555, compared with £6,756 in 1915, and this, with the balance of £3,999 in hand at the end of 1915, enabled payment to be made of the full year's interest, £10,000 on the old debenture stock, and left a balance of £2,553. 14s. 7d. to be carried forward.

SUBMARINE CABLES' TRUST.—The revenue for the year to April 15 amounted to £29,304. 10s. 5d., and the expenses to £1,745. 1s. 7d., leaving £27,559. 8s. 10d., to which is added £77. 7s. 2d. brought forward, making an available balance of £27,636. 16s. After providing £15,432 to meet payment of the coupons, the sum of £12,138. 6s. has been transferred to redemption fund, leaving £66. 10s. to be carried forward. Since the last report 102 certificates have been redeemed (exclusive of the coupons of reversion), 28 by purchase, six by tender and 68 were drawn by lot on 1st inst., absorbing £12,138. 6s.

CITY NOTES.

MEMORANDA.—(May 15).—Consols, 55 5/16. Consols Pay Day, June 1. Stocks and Shares Ticket Day, May 29. Pay Day, May 30. Price of Silver, 38d.

ADELAIDE ELECTRIC SUPPLY CO (LTD.)—The directors have declared an interim dividend on the ordinary shares at the rate of 10 per cent. per annum, tax free, for the half-year to Feb. 28.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—The directors notify that it will not be possible to complete the 1916 accounts for some time, but they have decided to pay a dividend of 1s. 6d. per share (tax free) on the ordinary shares. The preference dividends have already been paid.

Digitized by Google

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—The atmosphere of the London streets is relieved of the burnt petrol stench from a few thousand 'buses, and the walking public is compensated by the saving of 25,000 gallons of petrol per day!

* * * *

According to a number of doctors, the changes in diet brought about by the war are bringing out spots on people hitherto spotless. I think there should be a splendid opportunity here for the treatment of all such sufferers with the now world-famed "Megger." Why? Because one of the features of the advertising of the instrument was the slogan "Out, damned spot!"

* * * *

A correspondent calls my attention to the adjoining sketch from a recent advertisement and points out that the artist has

shown the monster shells mounted *between centres*. That's the worst of having the critical eye in purely artistic matters!

* * * *

From "Punch":—

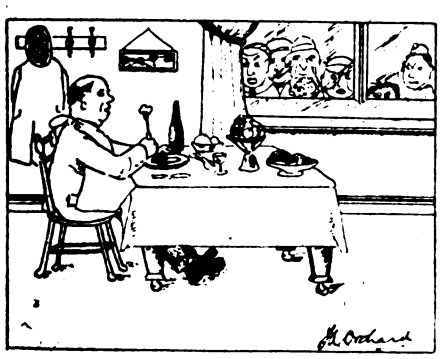
MOTOR LAUNCH OFFICER (*who has rung full speed ahead without result*): "What's the matter?"

VOICE FROM BELOW: "One of the cylinders is missing, sir."

COMMANDER: "Well, look sharp and find the bally thing; we want to get on."

* * * *

This picture should be brought to the notice of the Food Controller. I understand that it is intended to illustrate a well-



known electrical instrument—to wit—the 'am-eater! If the prices of food go up much higher there'll be a raid on all the switchboards in the country.

* * * *

Mr. Edison is credited with being engaged upon one of the phases of the submarine strafing problem, and from this, I presume, we may take it that the strafing device is electrical and employs an alternating current. At any rate, America can now claim to be no longer an earthed neutral!

* * * *

The "Journal of Education" says:—

It is desirable that our pupils should learn something in school about the internal combustion engine, which is doing so much for transport at home and at the front. It was the petrol engine which made aviation practicable, and we are as yet only at the beginning of the industrial and social era in which it is destined to play a part comparable with that of steam in the last century.

With the last sentiment electrical men will naturally disagree, because after steam will come not petrol but electricity.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, May 15, 1880.]

TOO GOOD TO BE TRUE.—It is said that a Mr. Parodie claims to have discovered a method of transmitting large quantities of electricity over long distances, distributing it at any number of points as required on the way.

A RIVAL.—Our contemporary "Gas and Water Engineering" writes: "The doctors are after the electric light. They say it will eventually destroy the eyesight, and one medical man says he was blind for three days, the result of attending a concert at San Francisco in a hall supplied with the electric light. Edison has given up this eye destroyer; now let him give us invulnerable eyes."

THE ELECTRIC LIGHT AT THE LIZARD.—The crew of the schooner "Conovium," of Aberystwith, bound from London for Dublin, with cement, landed at Penzance on Wednesday morning, their vessel having struck on the Stag Rock, near the Lizard, on Tuesday night, and foundered. The captain attributed the disaster to the glare of electric light at the Lizard, which made him believe that he was at a greater distance from the land than he actually was.

"Jitney" Competition in Canada.—Like most electric railway and tramway companies in Canada, the Winnipeg Electric Railway Co. has suffered from the competition of "jitney" cars.

A strong protest was recently addressed to the City authorities by the general manager of the company, accompanied by a claim of £500,000 compensation. The company contends that the action of the city in encouraging "jitney" competition is in direct breach of its contract. During the last two years the company has paid to the city $545,700 for general taxes and has incurred other expenses, while, on the other hand, the "jitneys" are allowed free and unlimited competition upon payment of $20 per year per car. Unless the Council takes steps to carry out its part of the contract the company threatens to refuse payment of further sums as percentages of gross revenue, as taxes on the cars or as pavement charges, and in any event will insist that the city re-imburses the amount lost through "jitney" competition during the period this competition has been permitted by the city.

Electric Vehicles in Shanghai.—In the annual report of the electrical engineer (Mr. T. H. M. Aldridge) for the year ended March last it is stated that for the first time electric vehicles were introduced into Shanghai during the year. The department purchased three Milburn light cars and one Waverley, also a 2-ton General Vehicle Co. and a 700 lb. Milburn truck. These have all proved so satisfactory that two more trucks, one of 2 tons and the other 1 ton carrying capacity have been ordered from the General Vehicle Co.

Records are kept of the operating costs of the cars and the trucks, which show that the former effect a saving of about 9 per cent. per annum over cheap petrol-driven cars, including capital and running costs, on a basis of 25 miles run per day. With a daily mileage of 50 miles the saving is about 30 per cent. In addition to the electric cars used by the department, there were also three privately owned ones on the road, and these have given satisfaction to their owners. There are several more on order for private use.

The department is making arrangements to hire out small motor-generator charging sets to be installed in the owners' garages. A more general use of electric cars and trucks should lead to a further profitable line of business for the department, as all units sold at off-peak times are profitable, and any means which may tend to obtain this end ought to be cultivated.

TUNGSTEN FOR ELECTRICAL CONTACTS
MORE EFFICIENT AND MUCH CHEAPER THAN PLATINUM.
Recommended for use for X-Ray Targets, and as Contacts on Induction Coils and Tapping Keys, Magnetos and similar devices where there is frequent making and breaking of Electric Current. Also suitable for Gas Engines, Circuit Controllers, and like purposes.
Write for Particulars:—
THE L.P.S. ELECTRICAL COMPANY, 14, Howick Place, Westminster, S.W.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

Digitized by Google

SIEMENS

IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars

Distribution Boards

Main Switchboards

Write for particulars to —

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."

HOME BRANCH ADDRESSES:

BIRMINGHAM—Central Ho., New St.
BRISTOL—30, Bridge Street.
CARDIFF—89, St. Mary Street.
GLASGOW—66, Waterloo Street.
MANCHESTER—196, Deansgate.
NEWCASTLE—64-68, Collingwood Bldgs.
SHEFFIELD—22, High St.
SOUTHAMPTON—46, High Street.

Branches in Principal Towns Abroad.

"I am particularly adapted for the stage."

For Theatre Lighting

POPE

ELASTA

(British made)

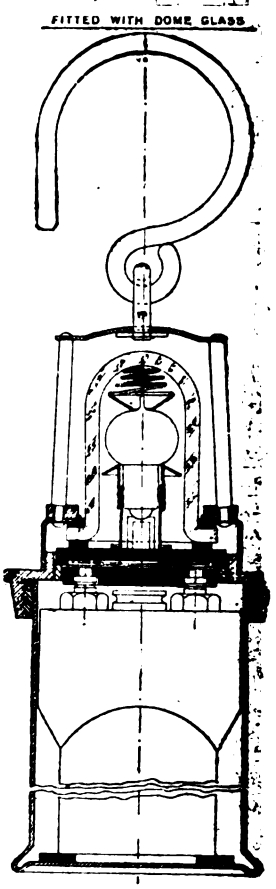
WIRE LAMPS

STRONG - BRILLIANT - ECONOMICAL.

Advt. of Pope's Electric Lamp Co., Ltd., Hythe Road, Willesden, N.W. 10.

THE "KINGSWAY" MINERS' ELECTRIC HAND LAMP.

In a leaflet recently issued by the General Electric Co., Ltd., 67, Queen Victoria-street, E.C., particulars are given of this lamp, which has been approved by the Home Office. In developing the lamp the chief points borne in mind were the efficiency of illumination over the full run of 9 or 10 hours, together with strong construction, durability of the parts and freedom from corrosion. In all these respects it is claimed that the new lamp is a complete success. At the present time considerable attention is being paid to the question of miner's lamps, and the following description of the method of constructing the "Kingsway" Lamp will prove interesting to engineers and managers of collieries, &c.



The accumulator is of the absolutely non-spillable type. The accumulator terminals and switch arrangements have been specially designed to minimise corrosion and particularly to stop corrosion during charging, at which time there is more liability of acid getting on to the terminals. There are no springs of any kind attached to the accumulator, the necessary spring conductors being fastened in the lamp itself. Consequently it has been possible to make the terminals of the accumulator out of solid pieces of non-corroding material. The spring controlled switch contacts are also of robust construction, consisting of strong flat springs with the upper ends screwed to the lampholder, and the lower ends having the switch knobs riveted into them. There is no possibility of "shorts" occurring by the displacement of the springs. The switch knobs also carry a pressure plate which maintains the pressure on the accumulator when the head is turned to the "off" position. No celluloid is used in the switchgear. The lampholder is provided with adjustable conical reflector to come below the lamp and another conical reflector is supported on top of the lamp bulb. These reflectors (of polished nickel) are so shaped that they considerably increase the illumination in the horizontal direction. In addition, a patent external reflector can be fitted at a small extra charge. The use of this external reflector has many advantages. The leaded steel case is fitted with a strong threaded sleeve which screws into the head of the lamp. The head is built on a strong brass casting and is provided with a magnetic lock of simplest construction. No parts of this lock are accessible when the head of the lamp is screwed on, but when it is off the taking out of one screw allows the bolt and controlling spring to be removed and examined; the total number of parts for the lock being the bolt, the spring and the aforementioned screw.

Prices and further particulars of the lamp may be obtained from the company.

INSULATION BEADS

ALDER & HARRIDEN, LTD.

"SISTOFLEX" (Regd.)

INSULATING. FLEXIBLE. TUBES or SLEEVING.
IN CLOTH AND SILK.
Suitable for Instruments, Small Machines, Switchboards, Switchgears, Circuit Breakers & other Electrical Apparatus.
SUPPLIED SOLELY by

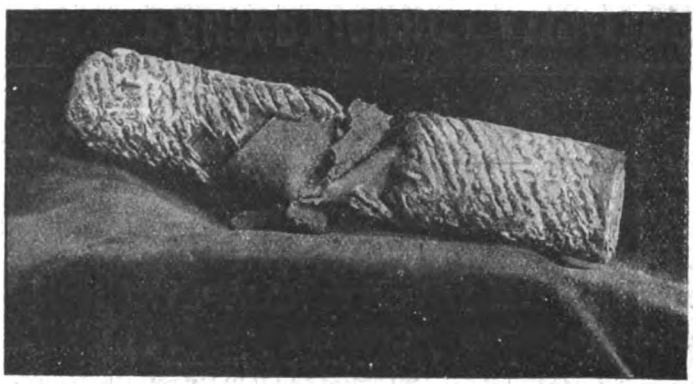
SPICER BROTHERS, LTD. 19, New Bridge St., LONDON, E.C. CITY 6251

Prices and Samples on application.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.



Thanks to the courtesy of Mr. Holden, Secretary and Engineer of the Scarborough Electric Supply Co., Ltd., we are able to show the above illustration, which represents a B.I. cable severely damaged by a fragment of German shell on the occasion of the bombardment of Scarborough in December, 1914.

The cable of common or "equal to" origin would have promptly blown out, but a B.I. cable has traditions to live up to, so, although almost eviscerated, and with its life's compound gently ebbing away, it carried on until quite recently, when it modestly drew attention to its condition by warming the snow in the neighbourhood of the fault.

NOBLESSE OBLIGE.

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED **SECOND HAND**

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4036. Grams: Vicelastor, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh. *See our Illustrated Advt. last week.*

Digitized by Google

THE ELECTRICIAN"
ANNUAL TABLES
OF
Electricity Undertakings

NOW READY.

These Tables, containing important statistics and data relating to

BRITISH ELECTRICITY SUPPLY,
COLONIAL AND FOREIGN UNDERTAKINGS,
ALSO
ELECTRIC TRAMWAYS and RAILWAYS of the WORLD,

are now published in new form in ONE VOLUME, with cloth cover, and constitute a valuable compilation for engineers and electricians.

PRICE 5/- post free if prepaid.

"THE ELECTRICIAN" OFFICES, 8, BOUVERIE ST., E.C. 4.

MORE LARGE SPINNINGS.

Some time ago we gave particulars of special large spinnings which had been executed at the works of the Benjamin Electric (Ltd.), and the accompanying illustration shows a special spinning in course of production, a large quantity of which have recently been supplied for an important Government contract. These were spun in aluminium from blanks 42 in. in diameter, of 18 gauge metal, the finished spinning measuring 31 in. in diameter and 16½ in. in depth.

This is only one example of the widely varied types of spinning undertaken and satisfactorily produced at the company's Rosebery-Avenue works, where a complete metal spinning plant is installed capable of turning out all classes of spinning work. Inquiries are invited for spinning work of an unusual and novel character, the company's past achievement in such direction guaranteeing their ability to successfully produce same.

Wells' Waste Oil Filters,

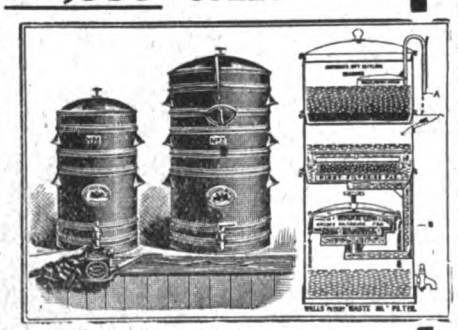
With Patent Sight Feed Syphons.

OVER 22,000 SOLD.

Invaluable to Electric Light Installations and all users of Machinery.

Supplied to the Principal Electric Light Stations and Works in the United Kingdom.

Pay first cost in a short time, as Dirtied Oil, which has hitherto been thrown away, can be filtered and used again and again.



No. 1.—For users having only a small quantity of oil to treat (no syphon)	17-in. by 9-in.	35/-
No. 2.—Two top chambers hold about 3 gallons oil,	22-in. by 10-in.	50/-
No. 3.—Two top chambers hold about 6 gallons oil,	27-in. by 12-in.	70/-
No. 4.—Two top chambers hold about 12 gallons oil,	36-in. by 16-in.	110/-
No. 5.—Two top chambers hold about 24 gallons oil,	43-in. by 23-in.	189/-

Wells' Oil Cabinets.

The **Cabinets** are made of tinned steel with galvanised iron bottoms, enamelled bright red, attractive in appearance.

The **Pump** is a force pump, made of polished brass, simple in its construction. It is screwed into its place, and can be easily taken out for filling the Cabinet from a barrel.

CAPACITY.	HEIGHT.	DIAM.	PRICE.
50 gallons	3 ft. 9 in.	2 ft. 2 in.	49/- each.
30 "	3 " 5 "	1 " 10 "	43/- "
20 "	3 " 1 "	1 " 6 "	40/- "
12 "	2 " 6 "	1 " 5 "	33/-
6 "	1 " 9 "	1 " 3 "	28/-

Prices subject to current rate of advance.

A. C. WELLS & CO.,
99, MIDLAND RD., ST. PANCRAS, LONDON, N.W. 1.

The
"Lancashire" Squirrel Cage Induction Motor

The "Lancashire" Squirrel Cage Induction Motor with centrifugal clutch and switch is cheaper in first cost, cheaper to maintain, easier to work and less liable to break down than any other type of Motor with switch-gear.

Ask us to send you Publications Nos. 139 and 146, which contain all details concerning both motors and clutches.

Hydro-Extractor driven by "Lancashire" Squirrel Cage Induction Motor.

Lancashire Dynamo & Motor Co., Ltd.,
TRAFFORD PARK, MANCHESTER.

Telephones:
CITY 7450 (6 lines).

Telegrams and Cables:
"IRONCLAD, MANCHESTER."

Digitized by Google

FERRY **FERROZOID**

CONSTANTAN **CHRONIC**

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:

HENRY WIGGIN & CO., Ltd.
George Street, Birmingham.
TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."

AGENT:

LIONEL ROBINSON,
3, Staple Inn, London, W.C.
TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

THE GREAT CENTRAL RAILWAY passes from the Metropolis Northwards through the centre of industrial England, throwing out its branches Eastward and Westward to the Coast.

¶ Its Lines run over the Great Midland Coalfield (of over 4,000 square miles area) which extends into the Counties of York, Nottingham, Derby and Lincoln. This Coalfield is the largest in the British Isles, and is estimated to contain not less than forty-nine thousand million (49,000,000,000) tons of coal.

¶ The important Coalfields of Lancashire and North Wales are also traversed by the Company's lines.

¶ There is thus afforded an easily accessible source of fuel supply.

¶ The New Eastern Port of Immingham should particularly attract traders, as its modern equipment and accessibility at any time of the day or night, irrespective of tides, are important time and labour saving factors.

¶ Adjoining the Great Central Railroad at various parts of the system are situated Valuable Sites for Works, where, by the introduction of siding accommodation, goods can pass right into and directly out of the works, which greatly assists the Manufacturer to attain his desired position in the World's Markets.

¶ For information please communicate with the G.C.R. Publicity Office, 216, Marylebone Road, London, N.W.

¶ Owners and Agents of LAND and BUILDINGS for SALE or TO BE LET near the Great Central Railway are requested to send particulars to the G.C. Estate Office, 12, Paton Street, Piccadilly, Manchester.

SAM FAY, General Manager.

ADMIRABLE SITES FOR NEW WORKS, FACTORIES, &c.

BUYERS of every description of Scrap Metals, viz: COPPER, BRASS, GUN METAL, BRONZE, ALUMINIUM, LEAD, ZINC, &c.
All descriptions of RESIDUES.

ESTABLISHED 1867.

METALS.

J. B. GARNHAM & SONS,
132, UPPER THAMES ST., LONDON, E.C.

Telegraphic Address: "Garnham Cannon London."
Cables " " "Garnham London."
Telephone " " Bank 5726.
ABC Code, 4th and 5th Editions and Lieber's Code.

ENQUIRIES SOLICITED.

SELLERS of COPPER and BRASS SHEETS, PLATES, TUBES, RODS, WIRE, &c., &c.

Digitized by Google

Electrical Engineers and Manufacturers

The House for Electric Heating.

Special Offer of "Quead" and "Ensign" Fires from Stock. Be Patriotic and Save Coal.

Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.

Telephone: Gerrard 7601 (2 lines)

Petrol Engine Sets.

Manufactured in sizes from 2 kw. to 20 kw.

Quotation for larger sizes on application.

F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON

FOR

High and Low Tension

SWITCHGEAR

THE

NEW SWITCHGEAR CONSTRUCTION CO., Ltd.

SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

Manufacturers of

PHOSPHOR · BRONZE,

GUN METAL, MANGANESE BRONZE

TRADE MARK.

Brass & Copper Tubes and Sheets.

BRASS CONDENSER TUBES FOR STANDARD SHIPS, &c.

CHARLES CLIFFORD & SON, LTD.,

BIRMINGHAM.

GENUINE

M & M VULCANISED FIBRE.

MOSSES & MITCHELL, 122 & 124, GOLDEN LANE, LONDON, E.C.

CANADIAN NICKEL.

The Royal Ontario Nickel Commission, which was appointed in September, 1915, to inquire into and report upon the resources, industries and capacities of the Province of Ontario in connection with nickel and its ores, &c., recently issued a lengthy and very interesting report on thesubject.

The report states that in recent years the two principal questions have been:—(1) Could nickel be economically refined in Ontario? and (2) were the nickel deposits of Ontario of such a character that the Province could compete successfully as a nickel producer with any other country? The Commissioners are of opinion that:—

1. The nickel ore deposits of Ontario are much more extensive and offer better facilities for the production of nickel at a low cost than do those of any other country. Nickel-bearing ores occur in many parts of the world, but the great extent of the deposits in the Province, their richness and uniformity in metal contents and the success of the industry, point strongly to the conclusion that Ontario nickel has little to fear from competition.

2. Any of the processes now in use for refining nickel could be successfully worked in Ontario, and conditions and facilities are at least as good in this Province as in any other part of Canada.

3. In view of the fact that practically no chemicals are required, that there is a much more complete saving of the precious metals, especially platinum and palladium, and that electric power is cheap and abundant, the most satisfactory method of refining in Ontario will be the electrolytic.

4. The refining of nickel in Ontario will not only benefit the nickel industry, but will promote the welfare of existing branches of the chemical and metallurgical industries, and lead to the introduction of other branches.

5. The methods employed at the Ontario plants of the two operating nickel companies are modern and efficient, although there are differences in both mining and smelting practice. Even during the present time of pressure the Canadian Copper Co. has materially increased its output without substantial enlargement of its plant, and the losses in smelting are less both at Copper Cliff and the Mond plant at Coniston than they were a year ago. These companies have each had their experimental stage. Neither has, itis pointed out, asked for nor received any Government assistance, and both have fully earned the success which they have achieved.

6. The present system of mining taxation in Ontario is just and equitable and in the public interest, and is the best system for the Province.

Experiments have been undertaken by the Commission in the production of nickel-copper-steel direct from Sudbury ore, and also in the electrolytic refining of nickel. Certain improvements in the latter process have been made the subject of application (on behalf of the Government of Ontario) for patents in Canada, the United States and Great Britain.

In an Appendix to the Report the evidence is given of the witnesses who appeared before the Commission with regard to the questions under investigation, together with memoranda, &c. The Report and Appendix may be consulted by British engineers and firms interested at the Department of Commercial Intelligence, 73, Basinghall-street, London, E.C. 2.

MEWBURN, ELLIS AND PRYOR
CHARTERED PATENT AGENTS AND TRADE MARK AGENTS.
70, Chancery Lane, London.
Telegrams: "Patent London." 'Phone: 243 Holborn.

MEWBURN, ELLIS AND PRYOR,
CHARTERED PATENT AGENTS AND TRADE MARK AGENTS,
3, St. Nicholas Buildings, Newcastle-on-Tyne.

"ANTI-SULPHURIC" ENAMEL

Should be used in all ACCUMULATOR ROOMS For Protection from Acid Fumes.

SOLE MAKERS: GRIFFITHS BROS. & CO., LONDON, LTD., Mack'e-rd., Bermondsey, LONDON, S.E.

BASTIAN METERS FOR DIRECT CURRENT ONLY.

Made in ENGLAND with

BRITISH CAPITAL and BRITISH LABOUR.

THE BASTIAN METER COMPANY, LTD., BARTHOLOMEW WORKS, KENTISH TOWN, N.W.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,036. [Vol. LXXIX. No. 8] FRIDAY, MAY 25, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES	297
Arrangements for the Week	299
The Theory of Armature Windings. By S. P. Smith, D.Sc. Illustrated.—*Continued*	300
Differential Drum Hoists. Illustrated	302
The Choice of Voltage for Railway Electrification on the Direct-Current System. By F. Lydall. Illustrated.—*Concluded*	303
Institution of Electrical Engineers	307
The Education of the Chemist. By Sir James J. Dobbie	309
THE SKILLED MECHANIC	310
Faraday, 1791-1867	313
The Electrical Properties of Gases	314
CORRESPONDENCE	315
Physical Society	315
Wayleaves	317
Patents in 1916	318
PARLIAMENTARY INTELLIGENCE	319
LEGAL INTELLIGENCE	319
Patent Record	320
Volunteer Notices	320
COMMERCIAL AND INDUSTRIAL SECTION	323
Electricity Supply	324
Tenders Accepted	326
Financial Matters	327

NOTES.

Electric Power Supply.

WITH commendable promptitude the Committee appointed by the Board of Trade in March to consider and report what steps should be taken to ensure that there should be an adequate and economical supply of electric power in the United Kingdom has reported briefly on the results of certain investigations that had previously been undertaken. The conclusions that are reached are given in another column, and some of these are sufficiently obvious. The most important conclusion reached is that the interconnection of existing electric supply stations as recommended by the Board of Trade in their letter of May 25, 1916, however desirable, cannot alone meet the requirements of the situation. It is well that this should be realised at an early stage. The fact is that the parochial policy which has been adopted for many years—indeed, from the early days of the supply industry—has led to the laying down of so many systems, differing in pressure, character of current and frequency, that simple interlinking in many cases is altogether out of the question, except at very great cost. Consequently, the only way in which to carry through a proper scheme is to scrap certain stations at the earliest possible opportunity. Their extension can only lead to the wasteful use of capital and to the perpetuation of systems which must in due course be replaced by those which have been proved to be more effectual and more suitable for a national system of electricity supply. We are glad to note that the Committee is of opinion that a comprehensive system for the generation of electricity, and where necessary re-organising its supply, should be established as soon as possible. The Committee has decided to invite representative associations throughout the country to give evidence for them with regard to the best methods of giving an effective distribution. There are, of course, many other points to be considered, to which we have alluded on other occasions; but it is encouraging to see that the Committee has got promptly to work, and we anticipate that many results of importance will ensue, though we cannot expect that the labours of the Committee will be brought to a very speedy conclusion.

Institution of Electrical Engineers.

THE annual general meeting of the Institution of Electrical Engineers was more notable for the meeting which immediately followed it than for the proceedings of the annual general meeting itself. The meeting to which we refer was a special general meeting called to alter the articles of association, so that members should have the right of voting by proxy. So far, it has only been possible to obtain the feeling of members generally by means of a postal ballot, which has no force in carrying any resolution under the Companies' Acts. It has been felt by the Local Sections that this state of affairs is unsatisfactory, and that if members could vote by proxy they would have a larger say in the affairs of the Institution. There is, of course, everything to be said in favour of the Local Sections being in complete touch with the central body. This is secured at present by means of the Chairman and immediate Past-Chairman of each section being ex-officio members of the Council, and it may be felt that this should be sufficient. In any general meeting, however, the decision at present necessarily rests with the London members. Whether the proposed new step will be in the right direction is open to some question. It was opposed by Mr. CAMPBELL SWINTON and by Mr. J. S. HIGHFIELD. We must confess that we feel there is a danger in the inovation, owing to the fact that a clique at any time could practically rule the decisions. It may be objected, of course, that a clique can be defeated by an opposing movement, but the difficulty in a scientific society is that the action of a clique is kept more or less quiet until the meeting takes place, and the Council will presumably take no steps to ensure that its views are adequately supported. In a company it is otherwise. If the board has decided upon a certain policy and any opposition to this policy is likely to arise, the board takes steps as far as possible to secure its position by obtaining the necessary proxies. The Council of a scientific society would consider this to be an undignified proceeding, and we are therefore inclined to think that voting by proxy may give rise to evils which are worse than those it is supposed to remove.

The Activities of the Council.

WITH regard to the annual general meeting it will be seen from the report of the Council that a good deal of activity has been displayed during the past year, and that advantage is being taken of grants by the Government Department for Scientific and Industrial Research to investigate various matters. We hope that full advantage will be taken of the facilities now available. So far the programme is not, perhaps, as extensive as it might be, though it will be agreed that a research on insulating materials may cover an immense amount of ground. Possibly progress is a little slow owing to the fact that there is co-operation between the Institution and the British Electrical and Allied Manufacturers' Association, which, of course, is as it should be. We hope, however, that full advantage will be taken of present possibilities. As to

Digitized by Google

other directions of activity, we may call attention to the Committee on Wiring Rules for Installations on Shipboard. It is highly desirable that authoritative rules of this kind should be drawn up. We notice that the names of the Committee are published in this instance, and also of the Committee on Electricity Supply. We suggest that the Council would do well to publish the names of all committees. When such names are not published people are inclined to think that there is some good reason for the omission—for example, a weakness in the membership. Publicity in such matters is adopted by the American Institute of Electrical Engineers, and we see no reason why a similar policy should not be adopted with advantage by our own Institution.

The Growth of Electricity Supply.

THE growth of electricity supply in the United Kingdom cannot be better emphasised than by the figures given in our Annual Tables of Electricity Supply Undertakings. These tables have hitherto been published during the early part of the year, and have been issued free to readers of THE ELECTRICIAN. The paper restrictions will not now permit of this course, and it has also been thought desirable to postpone the publication of the tables until May, so that results of the past year's reports can be obtained more readily. Comparing the present tables with the last issue we find that there are now 581 entries of supply undertakings, as against 564 last year. It is noticeable that the additional entries are chiefly quite small stations, and these stations are frequently supplied with energy from power companies. In regard to the larger undertakings, the growth in the maximum load has in many cases been very large; thus, at Sheffield, the maximum load in 1915 was 19,153 kw., whereas in 1916 it was 35,999 kw., or a growth of nearly 90 per cent. At Birmingham the maximum load in 1915 was 36,717 kw., and in 1916 was 44,355 kw. In other towns the increase has not been so marked. As an instance of one of the progressive towns we may take the case of Leicester, where the maximum load in 1915 was 3,874 kw., which rose in 1916 to 7,874 kw. This growth is, of course, due to the large demand for power. In the case of the power companies the same expansion is noticeable; more particularly in the case of the Clyde Valley Electrical Power Co. In this case the maximum load in 1915 was 43,500 kw., whilst in 1916 it was 69,830 kw. The growth here has been remarkably rapid. We notice that the maximum load of the Newcastle-on-Tyne Electric Supply Co. has now passed another century, having reached 210,932 kw. Two power companies this year appear with more extended entries—namely, the Leicestershire & Warwickshire Co. and the Shropshire, Worcestershire & Staffordshire Co.—showing that good progress is now being effected in these districts. Our readers will find many other points of interest in these tables, but space will not permit of our referring to them in greater detail at the present time. Accompanying the statistics of the British supply undertakings are the Tables of the Colonial and Foreign Electricity Works and Electric Railways and Tramways, and the whole are bound in one volume.

Aerial Transport After the War.—A Civil Aërial Transport Committee has been formed to inquire into aerial civil communications after the war. The chairman of the committee is Lord Northcliffe, and among the members of the committee are Lord Montagu, Lieut.-Col. M. O'Gorman, C.B., and Messrs. A. E. Berriman, Claude Johnson, F. W. Lanchester and T. Sopwith, with representatives of the Admiralty, Post Office, India Office, Colonial Office and the Dominions. Mr. D. O. Malcolm is secretary of the committee, whose office will be at Winchester House, St. James's-square, London, S.W. 1.

The Beama Journal.—We have received copies of the "Beama Journal" for March, printed in Spanish and Russian. We do not profess to have read them (except the diagrams, which, we observe, are still printed in English), but we do not doubt that such issues will prove effective in expanding our foreign trade. Efforts of this kind are most important at the present time.

Redditch Electricity Supply.—We have received from the Urban District Council of Redditch a pamphlet describing briefly the recent extensions to the Council's electricity works. On the recommendation of Messrs. Handcock & Dykes the works have been remodelled from single-phase to three-phase, two 1,000 kw. Parsons turbo-alternators being installed. For the time being some of the old consumers are being supplied with single-phase current by means of motor generators, but all extensions are on the three-phase system. The power load is developing rapidly. When the consulting engineers first reported, the output for the previous year was 1,323,870 units, but with the new plant it is anticipated that the output will very shortly amount to three-million units.

Ferro-concrete Ships.—Norway, Sweden and Denmark have already embarked on the construction of ferro-concrete vessels, and in view of these experiments some comments in a recent issue of "Engineering" regarding the quality of concrete best able to withstand the action of salt water is of some interest. Very extensive tests of this point have been conducted by the German Concrete Union, in the United States and elsewhere. One point that appears to be currently accepted is the unfavourable influence of lime in the cement, which is attacked by various ingredients in salt water such as magnesium sulphate. There are, however, varieties of concrete, such as "puzzolane," which contain no free lime; also, if very dense concrete is used, it is not materially penetrated, and any decomposition is only a surface process. The chief precautions against prejudicial action of salt water appear to be: (1) The use of rich concrete, (2) the use of cement with little free lime, gypsum and alumina, (3) the addition of puzzolane, containing silicic acid to fix the free lime, (4) the use of coarse sand, (5) the use of dense concrete, (6) special surface treatment.

Technical Committee of the Motor Industries.—We understand that a new committee under the above name has been formed by the Institute of Automobile Engineers and the Society of Motor Manufacturers and Traders to co-ordinate the many technical questions in connection with the automobile industry, which have been handled independently in the past. It is hoped that the new committee will assist in securing the co-ordination of effort and prevent overlapping. Invitations to be represented on the committee have already been accepted by the National Physical Laboratory, the General Post Office, the Institution of Mechanical Engineers, the Iron and Steel Institute and the Commercial Motor Users' Association. The Technical Committee will take over the work hitherto carried on by the Standardisation, Technical and Research Committee of the Society of Motor Manufacturers and Traders, the Steels Committee and the Standardisation Committee of the Institution and the Research Committee which is carrying out research on the E.S.C. British standard steels for automobiles, with the addition of aircraft steels, and which is financed by a Government grant of £1,000 and a donation of £1,000 from the Society of Motor Manufacturers and Traders, and the trade generally. Further information can be obtained from either of the joint secretaries, Mr. Basil H. Joy, secretary of the Institution of Automobile Engineers, 28, Victoria-street, London, S.W. 1; or Mr. T. F. Woodfine, secretary of the Society of Motor Manufacturers & Traders, 83, Pall-mall, S.W. 1.

Electric Power Supply.—We are informed that several sittings have been held of the committee recently appointed by the Board of Trade to "consider and report what steps should be taken, whether by legislation or otherwise, to ensure that there shall be an adequate and economical supply of electric power for all classes of consumers in the United Kingdom,

Digitized by Google

particularly industries which depend upon a cheap supply of power for their development."

The Committee, having considered the results of certain investigations that have been previously undertaken, have unanimously come to the following conclusions :—

1. That when British industry is subjected to the test of keen international competition after the war its success will depend upon the adoption of the most efficient methods and machinery, so as to reduce manufacturing costs as much as possible.

2. That a highly important element in reducing manufacturing costs will be the general extension of the use of electric power supplied at the lowest possible price, and it is by largely increasing the amount of power used in industry that the average output per head, and as a consequence the wages of the worker, can be raised.

3. That the present system under which a supply of electricity is provided in a large number of small areas by separate authorities is the result of a policy adopted at a time when the applied science of electrical engineering was in its infancy, and is incompatible with anything that can now be accepted as a technically sound system.

4. That the interconnection of existing electric supply stations recommended by the Board of Trade in their letter of May 25, 1916, however desirable in itself, cannot alone meet the requirements of the situation.

5. That a comprehensive system for the generation of electricity, and where necessary re-organising its supply, should be established as soon as possible.

The Committee have decided to invite representative associations throughout the country to give evidence before them with regard to the best methods of giving effect to these conclusions.

Illuminating Engineering Society, Annual Meeting.—At the annual meeting of the Illuminating Engineering Society on May 15th, the report of the council formed the chief item of interest, and included an announcement of the formation of a Joint Committee on Illuminiating Engineering, under the Department of Scientific and Industrial Research. This committee is the result of a deputation from the society, received by the Department on March 3rd. The constitution of the Committee is such as to bring it into touch with the other existing standing committees on other subjects. The members of the Committee are :—

Mr. A. P. Trotter (chairman), Sir Maurice Fitzmaurice and Mr. J. S. Highfield (representing the Standing Committee on Engineering), Prof. Herbert Jackson and Dr. C. V. Boys (representing the Standing Committee on Glass and Optical Instruments), Dr. Charles Carpenter (South Metropolitan Gas Co.), Mr. L. Gaster (illuminating engineer), Mr. F. W. Goodenough (chairman of Council of the Illuminating Engineering Society), Capt. J. H. Parsons, F.R.C.S. (ophthalmic surgeon), and Sir John Snell (electrical engineer). The committee is already proceeding with its work.

The society is also represented on the London Safety First Council, through which the recent alterations in street lighting throughout the metropolitan area have largely been carried out in a uniform manner. It is pointed out that this should serve as an important precedent for the future.

After the usual votes of thanks, Mr. A. P. Trotter was elected President for the coming session.

A discussion then ensued on "Economies in Lighting in Relation to Fuel Saving." The discussion was opened by Mr. L. Gaster, who quoted some data from the Report of the Committee on the Summer Time Act (1916) to show that the economies possible through the diminution in lighting could form but a small fraction of the total consumption of coal in the country. The combined consumption of coal for lighting by gas and electricity by the supply companies probably did not exceed six million tons per annum, which was about 2¼ per cent. of the total coal output. It was impracticable to aim at an indiscriminate saving of 10 per cent., as had been suggested. Lighting in factories and munition works was indispensable, and lighting necessary to the public safety should not be interfered with. Illumination for public convenience should not be reduced except in case of grave necessity, but some saving might be expected from lighting used for luxury and spectacular purposes. In this connection Mr. Gaster referred to the waste of light by the exhibition of glaring lamps outside places of entertainment. An extravagant display of this kind was not desirable, even in time of peace. The allocation of a certain amount of gas or electricity for certain purposes or in certain areas, with due regard to the conditions in each case, might also be considered. In conclusion, Mr. Gaster suggested the formation of a small committee to make inquiries during the summer months, with a view to being prepared for the next winter season. A communication from Mr. Faraday Proctor, urging the desirability of economy in connection with coal for power supply, was next read. Mr. Proctor urged that small private plants were necessarily inefficient, and that consumers should be required to take their electricity from bulk suppliers, unless they were able to produce in an exceptionally efficient manner. Mr. J. F. Crowley also advocated the survey of power supply, with the view to making coal economies, while Mr. Dow, although agreeing that the economies possible in lighting were necessarily small, thought that the education of the public in regard to the proper use of light was desirable with a view to the future.

OBITUARY.

Sir Alex. Binnie.—Sir Alex. Binnie, M.Inst.C.E., for many years chief engineer to the London County Council, died at Beer, Devon, on the 18th inst.

Sir Alex. Binnie, who was trained as a civil engineer, went in 1869 to India, where he was engaged on water supply works. He returned to England in 1875 and became water engineer to Bradford. In 1890 he became chief engineer to the London County Council, and among the works for which he was responsible are the Blackwall and Greenwich tunnels, the sewage disposal works at Barking and Crossness. On the occasion of the opening of the Blackwall tunnel in 1897 he was knighted.

Deaths on Active Service.—The following deaths on active service are reported :—

We have to announce with regret the death of Capt. John Chamberlain, managing director of Messrs. Chamberlain & Hookham (Ltd.), of Birmingham, and a director of other electrical and engineering companies. Capt. Chamberlain, who was 35 years of age, was attached to the South Wales Borderers, and was killed at the front on the 14th inst. He was educated at Rugby School, and as a young man joined the firm of Messrs. Chamberlain & Hookham. On the retirement of his father (Mr. Arthur Chamberlain) from the position of managing director Capt. Chamberlain succeeded to that position. During the period that he has guided the fortunes of the firm extensive developments and extensions have been made. Besides increasing the Birmingham business, a branch depot was opened in Canada and another in Hamburg. He was always on the most friendly terms with the large body of workers, and his loss will be keenly felt by a wide circle of friends both at home and in the Colonies where he has travelled for the firm. Capt. Chamberlain married a daughter of the late Prof. Poynting, and there are four children of the marriage.

Capt. B. Turner (R. Warwickshire Regt.), aged 25, was killed in action on May 8. He was a B.Sc. of Birmingham University and was on the staff of the British Aluminium Co. prior to the war.

Sec.-Lieut. T. C. Turton (Liverpool Regt.), aged 23, who was killed on May 8, had received electrical training at Faraday House, London.

Sergt. J. M'Intyre (Scottish Rifles), who has died of wounds, was formerly employed in the Glasgow electricity department.

Corp. J. Thomson (R.F.A.), who has been killed in action, was an electrical engineer of Aberdeen.

Bombardier F. A. Alcock (R.F.A.), who has been killed, was an employee of Sheffield electric supply department.

PERSONAL.

Mr. William Marsh, engineer and manager of Brighton Corporation tramways, has been appointed Assistant Director of Labour at Admiralty Shipyards. The Tramways Committee has granted him the necessary leave of absence.

Military Appointments.—The following appointments, &c., are announced :—

Lieut. T. R. Stanscombe, of the Army Ordnance Dept., has been promoted to Captain. He is an Associate Member of the Institution of Electrical Engineers and was formerly a technical assistant in the sales department of Bristol electricity department.

Sec.-Lieut. (temp. Lieut.) E. G. McHutchon (R.E.) relinquishes his temporary rank and is seconded for duty with R.E. Wireless Service. Temp. Lieut. R. T. Marris (R.E.) is appointed Adjutant and seconded vice Lieut. D. FitzJ. Fitzmaurice (R.E.).

Capt. (temp. Major) J. A. Chamier, D.S.O., Sqdn. Comdr., Ind. Army, is appointed Commandant of the Wireless and Observers' School and to be temp. Lt. Col. and graded as a Wing Commander while so employed.

Lieut. (temp. Major) H. A. Oxenham, M.C., Spec. Res., is appointed Asst. Commandant of the Wireless and Observers' School and will retain his present grading as a Park Comdr. and hold temp. rank of Major while so employed.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 25th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, South Kensington, S.W. Papers to be read on "An Investigation of Radium Luminous Compound," by Messrs. C. C. Paterson, J. W. T. Walsh and W. F. Higgins; "The Resistance to the Motion of a Lamina, Cylinder or Sphere in a Rarefied Gas," by Mr. F. J. W. Whipple; and "The Effect of Stretching on the Thermal and Electrical Conductivities of Wires," by Dr. C. H. Lees, F.R.S.

Junior Institution of Engineers.

8 p.m. At 39, Victoria-street, S.W. Dr. William Wilson, F.R.S., will exhibit and describe a Tellurion.

SATURDAY, May 26th.

Royal Institution.

3 p.m. At Albemarle-street, Piccadilly, W. Lecture on "The Electrical Properties of Gases," by Prof. Sir J. J. Thomson, O.M. (Lecture IV.)

Digitized by Google

THE THEORY OF ARMATURE WINDINGS.*

BY S. P. SMITH, D.SC.

(*Continued from p. 260.*)

Summary.—In this Paper an attempt is made to outline the theory of armature windings in machines with alternate north and south poles.

2. SINGLE-LAYER WINDINGS.

(I.) *Arrangement of Single-layer Windings.*†—The peculiarity of the single-layer winding is the use of one coil-side per slot, so that every coil fills two slots. Consequently if the coils of a phase are to lie in adjacent slots, as is usual in single-layer windings, each pole-pair must be divided into $2N$ equal parts, two of which are monopolised by each phase. The phase-spread in a single-layer winding is then $\sigma=2\pi/2N=\pi/N$ radians. In a single-layer winding, the coils can have a constant span, as in the mush winding; but winding the coils one inside the other forms a better arrangement for high-tension work and is preferred by some makers for all voltages. The variable coil-span, however, is due merely to the arrangement of the overhang, and by changing this we can obtain constant-span coils without affecting the position of the coil-sides in the slots in any way (*see* Fig. 2).

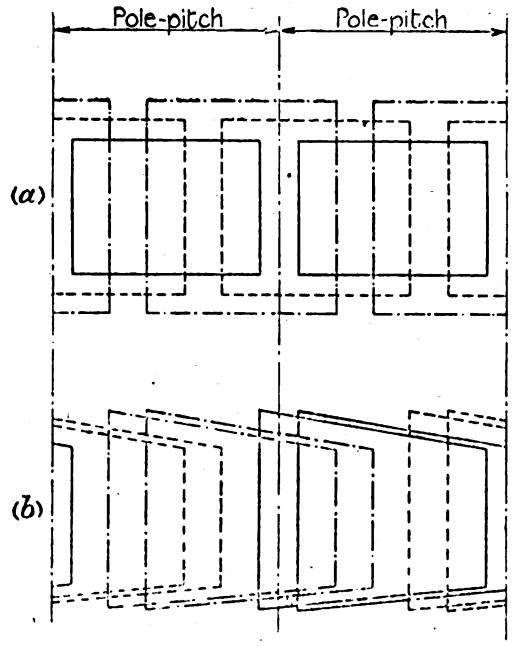


FIG. 2.—EQUIVALENT CONSTANT-SPAN COILS IN SINGLE-LAYER WINDING. (*a*) Actual coils (variable span). (*b*) Equivalent coils (constant span).

(II.) *Number of Armature Slots.*—In single-layer windings it is common practice for a phase to have the same number of coils in each pole-pair. Let q_0 denote the number of coils per phase in each pole-pair. Those q_0 coils require $2q_0$ slots so that for the N phases there must be $2q_0N$ slots per pole-pair, or in p' pole-pairs there must be $2q_0Np'$ slots. The total number of slots S' in the p' pole-pairs can be written

$$S'=2q_0Np'+x,$$

where x denotes the number of slots in the p' pole-pairs not needed by the q_0 coils per group, and will be left empty when all groups are alike—*see* sub-section (*a*) below. If the x slots are wound, some groups will have more coils than others—*see* sub-section (*b*) below.

In order to obtain a symmetrical N-phase winding, the number of slots S' must satisfy equation (4)—that is, the phase-pitch must be

$$y_{ph}=\frac{S}{aN}=\frac{S'}{N}=2q_0p'+\frac{x}{N}\text{slots}, \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where $p'=nN\pm1=p/a$.

Since y_{ph} must be a whole number and $2q_0p'$ is integral, it follows that the number of extra slots x in the p' pole-pairs must be divisible by the number of phases N, and each phase-pitch contain x/N extra slots.

The total number of slots S in the machine is then

$$S=S'a=2q_0Np+xa. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5a)$$

In the common three-phase single-layer winding, this becomes

$$S=6q_0p+xa, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5b)$$

where $x=0$, 3, 6, &c., and $a=p/p'=p/(3n\pm1)$ is an integer $\leq p$.

As these expressions are so simple, there is no need to tabulate the slottings for single-layer windings, and we shall, therefore, only consider the general cases.

(*a*) *Whole Number of Slots per Pole.*—In most single-layer windings the number of slots per pole Q is an integer. In this case every pole-pair is alike, and forms a complete N-phase system. Thus, $S'=2q_0N+x$ and $Q=q_0N+x/2$, where x can be zero or any multiple of N. The total number of slots $S=S'p$, since $a=p$ when $p'=1$.

The important case in practice is when a three-phase winding has a whole number of slots per pole. In this case the slotting is always that of a symmetrical six-phase winding. Thus, when $N=6$, $Q=6q_0+\frac{1}{2}x$. If now $x=0$, then Q is a multiple of 6, that is, an even multiple of 3, so that the six-phase winding consists of two three-phase windings, which can be joined in series or parallel. If $x=6$, $Q=6q_0+3$; that is, Q is an odd multiple of 3, so that we have a symmetrical six-phase winding with three empty slots per pole, or a symmetrical three-phase winding with $Q/3=2q_0+1$ slots per phase and pole. In the latter case there are not two equal circuits per phase per pole-pair when all slots are wound, but this is immaterial when only the series connection is required. It is thus seen that with a whole number of slots per pole, the slotting for a symmetrical three-phase winding is the same as that for a symmetrical six-phase winding, and it is due to this fact that it is possible to obtain a three-phase single-layer winding with one circuit per pole and phase.

When the number of slots per pole is integral, the same slot positions recur under every pole, and the coil-sides of the whole winding can only occupy Q positions in the field. Consequently, any effect due to the spacing of the slots or the swinging of the flux is repeated under every pole and appears undiminished in the phase pressure in the form of a spacing ripple or a tooth ripple. Thus for obtaining a smooth wave for the phase pressure we have the worst possible conditions with a whole number of slots per pole. There are several ways of suppressing the effects of the slots and teeth, most of which make the winding equivalent to a uniformly distributed winding. Thus, by skewing the slots or the pole-shoes by an amount equal to the slot-pitch this result is obtained. An equally effective method, and one that is often simpler and cheaper than the foregoing from the works' point of view, is to make the number of slots per pole fractional by adding extra slots.

(*b*) *Fractional Number of Slots per Pole.*—When Q is a fraction, the coil-sides do not occupy the same position in the field under the different poles, consequently the effect of the teeth is not reproduced throughout the phase. Expressed mathematically, we can say that $2Q+x$ and $2Q-x$, where $x=1$, 3, 5, &c., no longer represent harmonics when Q is a fraction, whereas they do so when Q is an integer, and have a high winding factor f_x, when x is small (*see* footnote to sub-section (I.), section 2).

We shall only consider the practical case of the symmetrical three-phase winding. Inserting $N=3$ in equation (4), we have $y_{ph}=S/3a=S'/3$.

The coils will occupy the greatest number of positions in the field when $a=1$ and $p'=p$, that is, when there can be only one circuit per phase. We can always make $a=1$ unless p is a multiple of 3. If p is a multiple of 3, we must make a a multiple of 3, so that $p'=p/a=3n\pm1$, is not a multiple of 3, and so obtain a similar parts per phase—*see* Table 1. For example, when $p=3$ we must take $a=3$, so that $p'=1$; with $p=6$, we can take $a=3$ to make $p'=2$, or $a=6$ to make $p'=1$. With $a=3$, the slot positions in the field repeat themselves three times; with $a=6$, six times.

(i.) *Use of Empty Slots.*—The simplest way to make Q fractional is to have a number of extra slots not needed by the winding. From equation (5) we get, for $N=3$, the phase-pitch $y_{ph}=2q_0p'+x/3$. Thus, x must be a multiple of 3.

Taking $x=3$ as the smallest number of empty slots that can be added, we have, when $p'=3n\pm1=p$, $S'=3y_{ph}=6q_0p'+3=S$. This gives the largest number of positions possible in p pole-pairs with a symmetrical three-phase winding, for in this case the slot positions in the field never recur, and there can only be one circuit per phase.

When $p'=1$, or in a two-pole machine, with three extra slots we get $S'=6q_0+3=2Q$, so that $Q=$an integer$+\frac{1}{2}$. This also has the effect of suppressing the tooth or spacing ripples owing to the action of the coil-span (*see* footnote to sub-section (I.), section 2).

* Abstracted from an Original Communication in the "Proceedings" of the Institution of Electrical Engineers, Vol. LV., p. 18. For the parts showing the arrangement of windings and illustrative examples, the original Paper must be consulted.

† See the original paper and also S. P. Smith and R. S. H. Boulding: "The Shape of the Pressure Wave in Electrical Machinery," "Journal" I.E.E., 1915, vol. LIII., p. 205.

Digitized by Google

In some cases it is found desirable to make $x=6$, that is, to use six empty slots, but it must be remembered that with an even number of pole-pairs this makes two a common factor of S and p, or $p'=p/2$ and $a=2$, thus giving two similar parts and only half the maximum number of possible positions in the field for each phase.

(ii.) *Use of Unequal Coil Groups.*—It is clear that when the number of extra slots in the machine is an even multiple of 3—*i.e.*, when $x=6n$—these slots can be wound and an equal number of extra coils allotted to each phase. In this way the coil groups in the several pole-pairs are made unequal.

Taking the case of 6 extra slots in p' pole-pairs, we get one extra coil per phase in each circuit. Thus, in a four-pole machine there are then $S=6q_0\times2+6=12q_0+6$ slots, that is an odd number of slots in each pole-pair, which is equivalent to a two-pole machine with three empty slots. In one group there will be q_0 coils and in the other q_0+1, thus making $(q_0+\frac{1}{2})$ slots per phase and pole. This arrangement can be used whenever the number of poles is a multiple of 4. In general, with six extra slots in the periphery there are in each phase $(p-1)$ groups containing q_0 coils and one group with (q_0+1) coils. According to whether $p=3n\pm1$ is even or odd, the number of slot positions in the field is increased p or $2p$ times.

Generally speaking, unequal coil groups are not desirable in practice, owing to the varying magneto-motive force from pole to pole and the constructional complications.

Example.—As an example of the use of extra slots, we can consider an eight-pole three-phase machine with a normal slotting for two slots per pole and phase—*i.e.*, $q_0=2$. The total number of slots is then 48, and according to whether we make the mean coil-span equal to the pole-pitch or to five-sixths of the pole-pitch, we get a three or six-phase winding, so that a three-phase winding with four or eight circuits per phase respectively is possible.

When extra slots are used, we get the following alternatives :—

No. of similar parts a.	$p'=p/a$.	Extra slots in p' pole-pairs x.	Slots in p' pole-pairs $S'=6q_0p'+x$	Total slots $S=S'a$	Extra possible coils per phase.
1	4	3	51	51	None.
2	2	3	27	54	1
4	1	3	15	60	2

The phase-pitch in each case is $y_{ph}=S'/3$. We thus have no fewer than five alternatives for the above winding—two usual and three unusual. All the latter are effective in suppressing tooth effects—the suppression in the case of $S'=15$ slots per pole-pair being due to the fact that the coil-span differs from the pole-pitch by an odd number of half slot-pitches (*see* footnote to sub-section (I.) section 2).

3. Double-Layer Windings.

(I.) *Arrangement of Double-layer Windings.*—When the sides of the coils are in two layers in the slots, one side of a coil lies in the top layer in one slot and in the bottom layer in some other slot, usually about a pole-pitch away. Generally all the coils are identical and arranged so that they can be joined in mesh, by means of lap or wave connections, to form a closed winding (*see* Fig. 3).

The smallest number of coil-sides per slot is 2, but any even number can be used, the commonest numbers being 4, 6, 8 and 10 coil-sides per slot. Since only one side of a coil has a place in either layer, the 2π radians—represenring one of the a similar systems—need only be divided into N equal parts—one part being allotted to each phase. In this case the phase-spread $\sigma=2\pi/N$ radians. When, however, a commutator is not used, it is usual and better to divide the 2π radians into $2N$ parts, and so reduce the phase-spread to $2\pi/2N=\pi/N$, as in a single-layer winding, in order to obtain the larger output.

(*a*) *Phase Tappings off Closed Windings.*—By observing the conditions developed in equations (2) and (3) it is possible to obtain a lap or wave winding having a simular, symmetrical polyphase windings in each of which the sum of the phase angles between the pressures is 2π radians and the resultant pressure is zero. Consequently the coils can be joined in mesh to form a closed winding, and according to the relation between the number of coils and the pitch between successive coils, the a systems can be made independent of one another or can be interconnected. (To join the coils in mesh, the finish of one coil is joined to the start of the successive coil until the winding closes.)

Permanent connections to a closed winding take the form of tappings—the corresponding equipotential points in each of the a systems being connected together to place the latter in parallel. Each point where a closed winding is tapped makes connection with the start of one phase and the finish of another. Pressures can be tapped off a closed winding in two ways: (i.) polygon tappings; (ii.) diametral tappings.

(i.) *Polygon Tappings.*—For an N-phase system each of the a similar parts of the winding is simply divided into N equal parts by means of N equidistant tappings, and the loads are placed across adjacent tappings. Tappings taken off a closed winding in this way can be conveniently called "polygon" tappings. The angular phase-pitch β is then equal to the angular phase-spread σ, that is, $\beta=\sigma=2\pi/N$. The pressures and currents in such a system are thus those in a mesh-connected system.

(ii.) *Diametral Tappings.*—Here each of the a similar parts of the winding is tapped at twice as many points as the number of phases

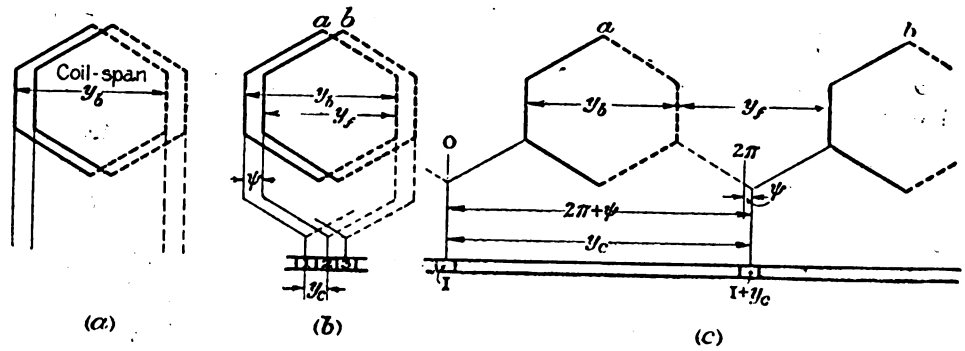


Fig. 3.—Double-layer Windings.

(*a*) Coils of Double-layer Winding. (*b*) Lap connection. (*c*) Wave connection.

required, and each load phase is formed by placing two opposite winding phases in parallel by means of diametral tappings. Thus for an N-phase load, we have $2N$ tappings in each part—two exclusively for each phase.

The angle between successive load phases is then $2\pi/(2N)=\pi/N$ radians. This is the common way of loading a rotary converter with six slip-rings.

It is easily shown that the method of diametral loading of a closed winding yields the same output as is obtained from an open winding with a phase-spread of π/N.

(*b*) *Open Double-layer Windings.*—If a commutator is not used, the windings can be opened at the points tapped. Each phase has now its own start and finish and can be loaded independently, or the phases can be interlinked in star (the original closed winding with polygon tappings is the mesh connection); but the phase-spread and phase-pitch remain unaltered, that is, $\sigma=\beta=2\pi/N$.

It is much better, however, to halve the phase-spread in order to obtain a larger output with the same number of phases in the load. To do this, the 2π radians are divided into $2N$ parts, thereby making the phase-spread $\sigma=2\pi/(2N)=\pi/N$, and the two parts which completely overlap are joined in parallel or series, as desired, to form a single phase. This is always possible, since $2N$ is always even. To join the two equal and opposite parts in series, either both finishes or both starts must be joined together; whilst to join them in parallel, the start of one must be connected to the finish of the other, and conversely. Thus, by opening a double-layer winding at $2N$ equidistant points, an N-phase system is obtained with a phase-spread equal to π/N radians.

(*To be continued.*)

Spontaneous Generation of Heat in Recently Hardened Steel.—In the "Physical Review," Mr. C. F. Brush describes a peculiar effect in recently-hardened steel—namely, an apparently spontaneous generation of heat which persisted for several weeks, the rate of generation gradually decreasing. The effect appears to be due to the relief from a condition of very great molecular strain, and is attended by a shrinkage in the material. Curves are presented showing the rate of diminution of the effect for various specimens.

Digitized by Google

DIFFERENTIAL DRUM HOISTS.

A good example of the use of the differential drum hoist is furnished by the bridge-diggers installed by the Bergen Point Ironworks over the storage pile at the Cristobal coaling station on the Panama Canal. The diggers, of which there are four, have a total capacity of 2,000 tons an hour, each machine being provided with a 5-ton grab-bucket. The differential drum is used for controlling the horizontal position of the grab. But such drums have a much wider application, They may be used for automatically controlling skip hoists, lifts, truck dumpers, hoists or any mass which has to be started, accelerated, moved, retarded and stopped within fixed limits.

The differential drum is a spirally-grooved drum, or sometimes two spiral drums of varying diameters, on which a rope is wound in such a manner that when the drum is rotated one end of the rope is wound up while the other end is paid out. The skip or other load is lifted by a sheave hanging in the loop or bight of the rope. Varying diameters are selected for the drum or drums, so that one end of the rope may be paid out at any desired rate faster than the other end is wound up, or *vice versa*, thus giving any required path and rate of acceleration or retardation to the load that is being handled.

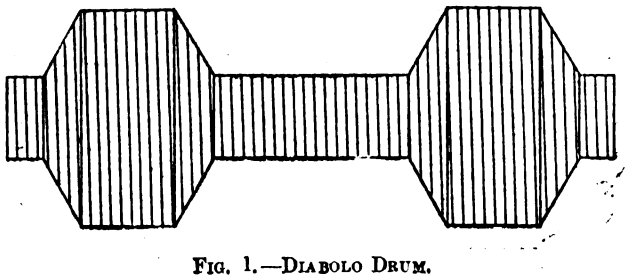


FIG. 1.—DIABOLO DRUM.

Fig. 1 shows the drum applied to an ash-handling skip hoist. The skip, weighing with its load of ashes about 3 tons, is raised vertically a distance of 103 feet, is then dumped and returned to the ash-pit in 35 seconds, the control being entirely automatic after the motor is started. The drum is made with end cylinders and the middle cylinder turned to a diameter of 20 inches, while the large cylinders have a diameter of about 48 inches, the large and small diameters being connected by six-turn spirals on each side.

At the beginning of a trip the drum is started in motion so as to wind in one end of the rope on the small cylindrical portion at the end of the drum, while the other end of the rope is unwound at the same rate from the small cylindrical portion in the centre of the drum, so that the skip supported in the bight of the rope is neither raised nor lowered, and the motor has only to overcome the inertia of starting the drum, gearing and rope. As the rotation of the drum continues, the short end of the rope commences to be wound up on the spiral while the other end continues to be paid out at a uniform speed. The skip, therefore, rises at a gradually increasing velocity until the short end of the rope begins to be wound upon the cylinder of large diameter, which had no rope on it at the beginning. In the meantime the other end of the rope continues to be paid out from the long central cylinder of small diameter at the original speed. Hence the skip is now raised at a uniform velocity depending on the relative diameters of the cylindrical parts of the drum and on the speed of rotation. The rotation of the drum continuing, the short end of the rope reaches the descending spiral connecting the large diameter cylinder (which had no rope on it at the start) to the central portion of the drum. This brings the skip gradually to rest at the top of its travel until both ends of the rope are on the central cylindrical portion of the drum, when one end will be paid out as fast as the other end is wound in and the skip remains at rest at the top of its travel.

If so desired the drum can be stopped at this point and the skip will be held at the top of the shaft without any tendency to rotate the drum in either direction. To cause the skip to make the return journey the direction of rotation of the drum must be reversed, or with a drum having two smalls, as shown in Fig. 1, the rotation may be continued in the same direction and one end of the rope will presently begin to be paid out from the spiral of gradually increasing radius, while the other continues to be wound upon the central portion of the drum. The skip, therefore, will gradually acquire a velocity of descent, which will reach a maximum and continue uniformly when the unwinding rope reaches the large diameter of the other cylindrical drum which was wound full of rope at the commencement of the hoist. Further rotation will cause the rope finally to be paid out from the last spiral connecting with the cylindrical portion of the drum of small diameter, thereby retarding the descent of the skip until the outgoing rope is finally unwound from the other small end cylinder; the incoming rope still being wound up on the central cylinder of small diameter when the skip will finally be brought to rest again at the bottom of its travel. The drum must then be stopped to prevent all the rope being unwound at one end.

Some advantages of the differential drum are :—

(*a*) Complicated accelerating, retarding, reversing and stopping devices are eliminated.

(*b*) The path of the load is absolutely limited. Overwinding at the top of a hoist or collision at the bottom is impossible (unless the rope breaks).

(*c*) Full load is not thrown on until the drum is brought up to speed.

(*d*) There are no sudden shocks or jerks on the rope or any other part of the mechanism.

(*e*) High speeds are obtainable with economy, simplicity and safety.

(*f*) Maintenance charges are small.

(*g*) The motor need not be reversed to lower the load, and dynamic braking can be used in lieu of a friction brake.

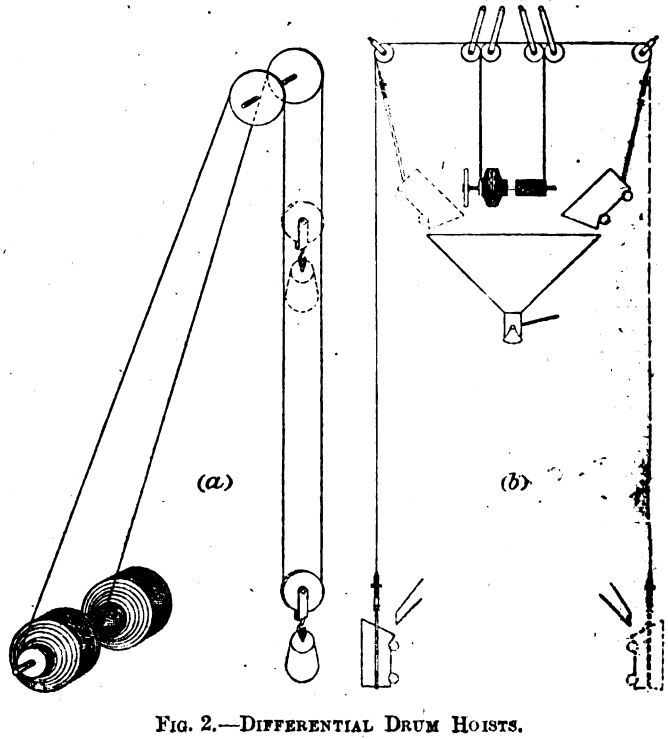


FIG. 2.—DIFFERENTIAL DRUM HOISTS.

Two applications of this ingenious drum are shown in Fig. 2 (*a*) and (*b*). In Fig. 2 (*a*) a load is raised by a differential drum made with two swells in it such as is shown in Fig. 1, so that the load can be raised, held and returned to the starting point without stopping or retarding the motor. Fig. 2 (*b*) shows a hoist of the balanced type where two skips are controlled from the same drum. In this case the drum is stopped and reversed every time each skip reaches the top or bottom of the shaft, the ropes being so wound that one skip is raised when the other is lowered. For handling coal, filling gates can be arranged to be opened automatically by the skips or buckets, so as to fill the skips at the bottom of the hoist, the gates being closed by the skips as they ascend. Reversal of rotation of the drum can be effected automatically by the skips themselves, so that after the machine is once put in motion the operation will continue indefinitely. The drums are built by the Bergen Point Ironworks to fit each individual case.

Digitized by Google

THE CHOICE OF VOLTAGE FOR RAILWAY ELECTRIFICATION ON THE DIRECT-CURRENT SYSTEM.

BY F. LYDALL.

(*Concluded from p.* 266.)

Summary.—The author considers first the conditions which apply to the problems of main line electrification in this country, and assuming that the high voltage direct-current system is adopted, gives reason for supposing that the voltage selected for a general electrification scheme would not be especially high. The number of different classes of locomotive is discussed, and designs for each class are worked out on the basis of four different line voltages—viz., 1,500, 2,000, 3,000 and 4,000. Details relating to these designs are given, and it is shown that even for the highest voltage considered there are no technical difficulties in the construction of suitable locomotives of all classes. Finally, a rough estimate is given of the extent to which the cost of a locomotive of any of the classes proposed is affected by the voltage selected.

PASSENGER LOCOMOTIVE MOTOR.

As already remarked, the freight locomotive motor has been designed bearing in mind the possibility of its use on the high-speed passenger engine with a different gear ratio and wheel diameter. The general type of locomotive proposed is an articulated 4—4+4—4, or 2—*B*+*B*—2, according to the Continental system of indicating the wheel arrangement. In other words, each half locomotive has a four-wheel leading or trailing bogie and two driving axles. Each driving axle is connected to a pair of motors, both motors of a pair driving on to a single gear wheel. The same limit of armature peripheral velocity has been taken as before, to correspond in this case to a speed of 90 miles per hour; the gear velocity at this speed has been taken as 20 metres per second (about 4,000 ft. per minute), and from these two limits the gear ratio and the driving wheel diameter have been deduced. It will be seen from Table VI. that the wheel diameters for the different motors do not exceed practicable limits, and the conclusion to be drawn from the calculations is that, assuming that the limit of 4,000 ft. per minute for the gear velocity is permissible, there is no difficulty in constructing an express passenger locomotive to meet the specified requirements without being compelled to use diagonal or vertical connecting rods, or to depart from the ordinary design of geared motor with single reduction gearing.

Now, although a gear velocity of 4,000 ft. per minute is much higher than has been generally used up to the present in traction work, it would not be regarded as abnormally high for gears used with high-speed turbines. For example, in the gearing described in the "Engineer" for October 1, 1915, the gear velocity is 6,000 ft. per minute, the gears running continuously at this speed. In the locomotive design now suggested the velocity during most of the running time would vary between 3,000 ft. and 3,500 ft. per minute. Whether it would be necessary or advisable to employ forced lubrication under these conditions I am not prepared to say; but it is clear that there is no reason to regard the velocity as prohibitive.

Two alternative methods present themselves of utilising the motors in pairs, each pair being connected to a single driving axle.

First Method.—The two motors are rigidly mounted in the locomotive and supported by fixed transverse beams between the side frames, and are geared to a countershaft or jack shaft which carries a single gear wheel. This shaft runs in fixed bearings and is provided with two cranks set at right angles. From these cranks standard locomotive wheels of a suitable diameter with crank pins are driven by horizontal connecting rods. The general arrangement is clearly shown in Fig. 7.

This arrangement has the following advantages:—

(*a*) Standard engine wheels and axles are used.

(*b*) Inside frames and standard bearings are used.

(*c*) The weight of the two motor pairs is conveniently distributed.

(*d*) The non-spring-borne load is a minimum.

(*e*) The centre of gravity of the whole locomotive is reasonably high.

(*f*) The driving wheels and axles and the jack shafts and gear wheels are easily removed downwards and the motors upwards through the roof.

The disadvantages of this arrangement may be said to lie in the use of connecting rods. This, however, is minimised as much as possible by keeping the rods fairly long (the length shown in the general arrangement drawing in Fig. 7 being 5 ft. 6 in.), and by avoiding the use of coupled wheels. All the motion is rotational, there being no reciprocating action, and all the rotating parts are balanced. With reasonable care in maintenance such an arrangement should give no trouble.

Second Method.—Each pair of motors drives on to a single gear wheel carried on a hollow shaft or quill surrounding the driving axle, each end of the hollow shaft being fitted with a claw coupling which drives the adjacent wheel by springs fixed between the wheel spokes. This arrangement has the following advantages:—

(*a*) Elimination of all connecting rods.

(*b*) The overall length of the locomotive is reduced to a minimum.

As compared with the first arrangement, it has the following disadvantages:—

(*a*) Special driving wheels of a large diameter are necessary.

(*b*) Outside frames are necessary.

(*c*) The gear wheel and the claw clutches cannot be removed from the hollow shaft without pressing the driving wheel off its seat.

(*d*) The weight of the motors is not so well distributed.

On the balance of advantages, I would be inclined to favour the first arrangement, but in the present consideration this is only a subsidiary question.

The motor as used for the goods locomotive is arranged for twin gearing, and is designed for $\frac{3}{8}$ in. to $\frac{1}{2}$ in. clearance at each end from the wheel flanges, the distance between the flanges being 4 ft. 5$\frac{1}{2}$ in. When used for the express locomotive, the motor is arranged for single ended gearing, and the saving of axial length on this account makes it possible to get the motor in between the side frames 4 ft. 2 in. apart. I have assumed that with the same axial length there is sufficient room at each end for the claw clutch if motors with hollow shafts are used.

The following are the particulars of the motors and locomotives for each of the two arrangements:—

Table VI.

Line voltage	1,500	1,500	2,000	2,000	3,000	4,000
Motor voltage	750	1,500	1,000	2,000	1,500	2,000
For Locomotive with Connecting Rods.						
Weight of a pair of motors with 2 pinions, 1 gear wheel and gear case, lbs.	14,100	16,600	16,900	18,100	18,300	19,900
Gear ratio	28/87	32/91	32/91	34/95	34/95	37/97
Wheel diameter	70″	72″	72″	75″	75″	78″
Height of motor centre above rail level	46·8″	49·2″	49·2″	51·6″	51·6″	53·1″
Driving wheel base, A	9′ 11″	10′ 0″	10′ 0″	10′ 1½″	10′ 1½″	10′ 3″
Driving wheel to bogie centre, B	13′ 3½″	12′ 3″	13′ 3½″	13′ 4″	13′ 4″	13′ 5″
Total wheel base, C	63′ 5″	61′ 8″	63′ 9″	64′ 4″	64′ 4″	65′ 0″
Length over buffers, D	71′ 9″	70′ 0″	72′ 1″	72′ 8″	72′ 8″	73′ 4″
For Locomotive with Hollow Shafts.						
Gear ratio	28/97	32/98	32/98	34/106	34/106	37/108
Wheel Diameter	78″	78″	78″	84″	84″	87″
Height of motor centre above rail level	54·3″	56″	56″	59·8″	59·8″	61·5″

One-hour rating of all motors, 350 H.P.; 2,565 lb. tractive effort at about 51 miles per hour.

In this table I have not given the wheel base dimensions for the locomotives in which hollow shafts are used, as these dimensions are not determined by the motors so much as by

Digitized by Google

the general mechanical design and the space requirements of the complete equipment including the control apparatus.

It will be noticed that the distance between the bogie centre and the nearest driving axle is less in the case of the locomotive equipped with 1,500 volt motors for a line voltage of 1,500 than in any of the others. The reason for this is that the motor in question is shorter in an axial direction than the other motors, including that designed for 750 volts on a line voltage of 1,500, on account of its shorter commutator. As a consequence of this there is a clearance between the motor frame and the flange of the bogie wheel of 5 ins., and with this clearance there should be no objection to the bogie wheel and the motor overlapping each other, provided there is no danger of the bogie wheel coming into contact with the gear case at the other end of the motor. The other motors in the series are all longer, due to greater insulation surfaces in spite of still shorter commutators, and it seems hardly safe to allow the motor and the wheel to overlap if the clearance is less than 5 ins.

Fig. 6 shows the speed-tractive effort curves for the express passenger engine equipped with four pairs of 2,000 volt motors for operating on a line voltage of 4,000. These may be regarded as typical for all the equipments containing motors of different voltages of which particulars have been given above.

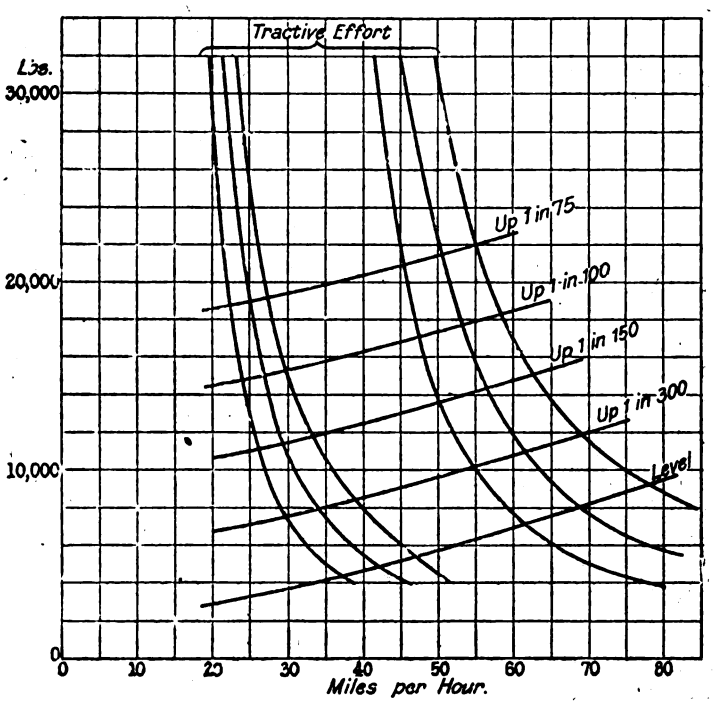


FIG. 6.—SPEED TRACTIVE-EFFORT CURVES FOR EXPRESS PASSENGER LOCOMOTIVE WITH FOUR PAIRS OF 2,000-VOLT 350 H.P. MOTORS.

The same sheet of curves contains curves of tractive resistance against speed for a 525 ton train (*i.e.*, a trailing load of 425 tons with a 100-ton locomotive) on the level and on different rising gradients. From these it will be seen that there is the following choice of steady speeds on the level :—

37·5, 42, 47·5, 61·5, 69, 78 miles per hour.

Up a gradient of 1 in 100 there is the following choice :—

24, 27, 29·5, 47·5, 53·2, 58·5 miles per hour.

These figures show clearly the power of an electric locomotive to maintain a high speed up a steep gradient, due to the great overload capacity of the motors, as compared with a steam locomotive which exerts a more or less constant horse-power (if sufficiently well designed) whether travelling on the level or up a gradient.

A locomotive such as has been suggested could haul a train of 425 tons for a distance of 150 miles over a track including 15 miles of one per cent. rising gradient with an equal length of one per cent. falling gradient at an average speed of 73 miles per hour, including starting and stopping, the speed down the gradient being limited to 80 miles per hour. In other words, the total distance would be covered in 2 hours 3 minutes. After a lie-over of 27 minutes, the performance could be repeated, and continued at equal intervals throughout the day. Or, if one intermediate stop is required of say 5 minutes duration, the total journey would take 2 hours 12 minutes including everything, and this also could be repeated at the end of 2½ hours. These times are based upon the tractive resistance curves shown in Fig. 6, and do not include any allowance for signal stops or extra resistance due to head winds or side winds. They may be compared with the run from King's Cross to Doncaster, a distance of 156 miles, the fastest train being timed to do the journey in 174 minutes, with one intermediate stop of 3 minutes at Peterborough. There is, of course, no stretch of 15 miles of one per cent. gradient on this line.

In order to satisfy myself that there would be no insurmountable difficulty in building and equipping a 4,000-volt locomotive for express passenger service on the lines suggested above, I have worked out the electrical equipment in some detail and have attempted to design the mechanical part to meet the running requirements and accommodate the equipment. The design is shown in the general arrangement drawing in Fig. 7, already referred to.

In considering the auxiliary apparatus, I have assumed that the power for the blower motors, the motor compressor, the control circuits and the lighting would be obtained from a rotary transformer taking current from the overhead line and supplying power at about 500 volts. In this way the high tension apparatus is limited to the main circuits and the high tension side of the rotary transformer with its controlling switch and fuse and starter.

This arrangement possesses a further advantage. I think it may be taken for granted that when electrification on a large scale eventually takes place, the existing urban and suburban electrified zones which have been developed mostly on the basis of a direct-current supply at 500 to 600 volts will be left undisturbed. These zones are or will be in general separated from one another by considerable distances and it is most unlikely that the intervening railways will ever have enough traffic to justify the 500-volt supply being extended to cover these distances. London, Manchester, Newcastle, Glasgow and other big cities will have their suburban low voltage systems and will adhere to the low voltage whatever may happen to the long distance traffic between them. Now in these low voltage areas there will certainly be some locomotive sheds and repair shops, and it will undoubtedly be a great convenience if the main line locomotives, whether freight or passenger, can run over these lines under their own power, purely for the purpose of getting to or from the repair shops. All that is needed to meet this requirement is to fit third rail collector shoes and provide a throwover switch so that all the auxiliaries can be operated from the low voltage supply instead of from the low tension side of the rotary transformer. The locomotive speed will be, of course, much below its normal value when taking power from the overhead line, but it will be sufficient for the purpose suggested. Thus, for example, the 4,000-volt freight locomotive would travel light on the level at about 20 miles per hour and the passenger engine at about 35 miles per hour.

On this basis then the passenger locomotive equipment would consist of the following :—

Each half locomotive would contain :
Two motor pairs with an aggregate capacity on the one-hour rating of 1,400 H.P.
One motor generator consisting of a 20 kw. 500-volt generator direct coupled to a 4,000-volt double commutator motor.
One 500-volt motor compressor with a nominal capacity of 50 cubic feet per minute.
Two 500-volt motor blowers, one for each motor pair.
Two pantagraph current collectors.
One main circuit breaker.
Twenty-four resistance and field shunting contactors.
One reverser.
Six controlling contactors.
Two sets of main resistances.
Two field shunting resistances.
Master controller, main and auxiliary wiring, switches, fuses and couplers.

Digitized by Google

The control system would provide for the following :—

Eleven positions, motors in series, full field, resistance in circuit.
One position, full series, full field.
One position, full series, intermediate field.
One position, full series, weak field.
Transition from series to parallel.
Seven positions, motors in parallel, resistance in circuit.
One position, full parallel, full field.
One position, full parallel, intermediate field.
One position, full parallel, weak field.

The main resistances would be capable of dealing with a start from rest to full speed with a full-sized train on a rising gradient of 1 in 75, and the tractive effort of the complete double locomotive on the first position would be not more than 9,000 lb., thus ensuring an easy start without any severe jerks.

The approximate weights of the various items composing the complete equipment of a half locomotive for a line voltage of 4,000 would be as follows :—

Two motor pairs, each with motor blower attached	18·00 tons.
One rotary transformer	2·30 ,,
One motor compressor	0·65 ,,
Two sets of main resistances	2·95 ,,
Thirty contactors and circuit-breaker	1·35 ,,
Two pantograph collectors	0·85 ,,
Reverser, master controller, switches, fuses, couplers, main and auxiliary wiring, sundries	1·25 ,,
Total	27·35 tons.

The arrangement would be somewhat as shown in the drawing (Fig. 7)—*i.e.*, the main resistances and the contactors would be fixed on both sides of the main body of the locomotive having a gangway down the centre sufficiently wide to allow the motors to be lifted out of the locomotive through an opening in the roof.

The question of heating the train is a difficult one, but it only indirectly affects the electrical equipment. I take it for granted that the present system of steam heating would be continued, as has been found advisable in the United States and on the Continent. The steam for this purpose would be raised in a boiler fitted in the locomotive. This can be fired either by coal or by oil, or can be heated electrically. In the United States I believe the boilers are usually oil fired, and on the Continent either coal fired or electrically heated. The objection to producing the steam electrically is the high cost as compared with the cost of fuel, but it may be that pressure from the Board of Trade would lead to its adoption in this country in order to minimise fire risks in case of a collision. If the locomotive draws power from a low-voltage supply, such as 500 volts, there is no serious difficulty in designing a suitable heater for the boiler, but this would be much more difficult if the supply were at 4,000 volts. The alternative is to take the current for heating from the auxiliary motor generator; but this would lead to a very considerable increase in its size and cost.

5. *The Cost of Locomotives as Affected by the Supply Voltage.*—So far the matter has been one of purely technical consideration. The question of cost is much more difficult to deal with for several reasons. Manufacturing costs are continually varying, and this was true even before the war, and the variation is much more pronounced in the last two years, due to increases in the costs of material and labour. Further, it is difficult to make a close estimate of a new design of motor, even when worked out in considerable detail. Still more difficult is it to judge what allowance to make for contingencies to guard against possibilities of trouble which are probably greater the higher the voltage.

The increase in cost due to an increase in the supply voltage may be divided into four sections :—

(*a*) That due to the greater size of the main motors, and the greater amount of labour involved in their construction.
(*b*) That due to the increase in the rotary transformer.
(*c*) That due to additional insulation of the high-voltage circuits and the high-voltage parts of the control equipment.
(*d*) That due to the increased weight and size of the mechanical structure of the locomotive.

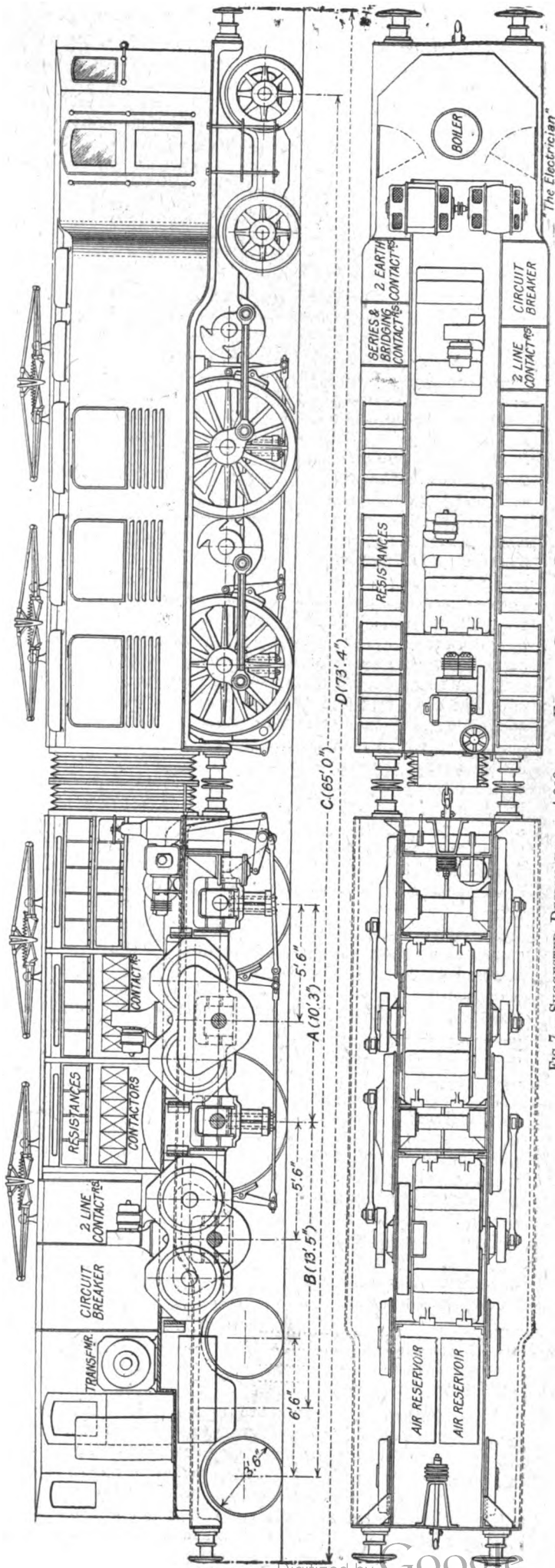


FIG. 7.—SUGGESTED DESIGN FOR A 4,000-VOLT EXPRESS PASSENGER ENGINE.

Digitized by Google

Dealing with these seriatim, the design of the main motors has already been considered, and with sufficient estimating experience it should be possible to arrive at a reasonable estimate of the cost on some fixed basis, such as that which held good just before the war. It should be observed that for the motors used in the goods and passenger locomotives the weight of copper is very nearly the same whatever the voltage. The increase in cost of materials is therefore mainly due to the greater amount of steel in the castings and the stampings and of insulating material for the windings and commutator. The wages will also be higher for the higher voltage motors, on account of the greater number of commutator segments and armature conductors and the greater number of turns in the field coils. As, however, the price of steel is low compared with that of copper, the total increase in the cost of the motor is not so great as might be expected.

The rotary transformer may be a single machine, usually called a dynamotor, or a motor generator. For 1,500 and 2,000 volts, and even for 2,500 volts, if an intermediate voltage should be chosen, there is no reason why a dynamotor should not be employed. The voltage on the low-tension side would in all cases be 500 and on the high-tension side 1,000, 1,500 or 2,000, according to whether the supply voltage is 1,500, 2,000 or 2,500. But for a small machine, even with a two-pole design, it seems hardly practicable to go beyond 2,000 volts on a single commutator, and consequently for a supply voltage of 3,000 or 4,000 a motor-generator must be employed, the motor being a two-pole double commutator machine for the full-line voltage and the generator a standard 500-volt machine of the requisite capacity. There is, therefore, a substantial increase in cost on the score of the rotary transformer as between 1,500 and 4,000 volts, or even between 2,000 and 3,000.

The additional insulation of the high-tension portions of the equipment is difficult to estimate at all accurately. Until all the details are actually worked out one can only form a rough guess. This item includes the extra cost of main connecting cables, if any, the cost of contactors and reverser for dealing with relatively small currents at high voltage, the additional insulation of the main resistances, the extra cost of the control apparatus for the rotary transformer, and any special arrangements that may be found necessary for dealing with arcs formed when the main circuit-breaker opens on overload, such arrangements being more elaborate or extensive as the voltage is increased.

Finally, there is the increase in the cost of the mechanical structure of the locomotive consequent upon the increased size and weight of the motors, and possibly of the rest of the equipment. For instance, the goods locomotive for 4,000 volts has 56 in. driving wheels and bogies of 10 ft. 4 in. wheel base as compared with 50 in. wheels and bogies of 9 ft. wheel base in the case of the 1,500-volt locomotive. Similar increases are shown in Table VI. relating to passenger locomotives.

It will be obvious, therefore, that an a priori estimate of the total increase of cost for the locomotives of the different classes is necessarily approximate and to a certain extent dependent upon individual judgment. On a given basis, however, such as what may be called pre-war prices, it should be possible to arrive at a set of figures which, however approximate, may be of use in considering the whole question of the most suitable voltage to be adopted. Taking the various factors into account I estimate that for the different classes already discussed the extra costs due to increased voltages ought not to exceed the following :—

Voltage	1,500	2,000	3,000	4,000
Shunting locomotive	0	£210	£370	£620
Goods locomotive	0	£230	£440	£600
Double passenger locomotive	0	£340	£680	£960

I repeat that these figures are approximate, and cannot be regarded as possessing any scientific accuracy, but I venture to put them forward for what they are worth. In any case they are only a single factor in the general calculation, which takes into account the first cost and working expenses of the distribution system and the sub-stations, and can only be brought into such a calculation when a reasonable estimate has been arrived at as to the average number of locomotives of each class which should be provided per mile of railway.

Postscript.—It is perhaps worth remarking that, if desired, the motor units for the goods locomotive can be made completely interchangeable with those required for the passenger engine, by adopting a somewhat different mechanical design for the former. The design assumed in the foregoing was that which has been most largely used, especially in this country, and consists of a body carried on two motor bogies, each bogie equipped with two independent motors geared to the driving axles. If now, instead of this arrangement the locomotive is built in two complete halves, articulated together in the centre, the two axles of each half can be driven by side coupling rods from a jack shaft midway between them geared to a pair of motors in precisely the same way as in the design for the passenger locomotive. The gear ratios and wheel diameters would not, of course, be the same, but a part from this the motors would be identical.

The particulars of gearing and driving wheels would be as follows :—

Voltage of supply	1,500	1,500	2,000	2,000	3,000	4,000
Voltage per motor ...	750	1,500	1,000	2,000	1,500	2,000
Gear ratio	20 : 95	23 : 100		25 : 104		27 : 107
Wheel diameter	54 in.	56 in.		58 in.		59 in.

Apart from the question of interchangeability this arrangement would have several advantages over the more usual design of bogie locomotive. From the mechanical point of view it might be expected that there would be less wear and tear of the track, as the dead load on the rails would be reduced to a minimum, and due to the position of the motors the centre of gravity would be fairly high. The wheels and axles and also the motors could be removed without difficulty, and the motors would be accessible for inspection from the interior of the locomotive.

From the electrical point of view the following points may be mentioned : (*a*) As the two armatures of a motor pair are definitely coupled together through the gearing, there is no possibility of the full voltage being concentrated on the commutator of one motor, as may occur when the motors are independent, through the slipping of one pair of driving wheels on the rails ; (*b*) as the motor is completely carried on springs, there is not the same liability to sparking at the brushes, due to vibration and shocks when passing over rail joints as when the motors are partly supported by the driving axles.

As against these advantages, it may be urged that the design does not lend itself to an arrangement with a central cab from which the driver can look out in both directions over sloping ends. The importance of this point, however, is a matter for individual judgment.

Application of Oscillograph to Tests of Internal Combustion Engines.—In the "Revue Générale d'Électricité" M. Camillerapp describes an interesting application of the Blondel oscillograph. In studying internal combustion motors it is desirable to record (*a*) the pressure variations in the cylinder, (*b*) the period between two explosions, giving the speed of the engine, and (*c*) the magnitude and duration of the ignition current. By means of oscillographic methods (*b*) and (*c*) can be readily followed. A special device has been designed for studying (*a*). For this purpose a microphone, in electrical connection with an oscillograph, is mounted in the cylinder. In view of the high temperature of the cylinder gases, the latter are only allowed to impinge on a mica disc, which, in turn, communicates its vibrations through a metal needle to the disc in the microphone. In order to minimise the effect of vibrations it is convenient to mount a second microphone, back to back with the microphone registering the pressure, so as to be affected by mechanical vibrations only and not by pressure fluctuations. The two microphones are then connected up on the Wheatstone bridge principle so that the vibration effects cancel out. The three factors (*a*), (*b*) and (*c*) can be studied simultaneously and the oscillograph method of attack is expected to throw light on many debateable questions in this field.

Digitized by Google

INSTITUTION OF ELECTRICAL ENGINEERS.

ANNUAL GENERAL MEETING.

The annual general meeting of the Institution of Electrical Engineers was held on Thursday, May 17th, under the presidency of Mr. C. P. Sparks.

The PRESIDENT opened the proceedings by announcing the result of the ballot for new members of the Council. The following were elected: *President*, Mr. C. H. Wordingham; *vice-presidents*, Mr. G. W. Partridge and Mr. W. B. Woodhouse; *honorary treasurer*, Mr. J. E. Kingsbury (re-elected); *ordinary members of Council*, Mr. Ll. B. Atkinson, Mr. W A. Chamen, Mr. J. S. Highfield, Sir Wm. Slingo, Lieut.-Col. H. C. Sparks, D.S.O., M.C., and Mr. A. P. Trotter.

The new Council therefore is constituted as follows:—

PRESIDENT.

C. H. Wordingham.

VICE-PRESIDENTS.

R. A. Chattock. R. T. Smith.
G. W. Partridge. W. B. Woodhouse.

HONORARY TREASURER.

J. E. Kingsbury.

ORDINARY MEMBERS OF COUNCIL.

L. B. Atkinson.	H. H. Harrison.	G. S. Ram.
J. O. Callender.	J. S. Highfield.	W. R. Rawlings.
W. A. Chamen.	Prof. T. Mather, F.R.S.	Sir W. Slingo.
F. W. Crawter.	G. H. Nisbett.	Lt.-Col. H. C. Sparks,
J. Devonshire.	W. Ll. Preece.	D.S.O., M.C.
H. Dickinson.	H. Faraday Proctor.	A. P. Trotter.
J. Hunter Gray.		

The PRESIDENT then proposed that a message be sent to the American Institute of Electrical Engineers expressing the Institution's sincere appreciation of the entry of the United States into the war on the side of Great Britain and her Allies.

Mr. C. H. WORDINGHAM, in seconding the motion, said there were few, if any, of the members who did not number among their friends many individual Americans, and their experience had led to their entertaining for them the highest possible regard, and looking upon them as their brothers in every sense of the word. One could not help feeling that if these two great nations—the American nation and the British nation—could purge themselves of the German taint that had invaded them there might in the not very far distant future come about some great federation of the whole Anglo-Saxon race. Such a result would make for civilisation, and perhaps for that far greater ideal, the reunion of Christendom.

The motion was carried unanimously.

The message was as follows:—

> The President and Council and the members of the Institution of Electrical Engineers send hearty greetings to their brothers of the American Institute of Electrical Engineers, and hereby express to them their sincere appreciation of the entry of the great American Nation into the war on behalf of civilisation and its ideals, and of the significance of their action for the cause of the British Empire and its Allies.
>
> Dated the 17th day of May, 1917.
>
> Signed by the President, President-Elect and Secretary.

The PRESIDENT announced that this would be engrossed on vellum and forwarded by mail.

The PRESIDENT then dealt with and moved the adoption of the annual report of the Council, an abstract of which is given below.

REPORT OF THE COUNCIL.

In the report of the Council it is stated that the membership shows a net decrease of 63 over that of the previous year. During the year 39 members lost their lives on active service. In the same period 10 ordinary meetings, 16 Council meetings and 122 Committee meetings were held. There have been 42 meetings of local sections.

Premiums for Papers have been awarded by the Council to Messrs. G. V. Twiss, F. R. McBerty, C. Vernier, F. Gill and W. W. Cook, and to S. P. Smith, D.Sc. No students' premiums have been awarded, but the Papers read will be taken into consideration at the next award of students' premiums.

Since the publication of the seventh edition of the wiring rules in March, 1916, a number of suggested alterations have been submitted for the consideration of the Committee. It is not proposed, however, to undertake a further general revision of the rules until after the war.

A sub-committee has been appointed to collect evidence in regard to the use of lead-covered conductors for house wiring.

In May last the Council appointed a committee to draw up regulations for electrical installations on ships other than warships. This committee is constituted as follows:—

Ship Electrical Equipment Committee.

C. H. WORDINGHAM (*Chairman*).
C. P. Sparks, President (*ex-officio*).

J. H. Collie.	J. F. Nielson.
B. M. Drake.	Lieut. N. W. Prangnell.
A. Henderson.	Capt. A. P. Pyne.
J. W. Kempster.	S. G. C. Russell.

T. A. Sedgwick.

And	*Nominated by*
W. S. Abell, J. T. Milton	Lloyd's Register of Shipping.
H. H. Berry	British Electrical and Allied Manufacturers' Association.
T. Carlton	Board of Trade.
W. Cross	Electrical Contractors' Association.
J. Foster King	British Corporation for the Survey and Registry of Shipping.
J. Lowson	Institution of Engineers and Shipbuilders in Scotland.
A. W. Stewart	Institution of Naval Architects.
H. Walker	N.E. Coast Institution of Engineers & Shipbuilders.

The regulations will be published in the course of the next few months, and it is hoped that they will prove of value to the shipping industry and be generally adopted.

The standard specification for street lighting prepared by the special committee appointed for this purpose will be published in the "Journal" at an early date as a majority report of the committee.

Research.—Progress has been made with the research on the heating of buried cables, and a number of tests have been carried out, but further work is required before any results are available for publication.

Specimens of 10 different brands of insulating oils have been distributed among six investigators, who are carrying out tests 1 to 7 from the following list, and as many of the others as they can arrange for: (1) Tendency to sludge, (2) loss by evaporation, (3) flash point, (4) viscosity at different temperatures, (5) chemical reactions, (6) density and coefficient of expansion, (7) cold test (solidification), (8) moisture absorption, (9) dielectric strength, (10) specific resistance, (11) thermal transference, and (12) specific heat.

Panel committees have been appointed by the Council to formulate schemes of research on various insulating materials with a view to drawing up standard specifications for the purchase of such materials and for discriminating between the various grades. The following materials are included in the research: Porcelain, ebonite, mica, micanite, fibrous materials, insulating varnishes and composite materials. Application has been made to the Research Department for grants in aid of these researches. The proposed schemes of research have already been drawn up in the case of most of the materials.

It has been agreed between the Institution and the British Electrical and Allied Manufacturers' Association to co-operate in this research, and, with a view to ensuring that the two researches should not overlap but mutually assist one another, the Institution will deal mainly with the scientific part of these researches, and the Association with the industrial. Each body will have representatives on the Committees of the other dealing with this research.

Electricity Supply.—In October, 1916, the Council appointed a committee consisting of

R. A. Chattock (*Chairman*).

C. H. Merz.	T. Roles.
G. W. Partridge.	C. P. Sparks.
S. L. Pearce.	W. B. Woodhouse.

with the following reference:—

"To report to the Council on the best means of co-ordinating and improving electricity supply in the United Kingdom."

Six meetings have been held. The Committee have been in close touch with the National Electric Supply Joint Committee appointed by the Incorporated Municipal Electrical Association and the Incorporated Association of Electric Power Companies, and, in order to prevent overlapping, it has been agreed that the Institution Committee will devote its attention to the question of electricity supply from the point of view of the requirements of the country as a whole, and will deal with the engineering aspect of the matter, while the Joint Committee will go into more immediate questions of organisation and linking-up of existing undertakings, &c.

The following matters, amongst others, are engaging the attention of the Committee: (1) A standard frequency for the country; (2) the voltages that should be recommended for transmission and distribution purposes; and (3) the obtaining of reasonable facilities for wayleaves.

The Committee have already arrived at a decision as regards standard frequencies for certain large areas in the country, but they feel that it is not advisable to put forward their recommendations piecemeal.

They have been awaiting the publication of the report of the Electrical Trades Committee of the Board of Trade, in order that they might work as far as possible along the lines which it was anticipated would be indicated therein. It is uncertain when the report of this Committee will be published, especially in view of the recent appointment of an Electric Power Supply Committee by the Board of Trade, with a reference generally similar to that of the Institution Committee.

The Committee will, however, proceed with their deliberations in the hope that their recommendations will enable the Institution to render some effective assistance to the Board of Trade Committee.

The questions referred to above require careful consideration, and it is, therefore, probable that some time will elapse before definite recommendations can be made upon them.

Reserved Occupations Committee.—At the beginning of February the attention of the Council was drawn to a memorandum issued by the

Digitized by Google

Dealing with these seriatim, the design of the main motors has already been considered, and with sufficient estimating experience it should be possible to arrive at a reasonable estimate of the cost on some fixed basis, such as that which held good just before the war. It should be observed that for the motors used in the goods and passenger locomotives the weight of copper is very nearly the same whatever the voltage. The increase in cost of materials is therefore mainly due to the greater amount of steel in the castings and the stampings and of insulating material for the windings and commutator. The wages will also be higher for the higher voltage motors, on account of the greater number of commutator segments and armature conductors and the greater number of turns in the field coils. As, however, the price of steel is low compared with that of copper, the total increase in the cost of the motor is not so great as might be expected.

The rotary transformer may be a single machine, usually called a dynamotor, or a motor generator. For 1,500 and 2,000 volts, and even for 2,500 volts, if an intermediate voltage should be chosen, there is no reason why a dynamotor should not be employed. The voltage on the low-tension side would in all cases be 500 and on the high-tension side 1,000, 1,500 or 2,000, according to whether the supply voltage is 1,500, 2,000 or 2,500. But for a small machine, even with a two-pole design, it seems hardly practicable to go beyond 2,000 volts on a single commutator, and consequently for a supply voltage of 3,000 or 4,000 a motor-generator must be employed, the motor being a two-pole double commutator machine for the full-line voltage and the generator a standard 500-volt machine of the requisite capacity. There is, therefore, a substantial increase in cost on the score of the rotary transformer as between 1,500 and 4,000 volts, or even between 2,000 and 3,000.

The additional insulation of the high-tension portions of the equipment is difficult to estimate at all accurately. Until all the details are actually worked out one can only form a rough guess. This item includes the extra cost of main connecting cables, if any, the cost of contactors and reverser for dealing with relatively small currents at high voltage, the additional insulation of the main resistances, the extra cost of the control apparatus for the rotary transformer, and any special arrangements that may be found necessary for dealing with arcs formed when the main circuit-breaker opens on overload, such arrangements being more elaborate or extensive as the voltage is increased.

Finally, there is the increase in the cost of the mechanical structure of the locomotive consequent upon the increased size and weight of the motors, and possibly of the rest of the equipment. For instance, the goods locomotive for 4,000 volts has 56 in. driving wheels and bogies of 10 ft. 4 in. wheel base as compared with 50 in. wheels and bogies of 9 ft. wheel base in the case of the 1,500-volt locomotive. Similar increases are shown in Table VI. relating to passenger locomotives.

It will be obvious, therefore, that an a priori estimate of the total increase of cost for the locomotives of the different classes is necessarily approximate and to a certain extent dependent upon individual judgment. On a given basis, however, such as what may be called pre-war prices, it should be possible to arrive at a set of figures which, however approximate, may be of use in considering the whole question of the most suitable voltage to be adopted. Taking the various factors into account I estimate that for the different classes already discussed the extra costs due to increased voltages ought not to exceed the following :—

Voltage	1,500	2,000	3,000	4,000
Shunting locomotive	0	£210	£370	£620
Goods locomotive	0	£230	£440	£600
Double passenger locomotive	0	£340	£680	£960

I repeat that these figures are approximate, and cannot be regarded as possessing any scientific accuracy, but I venture to put them forward for what they are worth. In any case they are only a single factor in the general calculation, which takes into account the first cost and working expenses of the distribution system and the sub-stations, and can only be brought into such a calculation when a reasonable estimate has been arrived at as to the average number of locomotives of each class which should be provided per mile of railway.

Postscript.—It is perhaps worth remarking that, if desired, the motor units for the goods locomotive can be made completely interchangeable with those required for the passenger engine, by adopting a somewhat different mechanical design for the former. The design assumed in the foregoing was that which has been most largely used, especially in this country, and consists of a body carried on two motor bogies, each bogie equipped with two independent motors geared to the driving axles. If now instead of this arrangement the locomotive is built in two complete halves, articulated together in the centre, the two axles of each half can be driven by side coupling rods from a jack shaft midway between them geared to a pair of motors in precisely the same way as in the design for the passenger locomotive. The gear ratios and wheel diameters would not, of course, be the same, but a part from this the motors would be identical.

The particulars of gearing and driving wheels would be as follows :—

Voltage of supply	1,500	1,500	2,000	2,000	3,000	4,000
Voltage per motor ...	750	1,500	1,000	2,000	1,500	2,000
Gear ratio	20 : 95	23 : 100		25 : 104		27 : 107
Wheel diameter	54 in.	56 in.		58 in.		59 in.

Apart from the question of interchangeability this arrangement would have several advantages over the more usual design of bogie locomotive. From the mechanical point of view it might be expected that there would be less wear and tear of the track, as the dead load on the rails would be reduced to a minimum, and due to the position of the motors the centre of gravity would be fairly high. The wheels and axles and also the motors could be removed without difficulty, and the motors would be accessible for inspection from the interior of the locomotive.

From the electrical point of view the following points may be mentioned : (*a*) As the two armatures of a motor pair are definitely coupled together through the gearing, there is no possibility of the full voltage being concentrated on the commutator of one motor, as may occur when the motors are independent, through the slipping of one pair of driving wheels on the rails ; (*b*) as the motor is completely carried on springs, there is not the same liability to sparking at the brushes, due to vibration and shocks when passing over rail joints as when the motors are partly supported by the driving axles.

As against these advantages, it may be urged that the design does not lend itself to an arrangement with a central cab from which the driver can look out in both directions over sloping ends. The importance of this point, however, is a matter for individual judgment.

Application of Oscillograph to Tests of Internal Combustion Engines.—In the "Revue Générale d'Électricité" M. Camillerapp describes an interesting application of the Blondel oscillograph. In studying internal combustion motors it is desirable to record (*a*) the pressure variations in the cylinder, (*b*) the period between two explosions, giving the speed of the engine, and (*c*) the magnitude and duration of the ignition current. By means of oscillographic methods (*b*) and (*c*) can be readily followed. A special device has been designed for studying (*a*). For this purpose a microphone, in electrical connection with an oscillograph, is mounted in the cylinder. In view of the high temperature of the cylinder gases, the latter are only allowed to impinge on a mica disc, which, in turn, communicates its vibrations through a metal needle to the disc in the microphone. In order to minimise the effect of vibrations it is convenient to mount a second microphone, back to back with the microphone registering the pressure, so as to be affected by mechanical vibrations only and not by pressure fluctuations. The two microphones are then connected up on the Wheatstone bridge principle so that the vibration effects cancel out. The three factors (*a*), (*b*) and (*c*) can be studied simultaneously and the oscillograph method of attack is expected to throw light on many debateable questions in this field.

Digitized by Google

INSTITUTION OF ELECTRICAL ENGINEERS.

ANNUAL GENERAL MEETING.

The annual general meeting of the Institution of Electrical Engineers was held on Thursday, May 17th, under the presidency of Mr. C. P. Sparks.

The PRESIDENT opened the proceedings by announcing the result of the ballot for new members of the Council. The following were elected: *President*, Mr. C. H. Wordingham; *vice-presidents*, Mr. G. W. Partridge and Mr. W. B. Woodhouse; *honorary treasurer*, Mr. J. E. Kingsbury (re-elected); *ordinary members of Council*, Mr. Ll. B. Atkinson, Mr. W A. Chamen, Mr. J. S. Highfield, Sir Wm. Slingo, Lieut.-Col. H. C. Sparks, D.S.O., M.C., and Mr. A. P. Trotter.

The new Council therefore is constituted as follows:—

PRESIDENT.

C. H. Wordingham.

VICE-PRESIDENTS.

R. A. Chattock. R. T. Smith.
G. W. Partridge. W. B. Woodhouse.

HONORARY TREASURER.

J. E. Kingsbury.

ORDINARY MEMBERS OF COUNCIL.

L. B. Atkinson.	H. H. Harrison.	G. S. Ram.
J. O. Callender.	J. S. Highfield.	W. R. Rawlings.
W. A. Chamen.	Prof. T. Mather, F.R.S.	Sir W. Slingo.
F. W. Crawter.	G. H. Nisbett.	Lt.-Col. H. C. Sparks,
J. Devonshire.	W. Ll. Preece.	D.S.O., M.C.
H. Dickinson.	H. Faraday Proctor.	A. P. Trotter.
J. Hunter Gray.		

The PRESIDENT then proposed that a message be sent to the American Institute of Electrical Engineers expressing the Institution's sincere appreciation of the entry of the United States into the war on the side of Great Britain and her Allies.

Mr. C. H. WORDINGHAM, in seconding the motion, said there were few, if any, of the members who did not number among their friends many individual Americans, and their experience had led to their entertaining for them the highest possible regard, and looking upon them as their brothers in every sense of the word. One could not help feeling that if these two great nations—the American nation and the British nation—could purge themselves of the German taint that had invaded them there might in the not very far distant future come about some great federation of the whole Anglo-Saxon race. Such a result would make for civilisation, and perhaps for that far greater ideal, the reunion of Christendom.

The motion was carried unanimously.

The message was as follows:—

The President and Council and the members of the Institution of Electrical Engineers send hearty greetings to their brothers of the American Institute of Electrical Engineers, and hereby express to them their sincere appreciation of the entry of the great American Nation into the war on behalf of civilisation and its ideals, and of the significance of their action for the cause of the British Empire and its Allies.

Dated the 17th day of May, 1917.

Signed by the President, President-Elect and Secretary.

The PRESIDENT announced that this would be engrossed on vellum and forwarded by mail.

The PRESIDENT then dealt with and moved the adoption of the annual report of the Council, an abstract of which is given below.

REPORT OF THE COUNCIL.

In the report of the Council it is stated that the membership shows a net decrease of 63 over that of the previous year. During the year 39 members lost their lives on active service. In the same period 10 ordinary meetings, 16 Council meetings and 122 Committee meetings were held. There have been 42 meetings of local sections.

Premiums for Papers have been awarded by the Council to Messrs. G. V. Twiss, F. R. McBerty, C. Vernier, F. Gill and W. W. Cook, and to S. P. Smith, D.Sc. No students' premiums have been awarded, but the Papers read will be taken into consideration at the next award of students' premiums.

Since the publication of the seventh edition of the wiring rules in March, 1916, a number of suggested alterations have been submitted for the consideration of the Committee. It is not proposed, however, to undertake a further general revision of the rules until after the war.

A sub-committee has been appointed to collect evidence in regard to the use of lead-covered conductors for house wiring.

In May last the Council appointed a committee to draw up regulations for electrical installations on ships other than warships. This committee is constituted as follows:—

Ship Electrical Equipment Committee.

C. H. WORDINGHAM (*Chairman*).
C. P. Sparks, President (*ex-officio*).

J. H. Collie.	J. F. Nielson.
B. M. Drake.	Lieut. N. W. Prangnell.
A. Henderson.	Capt. A. P. Pyne.
J. W. Kempster.	S. G. C. Russell.

T. A. Sedgwick.

And	*Nominated by*
W. S. Abell ..... } J. T. Milton ..... }	Lloyd's Register of Shipping.
H. H. Berry	British Electrical and Allied Manufacturers' Association.
T. Carlton	Board of Trade.
W. Cross	Electrical Contractors' Association.
J. Foster King	British Corporation for the Survey and Registry of Shipping.
J. Lowson	Institution of Engineers and Shipbuilders in Scotland.
A. W. Stewart	Institution of Naval Architects.
H. Walker	N.E. Coast Institution of Engineers & Shipbuilders.

The regulations will be published in the course of the next few months, and it is hoped that they will prove of value to the shipping industry and be generally adopted.

The standard specification for street lighting prepared by the special committee appointed for this purpose will be published in the "Journal" at an early date as a majority report of the committee.

Research.—Progress has been made with the research on the heating of buried cables, and a number of tests have been carried out, but further work is required before any results are available for publication.

Specimens of 10 different brands of insulating oils have been distributed among six investigators, who are carrying out tests 1 to 7 from the following list, and as many of the others as they can arrange for: (1) Tendency to sludge, (2) loss by evaporation, (3) flash point, (4) viscosity at different temperatures, (5) chemical reactions, (6) density and coefficient of expansion, (7) cold test (solidification), (8) moisture absorption, (9) dielectric strength, (10) specific resistance, (11) thermal transference, and (12) specific heat.

Panel committees have been appointed by the Council to formulate schemes of research on various insulating materials with a view to drawing up standard specifications for the purchase of such materials and for discriminating between the various grades. The following materials are included in the research: Porcelain, ebonite, mica, micanite, fibrous materials, insulating varnishes and composite materials. Application has been made to the Research Department for grants in aid of these researches. The proposed schemes of research have already been drawn up in the case of most of the materials.

It has been agreed between the Institution and the British Electrical and Allied Manufacturers' Association to co-operate in this research, and, with a view to ensuring that the two researches should not overlap but mutually assist one another, the Institution will deal mainly with the scientific part of these researches, and the Association with the industrial. Each body will have representatives on the Committees of the other dealing with this research.

Electricity Supply.—In October, 1916, the Council appointed a committee consisting of

R. A. Chattock (*Chairman*).

C. H. Merz.	T. Roles.
G. W. Partridge.	C. P. Sparks.
S. L. Pearce.	W. B. Woodhouse.

with the following reference:—

"To report to the Council on the best means of co-ordinating and improving electricity supply in the United Kingdom."

Six meetings have been held. The Committee have been in close touch with the National Electric Supply Joint Committee appointed by the Incorporated Municipal Electrical Association and the Incorporated Association of Electric Power Companies, and, in order to prevent overlapping, it has been agreed that the Institution Committee will devote its attention to the question of electricity supply from the point of view of the requirements of the country as a whole, and will deal with the engineering aspect of the matter, while the Joint Committee will go into more immediate questions of organisation and linking-up of existing undertakings, &c.

The following matters, amongst others, are engaging the attention of the Committee: (1) A standard frequency for the country; (2) the voltages that should be recommended for transmission and distribution purposes; and (3) the obtaining of reasonable facilities for wayleaves.

The Committee have already arrived at a decision as regards standard frequencies for certain large areas in the country, but they feel that it is not advisable to put forward their recommendations piecemeal.

They have been awaiting the publication of the report of the Electrical Trades Committee of the Board of Trade, in order that they might work as far as possible along the lines which it was anticipated would be indicated therein. It is uncertain when the report of this Committee will be published, especially in view of the recent appointment of an Electric Power Supply Committee by the Board of Trade, with a reference generally similar to that of the Institution Committee.

The Committee will, however, proceed with their deliberations in the hope that their recommendations will enable the Institution to render some effective assistance to the Board of Trade Committee.

The questions referred to above require careful consideration, and it is, therefore, probable that some time will elapse before definite recommendations can be made upon them.

Reserved Occupations Committee.—At the beginning of February the attention of the Council was drawn to a memorandum issued by the

Digitized by Google

Reserved Occupations Committee in regard to substitution in electrical generating stations and to a statement by the Committee to the effect that the favourable reservation enjoyed until then by these undertakings could not be continued without modification after the end of that month.

In view of the risk to the nation which would be involved by the failure to maintain the supply of electricity through the skilled operating staff being cut down below a safe limit, the Council communicated with the Committee, and the latter requested the Institution to organise a deputation of representatives of supply undertakings to discuss the position with the Committee. A deputation of 14 representatives of the Institution, the Incorporated Municipal Electrical Association, the Incorporated Association of Electric Power Companies, the Conference of chief officials of the London electric supply companies and the Provincial Electric Supply Committee of Great Britain, introduced by Mr. C. P. Sparks, president, accordingly attended before the Committee on March 28th, and pointed out *inter alia* (*a*) the small amount of labour employed by electricity supply undertakings in proportion to the number of employés working in factories depending upon electric power supplied by such undertakings; and (*b*) the fuel economy effected through factories using electric power. After an exchange of views, in the course of which the chairman of the Committee stated that, although some of the undertakings might have done all that was possible, the wish of the Committee was to bring all into line, the deputation were requested by the Committee (*a*) to consider whether any other classes in addition to those mentioned in its memorandum can be replaced by women, (*b*) to prepare statistics to show to what extent substitution has already been made, and (*c*) to be prepared to attend another conference in three months' time to show what further substitution has taken place. This matter is having the further careful consideration of the Council.

Coal Supplies.—During the first half of 1916 representatives appointed by the Councils of the Institution and of the Institution of Gas Engineers repeatedly urged upon the Prime Minister and the Board of Trade the necessity of taking steps to improve the supply of coal to gas and electricity undertakings, and their action resulted in special consideration being given to these Public utility undertakings.

Annual Accounts.—The margin to the good on the revenue account is £3,776. 17s. 7d., compared with £1,847. 1s. in 1915, an improvement of £1.929. 16s. 7d. Since the accounts for 1916 were closed, £5,250 of the new 5 per cent. War Stock has been purchased by the Institution, and the existing holding of £661. 2s. in the 4½ per cent. stock has been converted into 5 per cent. stock.

Thompson Memorial Library.—The Council decided last year to set aside on behalf of the Institution the sum of £1,000 towards the setting-up of a memorial of the late Dr. Silvanus P. Thompson, and determined that in the event of the proposed purchase of his valuable collection of early and modern works on electricity, optics and other branches of physics, for the establishment of a Thompson memorial at the Institution being effected, the above-mentioned sum should be contributed for that purpose.

It has since been decided to purchase the collection by means of subscriptions from members of the Institution and others, with a view to its being presented to the Institution and preserved as a memorial of its distinguished past-president, and the above contribution has been made by the Institution towards the purchase money.

Mr. C. H. WORDINGHAM seconded the motion for the adoption of the report, and it was carried unanimously.

Mr. J. E. KINGSBURY (hon. treasurer), in moving the adoption of the accounts and balance-sheet for the year ended Dec. 31, 1916, said the surplus of income over expenditure was £3,776 17s. 7d. (£1,929. 16s. 7d. greater than that of the previous year). That £1,929 was made up of increased income and a net decrease of expenditure of £1,265. The balance-sheet showed total assets £120,798. He thought one would get a better idea of the figures they really had to deal with on behalf of the Institution if they eliminated from those figures £6,318. 18s. 5d., which represented sums which did not belong to the Institution, but were simply trust funds in the Institution's hands. It appeared on both sides of the balance-sheet, and if the assets were reduced by that amount, it left £114,479, and their liabilities were £36,290. A ready method of finding what those liabilities consisted of was to take off the £32,719 liabilities on mortgages, by which means one realised that the other liabilities were £3,571, and on making a comparison between their standing to-day and what it was last year it would be seen to be £4,453 better, while the assets consisted, according to the standard adopted in the accounts, of £78,188. 14s. 2d.

The PRESIDENT seconded the motion, and said as the result of the efforts of the Finance Committee and their very able secretary the surplus was £3,776 (£1,929 more than last year), the highest figure ever reached.

Mr. Ll. B. ATKINSON asked for information regarding life compositions. He said it seemed that members' subscriptions were passed through the revenue account, but when it was dealt with as a life composition it was passed into the balance-sheet as an asset, and stayed there till the member died, and it appeared that it never contributed towards the upkeep of the Institution or the services rendered to the member.

Mr. KINGSBURY said there was only one point which Mr. Atkinson did not seem to have grasped. He stated that the Institution got no benefit from the payment of the member until he died, but the Institution did get the benefit resulting from the investment of the sum paid by the member.

The PRESIDENT said the item £381. 1s. 1d. in the revenue account was dividends on investments, and part of those dividends was on the life compositions, so the revenue account got the benefit of the interest on £5,332.

Mr. SIDNEY SHARP (honorary auditor) said the £61 life compositions of deceased members was deducted from the composition fund, and transferred to the general fund because it had no further need to be in the first-named fund. The interest on the money was used year by year after a member's death as well as during his life.

The motion was then put and carried.

On the motion of the PRESIDENT, seconded by Mr. WORDINGHAM, votes of thanks were accorded to the secretary (Mr. P. F. Rowell), the honorary treasurer (Mr. J. E. Kingsbury), the honorary auditor (Mr. Sidney Sharp), the honorary solicitors (Messrs. Bristows, Cooke & Carpmael), the honorary secretaries of local sections and the local honorary secretaries and treasurers abroad.

Messrs. Allen, Attfield & Co., C.A., were reappointed as auditors and Mr. Sidney Sharp as honorary auditor.

SPECIAL MEETING ON VOTING BY PROXY.

A special general meeting of the corporate members (members and associate members) was then held, at which a resolution authorising the taking of members' votes by means of proxies was discussed. The following is an abstract of the resolution, which, as the President explained, is framed to permit proxy voting according to the usual practice of public companies:—

That the articles of association of the Institution be altered by adding thereto the following new articles: 80*a*. Votes may be given at all annual or special general meetings either personally or by proxy. On a show of hands every member present and entitled to vote shall have one vote. In case of a poll every member entitled to vote shall have one vote. 80*b*. No person shall be appointed a proxy who is not entitled to vote at the meeting. 80*c*. The instrument appointing a proxy shall as nearly as circumstances will admit be in the form following:

I.....of.....being (a corporate member *or* an associate as the case may be), of the above Institution, hereby appoint.....of..... ..... or failing him.....of..... ..... as my proxy at (the annual general meeting, special general meeting of corporate members and associates, *or* special general meeting of corporate members, as the case may be), of the Institution to be held on the.....day of.....19..... and at any poll held in connection therewith. As witness my hand this..... day of.....191..... Signature..... Class of membership in I.E.E..... 80*d*. The instrument appointing a proxy shall be deposited at the registered office of the Institution not less than 48 hours before the time for holding the meeting. 80*e*. A vote given in accordance with the terms of an instrument appointing a proxy shall be valid notwithstanding the previous death of the principal or revocation of the proxy unless previous intimation in writing of the death or revocation shall have been received at the registered office of the Institution. 80*f*. A poll may be demanded by the chairman of any annual or special general meeting or by any three persons personally present and entitled to vote, and shall be taken in such manner and at such time within 28 days next after the meeting, and at such place as the chairman of the meeting directs, and either immediately or after an interval or on adjournment. A demand of a poll may be withdrawn. No notice need be given of a poll not taken immediately. 80*g*. The chairman of the meeting shall have a casting vote in addition to his personal vote. 80*h*. The quorum at any annual or special general meeting shall be five.

The PRESIDENT said: When the subject of enemy members was dealt with last year it was discovered that the Institution was so constituted that they had to vote on a cut-and-dried resolution to alter the articles of association, and only the members present at the meeting could vote. So many members were away from London that it was necessary to adopt some method by which they could be represented, and the Manchester Local Section suggested that the articles should be amended so as to allow every member as far as possible to be able to vote. A committee was set up, on which he (the president), the vice-presidents and the chairman of the Manchester Local Section served, and they drew up a report advising that if an amendment to the articles was made it should be made to allow proxy voting. It might be said that a man who gave a proxy might know nothing of what took place at the meeting. That disadvantage could be easily overcome by holding informal meetings in different parts of the country, and circulating a report of those meetings before members give their proxies.

Mr. C. H. WORDINGHAM said it seemed to him essential that the whole of the members should have power to express their opinions on all matters affecting the Institution's welfare. The method proposed was likely to be of the utmost benefit to the Institution. It was manifestly absurd that a small meeting like the present one should make fundamental changes in the articles of association. The object of this motion was to correct that, and he hoped the proposal would be carried unanimously.

Mr. A. A. CAMPBELL SWINTON said he hoped the Council understood the snare they were laying for themselves. If the Council wanted to make a particular alteration in the articles, would they ask for proxies for themselves from particular members? If not, they were sure to be beaten. A clique could easily collect sufficient proxies to swamp a meeting such as the present one. He did not think it would be very dignified for the Council to have to ask for proxies for themselves. The Houses of Parliament and many of the most important societies did not permit proxy voting. He would prefer a postal vote.

The PRESIDENT said the Committee in charge of the matter were at one time strongly in favour of the postal vote, but their solicitors said a postal vote was not effective, but only indicated the opinion of the members.

Digitized by Google

Finally the Council adopted the present recommendation unanimously, and the local sections were also unanimously in favour of it.

Mr. J. S. HIGHFIELD supported Mr Campbell Swinton, and said if a burning question were to be considered, and 10 meetings were held with an average of 100 members at each, it would still be only one-sixth of the members who would hear the discussions. If the reports of the meetings were published, not more than 1,000 out of the 6,000 would read the report. The whole responsibility should be put on the Council, and the postcard method might be adopted to give them a guide in exceptional cases. It would take a lot of the Council's time if they had to attend local meetings to educate proxy voters. The least that could be done if this great change was to be made was to take a postcard vote.

Mr. A. M. TAYLOR (Birmingham) said he was sure the local sections greatly appreciated the interest taken in them by the Institution in London, but they could not always voice the opinion of the local sections, through the inability of the members to be present.

The PRESIDENT said the proposal was not in regard to voting at the Council, but concerned voting at a general meeting only.

Mr. P. ROSLING said he gave his vote in favour of the Council's suggestion. If 40 or 50 members in London wanted something, and 400 or 500 other members wished to stop it, it ought to be stopped.

Mr. Ll. B. ATKINSON said he did not think Mr. Campbell Swinton's difficulty was a real one. If an important question were before a meeting, the President could demand a poll, and fix a date ahead for the receipt of the proxies. It would not be necessary to send out the proxies for the first meeting. A well-organised minority could upset a resolution by personal voting as well as by proxy voting.

Mr. CAMPBELL L. SWINTON said it was not as Mr. Atkinson thought. The proxies would have to be produced at the first meeting.

The PRESIDENT confirmed Mr. Campbell Swinton's statement.

Mr. C. A. BAKER said he did not like the proposal on general principles. Nobody amongst the members could solicit proxies from the general list of members. It would cost £15 for postage to communicate with 3,600 members. The Council could send out forms of proxy and swamp any proposed resolution brought in by members. Another method would be to take the votes of the provincial centres at those centres. He asked that the proxy system, if adopted, should only be applied in special cases by the unanimous vote of the members.

The PRESIDENT said, while the Companies Act remained as it was, they could not adopt either of Mr. Baker's suggestions. They had before them the alternatives of having some special procedure for the Institution or of being governed by the common law. Under the latter they could not do anything more than they put forward in the resolution.

Mr. CAMPBELL SWINTON suggested that the meeting should adjourn, and that the Council should consider the matter further.

Mr. HIGHFIELD said he thought a proper discussion on the subject should be carried out, but if the Council were unanimous on the matter he would not oppose it.

The PRESIDENT said the local sections were more than unanimous. They knew that the Council was unanimous, because their chairman attended the Council's meetings regularly.

Mr. H. W. CLOTHIER (Newcastle) said he hoped the motion would go through. The average members of the local sections could not attend the meetings in London. They did a lot of the work of the electrical industry in the provinces, and they wanted to feel that they were in closer touch with London. A good way to give them that feeling of closer touch was to give them a vote in matters of moment such as this particular motion.

Mr. R. A. CHATTOCK (Birmingham) said it was at present impossible for the provincial members to take the part they wanted to in the conduct of the Institution. If it were possible to create any form of machinery other than the proxy vote for obtaining that end they would be pleased to fall in with it. The President had told them the Council had come to the unanimous conclusion that proxy voting was the only satisfactory way of doing it. There need be no fear that the Council would be swamped or the London members injured in any way.

Mr. CAMPBELL SWINTON said he did not wish to curb the activities or the power of the local sections, but he thought the method proposed was a dangerous one.

Mr. WORDINGHAM said they must remove any possibility of the idea that the Institution was run by a London "gang," and they had come to the conclusion that the only possible way was proxy voting. Outvoting by means of a clique could not be guarded against in the case of personal or postcard voting, therefore he did not think that was a legitimate argument against proxy voting. He did not admit that it would be undignified for the Council to send out proxies, and it was less important that the Council's dignity should suffer than that a large body of members should be in the undignified position of having no voting power.

Mr. E. T. WILLIAMS thought they were justified in voting for proxy voting, because the great majority of the members and some of the most excellent members were in the provinces.

The motion was then put and carried by 28 votes to 4.

Association of Engineering and Shipbuilding Draughtsmen.

The first meeting of the above association took place in Huddersfield on May 5th, representatives from a number of adjacent districts being present. A sub-committee for the Liverpool and Manchester district was decided upon, the next meeting being fixed for May 18th.

THE EDUCATION OF THE CHEMIST.*

BY SIR JAMES J. DOBBIE.

The events of the past year have served to emphasise the responsibilities of the Institute in connection with the education of the chemist. In future there will be a greatly increased demand for chemists competent to set going and control industrial concerns, and it is important to inquire whether the facilities at present provided for their training are adequate. So far as pure chemistry is concerned the curriculum of many of our colleges and universities may be regarded as fairly complete. But is that sufficient? At present no means exist whereby the student of chemistry can obtain the training necessary to enable him to translate the pure science of the laboratory into the industrial process of the works. Except in a few special cases it is futile to attempt to give instruction in the processes of particular industries in college classrooms and laboratories. We should aim at instruction in the principles and methods which find application in chemical industries generally.

The industrial chemist, however, must be trained in physical and applied physical chemistry. Yet no course of instruction exists at present in which the application of the principles of physical chemistry to manufacturing processes is systematically taught, although the University of London has now under consideration such a course.

It is not suggested that the chemist should become an engineer. The professions are distinct, and it is rare to find a high degree of aptitude for both united in the same individual. But the chemist should have sufficient knowledge of engineering to be able to make his requirements known to the engineer and to collaborate with him in the design and control of the plant required to carry out any particular series of operations.

It is hardly possible to add to the number of subjects at present included in a three-years course of study. Only by extending the ordinary course of study by the addition of a fourth year can time be found for new subjects or for the more thorough study of the existing subjects.

The training of many of our young chemists at the present time is too narrow. As a result the chemist is frequently relegated to a subordinate position when he ought to be in control. With wider qualifications the rising generation of chemists would be able to play their proper part in their new industries which are springing up in all directions and to occupy positions from which they are at present excluded.

As regards the sort of school education best suited for a boy who in after-life is to adopt chemistry as his profession, some might advocate that from an early period his education should be "vocational." But this view would probably find few supporters. It is open to the obvious objection that it would force the choice of a profession at an age when, in most cases, a boy's natural bent, if he has any, has not yet asserted itself. Others might declare for an education in which science played the predominant part. But probably the majority would answer that his education should be on the same lines and in the same subjects as for any other profession or calling.

The question now arises—What should these subjects be? The aim of education on its intellectual, as distinguished from its moral and physical sides, is the evenly balanced training of all the faculties of the mind. This aim can never be attained by the study of science exclusively on the one hand, or of the subjects commonly classed as the humanities, on the other. Both are essential.

Science, however, should form a part of everyone's education. What do we really mean when we speak of teaching science in schools? Is the object to imbue the pupil with the spirit and aims of scientific inquiry, while laying a solid foundation of fact and method for future specialisation, or is it merely to make him acquainted with the achievements of science? The expression "generalised science" is much on the lips of speakers on educational reform at the present time. But the attempt to make the science curriculum a comprehensive one, whether by teaching "generalised" science or the elements of the sciences individually, could only result in intellectual confusion. The one way to obtain really satisfactory results is to concentrate on a limited number of subjects, carefully selected with reference to the pupil's age and stage of mental development and to their suitability to serve as an introduction to further science studies.

It does not follow, however, that the pupil need leave school altogether ignorant of the leading facts and conclusions of other sciences. Much valuable, interesting and stimulating instruction concerning all branches of science can be conveyed through the medium of carefully selected reading lessons. This would not take the place of scientific education, but it would supplement it.

*Abstract of Presidential Address before the Institute of Chemistry.

Digitized by Google

The Electrician.
FRIDAY, MAY 25th, 1917.
Editorial and Publishing Offices:—
8, BOUVERIE STREET, LONDON, E.C. 4.
Telephone: City 9853 (4 lines). Telegrams: "Benbrotric Fleet London."

THE SKILLED MECHANIC.

In a leading article dealing with the scarcity of mechanics, a well-deserved tribute was paid recently by "Engineering" to the skilled mechanic. According to our contemporary, "a man having the mentality, dexterity and character taken for granted or implied in the term skilled mechanic, or competent all-round craftsman, is, *prima facie*, a competent individual in a much wider manner than in a purely trade sense. It may be said, without fear of contradiction, that a capable mechanic is at least the equal in most respects of 95 per cent. of the population. The craftsman is the backbone of all industry, and the interest to be found in the origination of mechanism and mechanical products has probably no parallel, except, perhaps, in those occupations distinguished as artistic. Natural aptitude, large mentality, resource, initiation, grit, character—all matters which make a man worthy of respect—are the inalienable possession of the man who becomes an expert mechanic."

With every word of the above we are in entire agreement, and we notice with a good deal of pleasure that a large and important section of the daily Press is striving to create a strong public opinion in favour of raising the status of the skilled mechanic.

There are those who are inclined to take what we imagine to be too serious a view of the cause of the present unrest in the engineering trades. It would be impossible to overestimate the seriousness of the unrest itself. In our opinion, and we have given long and earnest consideration to the matter, the primary cause of the unrest is overwrought nerves and over-fatigued bodies. A secondary cause, trifling in comparison with the primary, and may be one induced by the primary, is the accumulation of petty grievances which, were he in normal health, would be worked off by the craftsman with nothing more serious than a good deal of "grousing."

Believing, as we do believe, that the craftsman is the backbone of all industry, we refuse to accept the view held by many of the narrow-minded and ill-informed that the craftsman is less patriotic than his neighbour. Partly on account of the mentality and character taken for granted or implied in the term skilled mechanic, and partly on account of a genuine admiration for and an intimate acquaintance with many such men, we refuse to accept the view that the skilled mechanic is less ready than his neighbour to shoulder without complaint the very heavy responsibilities with which the country is overloaded at the present time. Mindful of the grey monotony of their surroundings and of the increasing difficulty of keeping their heads above water, we have oftentimes been impressed by the unswerving loyalty of the munition workers. Mindful of the coming victory, we hope that when the time comes for cheering, a thought will be given to the honest fellows in the mine, the steelworks, engineering works, woodworking shops and textile factories, to whose industry—an industry without parallel in the history of our country—victory is in large measure due.

We urge the engineering artisans, through their accredited representatives to lay their accumulation of grievances before the Government, and we urge the latter to leave no stone unturned in an endeavour to arrive at an honourable settlement. That such would be their intention is beyond question. The emphatic repudiation, in the House of Commons last week, of the idea that the Ministry of Munitions would do anything to facilitate skilled men being taken into the Army was opportune, as also was the statement by the Minister of Munitions to the effect that on account of the common agreement with all the societies, before any of the skilled workmen were taken the young dilutees of military age should be called first.

Particularly welcome now, when the idle machine means a delayed victory, would be an assurance from the Prime Minister that the skilled workmen are, in virtue of their skill, already members of the Army destined to bring a lasting peace into the world. None could give such an assurance in better or happier terms than he.

The Labour Minister's view that we can neither afford strikes now nor when peace comes is one to which no exception can be taken by those engaged in industry, and in arriving at a settlement it would be well so to draw up the terms as to make strikes in the future virtually impossible. The will on both sides to find a more satisfactory solution out of a difficulty than by striking, which is a most irrational and primitive method in so far as it is harmful to many in no way concerned, should go a long way towards ensuring industrial peace in the future.

On several occasions reference has been made in these columns to the anomalous position of the skilled munition worker. Notwithstanding the lateness of the hour, we believe the time to be ripe for getting rid of the anomaly. Mr. George Ryder, Mayor of Smethwick, and district delegate of the Amalgamated Society of Engineers, who is said to be spoken of in great respect by all classes as a very enterprising and conscientious administrator, in a recent interview referred to this subject. "There are many real grievances," said Mr. Ryder, "which men in the highly skilled trades are suffering from—grievances which come from glaring anomalies long existing and rapidly becoming more marked. The most highly skilled men in the engineering trades are relatively the most poorly paid. The toolmakers and gaugemakers, for example, who are supremely skilful men, do not get half the wages that are paid to unskilled or semi-skilled men who are new to the trade."

As we pointed out nearly 12 months ago, it is in virtue of the mechanics' skill that the semi-skilled and unskilled men are able to earn high wages. Owing to their indispensability it is impossible for the skilled man to engage on work calling for a lower degree of skill, and we believe that had the attention of the Government been called to this by the accredited representatives of the men, the matter would have been adjusted long ago. As it is we are of the opinion that there is time to settle amicably this phase of the dispute. The fact that for close upon two years these men have allowed themselves, without *serious* complaint, to be subjected to such an indignity, bears out the view that not only do they understand the meaning of patriotism, but that they practice partiotism. Such men are higher types of citizens than are those who talk of patriotism because they find it profitable so to do. The worth of the latter kind of patriots will be manifest during the next few months, and it may be revealed even more strikingly in the trial to come when we deal with the complex and difficult problems remaining after the conclusion of peace.

Mindful of what the country owes to him, it would be fitting recognition for the State to legalise the status of the skilled mechanic. Knowing him as we do, respecting him as we do, honouring him as we do, we believe him to be worthy of the distinction.

Digitized by Google

FARADAY, 1791—1867.

Taking the duration of his life into account, this son of a blacksmith and apprentice to a bookbinder had to decide between a fortune of £150,000 on one side and his undowered science on the other. He chose the latter and died a poor man. But his was the glory of holding aloft among the nations the scientific name of England for a period of forty years.—*Tyndall.*

In the present time of stress the respect due to the pioneers of the engineering industry is apt to be overlooked, if not forgotten. As long as memory holds its seat the name of Faraday will be honoured by educated men and women of all nationalities, and as long as a country can rear men like Faraday that country has nothing to fear either in science or industry. Since it is 50 years ago that Faraday died, it is thought that the following incidents* in his career will be of interest to many of our readers.

Michael Faraday's father was a blacksmith, and his great son was born in some mews near Newington Oval, in the south of London. There the first five years of his life were spent; the family then moved to Jacobs' Well Mews, near Manchester-square, and there Michael remained until he was 14. There are many incidents and traits in Faraday's career which will bear repeating, even if they are well known. He says: "My education was of the most elementary description, consisting of little more than the rudiments of reading, writing and arithmetic at a common day school. My hours out of school were passed at home and in the streets."

Once, when walking with a friend, Faraday passed a little newsboy, when Faraday said: "I always feel a tenderness for those boys, because I once carried newspapers myself."

He was apprenticed to a bookbinder, and no premium was paid, and he tells us that "Whilst an apprentice I loved to read the scientific books I had to bind, and amongst them delighted in Miss Marcet's 'Conversations on Chemistry' and the electrical treatises in the 'Encyclopædia Britannica.' I made such simple experiments in chemistry as could be defrayed in the expense by a few pence a week."

In 1812, when he was 21, he attended four of Davy's lectures, and made notes, from which he reconstructed the lectures in a fuller form, interspersing such drawings as he could make. He had a desire to be engaged in scientific work, even of the lowest kind, and that induced him to apply to Sir Joseph Banks, then professor of the Royal Society. Naturally enough, he says, "No answer" was the porter's reply. A friend told him not to be discouraged, but to send his written-out Davy lectures to Sir Humphry Davy himself, and ask for some employment. On Christmas Eve, 1812, Davy wrote to Faraday, and the letter from this so-called uncouth man is worth giving in full.

"SIR: I am far from displeased with the proof you have given me of your confidence, which displays great zeal, power of memory and attention. I am obliged to go out of town . . . till the end of January. I will then see you at any time you wish. It would gratify me to be of any service to you; I wish it may be in my power.—I am, Sir, your obed. humble servt."

He was engaged by the Royal Institution accordingly on March 1, 1813, at 25s. a week, with the use of two rooms in the attic. Later on in the year he accompanied Davy on a Continental tour as his amanuensis, but actually acted as his valet. Davy did what he could, and Faraday had no absurd pride. I give Faraday's own words, which shows the exact relationship.

"It happened a few days before we left England that Sir H.'s valet declined to go with him, and in the short space of time allowed by circumstances another could not be got. Sir H. told me that he was sorry, but that if I would do such things as were absolutely necessary for him until he got to Paris he should there get another. I murmured, but agreed. At Paris he could not get one; at Lyons he could not get one; at Montpellier he could not get one; nor at Genoa, nor at Florence, nor at Rome, nor in all Italy; and I believe at last he did not wish to get one; and we are just the same now as we were when we left England. This, of course, throws things into my duty which it was not my agreement, and is not my wish to perform, but which are, if I remain with Sir H., unavoidable. These, it is true, are very few, for having been accustomed in early years to do for himself he continues to do so at present, and he leaves very little for a valet to perform; and he knows that it is not pleasing to me, and that I do not consider myself as obliged to do it, he is always as careful as possible to keep those things from me which he knows would be disagreeable. But Lady Davy is of another humour. She likes to show her authority, and at first I found her extremely earnest in mortifying me. This occasioned quarrels between us, at each of which I gained ground and she lost it; for the frequency made me care nothing about them and weakened her authority, and after each she behaved in a milder manner. Sir H. has also taken care to get servants of the country, ycleped *lacquais de place*, to do everything she can want, and now I am somewhat comfortable."

On his return to England in 1815 he was engaged as assistant in the laboratory at 30s. a week, and apartments were given to him. In those days of poor facilities for locomotion commuters were unknown. In 1816 his salary was increased to £100 a year, and in 1832, when he was 40, the Committee of the Royal Institution reported: "The Committee are certainly of opinion that no reduction can be made in Mr. Faraday's salary, £100 per annum, house, coals and candles." Next year he got a sinecure appointment of £100, and in 1836 he got the appointment of Adviser to Trinity House, carrying £200 a year. How little money should have to do with these things. It has been remarked that if Faraday had died in 1830 his life might well have been called a notable success. He had made two leading discoveries, one on electro-magnetic motions, the other on the condensation of gases into liquids; he had carried out important investigations on the alloys of steel and the manufacture of optical glass, but his work was in fact only beginning. In 1831 he commenced his "Experimental Researches."

When he was 38 it is interesting to know that he enjoyed playing marbles and ball, and used to ride a velocipede. He never missed the sights of the day—acrobats and tumblers, giants and dwarfs, even Punch and Judy.

In 1835 the Government felt it should show some appreciation of Faraday's scientific discoveries, and bluff Lord Melbourne sent for Faraday, but the pension was offered so rudely that Faraday declined it. Melbourne wrote him, apologised for his "perhaps too blunt and inconsiderate manner, &c., &c.," and Faraday relented. In a letter to a friend about all this, he wrote that Government should reward and sustain scientific effort. In 1854 he wrote these still pregnant words:—

"I will make one or two remarks which have often occurred to my mind. A Government should, *for its own sake*, honour the men who do honour and service to the country. The aristocracy of the class should have distinctions which should be unattainable except to that of science. But besides, the Government should, in the very many cases which come before it having a relation to scientific knowledge, employ men who pursue science, provided they are also men of business. This is, perhaps, now done to some extent, but to nothing like the degree which is practicable with advantage to all parties. The right means cannot have occurred to a Government which has not yet learned to approach and distinguish the class as a whole."

In 1866 he wrote: "I entered the shop of a bookseller and bookbinder at the age of 13 years and remained there eight years, and during the chief part of the time bound books. Now, it was in those books, in the hours after work, that I found the beginnings of my philosophy. . . . . Do not suppose that I was a very deep thinker, or was marked as a precocious person. I was a very lively, imaginative person, and could believe in the 'Arabian Nights' as easily as in the 'Encyclopædia'; but facts were important to me and saved me. I could trust a fact and always cross-examine an assertion."

I could quote for pages, but must refrain. I will finish with some remarks on education. Faraday's words are:—

"All I can say is this, that at my juvenile lectures at Christmas-time, I have never found a child too young to understand intelligently what I told him. They came to me afterwards with questions which proved their capability. I do think that the study of natural science is so glorious a school for the mind, that with the laws impressed on all created things and the wonderful unity and stability of matter and the forces of matter, there cannot be a better school for the education of the mind."

From about 50 years of age he was troubled by loss of memory, and very gradually withdrew from all public life. In 1864 he wrote:—

"I find myself less and less fit for communication with society—even in a meeting of family—brothers and sisters—I cannot keep pace in recollection with the conversation, and so have to sit silent and taciturn. Feeling this condition of things, I keep myself out of the way."

Had he been no scientist, his patient unegotistical life would have made a pleasant study—as it is he was a revolutionary of the most violent class—wars may alter boundaries or the emptier forms of life—the discoveries of such men as Faraday, are changing the very structure of society.

* From an address by Mr. R. T. A. Innes before the South African Institute of Electrical Engineers.

Digitized by Google

THE ELECTRICAL PROPERTIES OF GASES.

On Saturday, May 5, Sir J. J. Thomson, O.M., P.R.S., opened a course of six lectures on "The Electrical Properties of Gases" at the Royal Institution. We give to-day a brief abstract of the first three lectures so far delivered.

Anticipating his aims in the first lecture, Prof. Thomson remarked that the subject was one of the most important in the whole range of physics, because the study of the electric discharge through gases was responsible for the views now taken of two fundamental questions: The nature of electricity, and the structure of matter. Electricity was atomic in structure. Every charge was made up of unit charges, and we differentiated sharply between atoms of positive and of negative electricity. As regards matter, there were still smaller systems beyond the chemical atom, which was a small universe in itself. It was believed that, chemically, two atoms might be of equal properties and yet not identical, and as they could not chemically be separated we could not say whether we got in atomic weight determination beyond mixtures. Perhaps Prout's idea that atomic weights were multiples of the atomic weight of hydrogen was not far wrong after all; the atomic weights were not integers, but mixtures of substances of weights; 2 and 3 might have any intermediate atomic weight.

Passing to gases, the lecturer said that it was very difficult to make a gas in its ordinary condition have anything to do with electricity at all. One might think that an electroscope (Zeleny type used) should lose its charge in a gas, as the gas particles striking to and fro should act like small proof planes; but they did not act so, and there was no leakage from a charged plate either when ether was evaporated from the heated plate. Even vapour from charged mercury did not carry any electric charge away. Again, when air was blown on the plate, no leakage was observed; but when the air was passed through a tube containing a small radium bulb there was leakage. When the tube and an aerial wire in it were joined to a battery, however, the leakage ceased again, showing that the conductivity was due to conducting particles created in the gas by the radium rays (or X-rays, &c.), which were removed again by the electric field, though able to survive in a tube of a certain length. These particles were electrons which were ejected from the molecules of the gas also by ordinary light, provided its frequency was at least that of ultra-violet light; any amount of red light would be quite ineffective. The efficiency of kathode rays was demonstrated by another experiment. The kathode particles (from a hot wire) streamed upward past the celluloid window, closing a horizontal tube containing an electroscope; a pump and the two tubes were joined to a closed circuit. The kathode rays entered the horizontal tube through the window and discharged the electroscope.

Thus ordinary air was a good insulator. But in all experiments air showed a certain residual conductivity, exceedingly small, equivalent to that of 8 electrons per cm.^{3} (which contained $2{\cdot}75\times10^{19}$ molecules), but never quite absent. This residual conductivity had caused much controversy. It had been ascribed to radium emanations, always present in the soil and air, and had been measured in sea water (which was free of radium), on the frozen American lakes, and in all climates and parts of the world. In the Atlantic it had been reduced to half its value in air, and J. C. McLennan (Toronto) had finally reduced it to one-quarter by making use, not of a zinc box, as usually done, but of an ice box, the walls of which consisted of snow over which water was poured. There was probably some trace of radio-activity in zinc or its impurities.

A gas rendered conductive did not behave like a conductor, however, and that fact had much been misunderstood. A wire had a certain resistance, and the longer the wire the smaller its current and the greater the resistance. That seemed to be essential to conductance. But when the conductivity of a layer of gas between two plates was measured, the opposite held. The thinner the layer the greater the resistance, and if the layer were made sufficiently thin there would be no conductivity. This was demonstrated with the aid of a radium tube and two plates, first about 1 cm. apart, and then approached to within 1 mm.; the current became much feebler. The reason was that the conductivity depended upon the number of electrons, and that number upon the mass of gas present. Provided the ionising force be strong enough, the more molecules of gas there were the more electrons would be liberated, and the greater would hence be the conductivity.

In this respect, Sir Joseph continued in the second lecture, a gas conducted like an electrolyte, there being carriers for the charge; but there were strange differences. In an electrolyte the current was proportional to the P.D.; not so in a gas. When an electric field was established between two plates it would make very little difference in the current if the potential were raised beyond a certain limit marking the current-carrying capacity under the conditions. A homely illustration might explain this: Suppose troops had to march up to a station, thence to be conveyed by a limited number of trains per day. When the soldiers came up slowly they would always find a train ready; when they came up fast there might not be a train available, and the rate of transport would no longer be proportional to the marching speed. There might not be enough carriers available in a gas, whilst in electrolytes plenty of carriers were available. Yet some liquids were bad conductors, and they behaved indeed like gases. Thus the often misunderstood difference between conductance in gases and in electrolytes was merely quantitative, not one of nature. The conductance excited in gases by radium, &c., was always small. With the aid of an electric field between two plates it could largely be increased, however. For every electron colliding with a molecule liberated other electrons which acted in the same way. It was like breeding families of electrons. The number depended upon the speed and the energy of the particles, and thus upon the P.D. applied, for a minimum speed was required to split up and ionise the molecules. Hence a galvanometer in circuit with two plates did not mark any current before a certain P.D. was applied.

It was, however, possible to show that a gas might conduct as well as sulphuric acid. For this purpose a wire was bent so as to form two coils in series, each loop being large enough to accommodate a bulb several inches in diameter A jar discharge was sent through the wire No galvanometer would indicate those oscillations of 30 millions per second, but the currents acted inductively upon the rarefied gas in the bulb and made it luminous, which implied energy absorption. When a bulb was placed in coil I. a luminous ring flashed up in it; when another bulb was placed in II., bulb I. shone less brightly. When a beaker full of water was placed in II., I. was bright again; when sulphuric acid was added to II. (a good deal of acid was needed), I. turned less bright once more, though the acid did not shine. In a similar experiment only one bulb was used, consisting of an inner bulb, *I* (rarefied gas), and an outer concentric bulb, *O* (air to be evacuated). As long as *O* was at atmospheric pressure, *I* was bright and *O* dark; as *O* was being evacuated *O* became luminous, and finally *O* (now itself rarefied) shone brightly and *I* was dark, *O* acting like a metallic screen for *I*.

These high gas conductivities were finite, however, and would not lead to the enormous currents and instability of spark and lightning discharges.

In the ordinary gas discharge only the negative electrons seemed to acquire sufficient energy to ionise the molecules, and the resulting conductivity was limited, as said. If, however, the field between the two plates were strong enough, there would not only be negative particles moving, say, from left to right in a constantly widening stream (because each colliding electron produced more electrons), but the positive particles left behind and moving in the opposite direction would themselves have sufficient energy to call forth ionisation. Thus enormous currents would result, and that would also happen when fresh negative particles were being supplied—*e.g.*, by Röntgen rays striking the anti-kathode. Although lightning was one of the first electric phenomena studied, many of the features, the directions (upward or downward) of the flash, its length and energy, the character of fire-ball lightning and its explosion—which Sir Joseph would very much like to watch—were imperfectly understood, and reliable measurements had only been made within the last few years by C. T. R. Wilson, at Cambridge.* England was not a good country for lightning studies, however. Supposing there was a thunder cloud at a height, h, above the ground. The earth would be charged by induction, and the surface density of this charge was measured by registering electrometers of large size at two stations some distance apart. When the flash passed, the charge was (partly) destroyed, and the change in the vertical force would produce a kink in the electrometer curve. From the two kinks the h (the length of the flash) and the quantity of electricity that had passed could be calculated. The average values found were: $h = 10$ km. and 30 coulombs with upward (and also downward) flashes. At a potential gradient of 2,000 volts per metre, 30 coulombs meant an energy expenditure in the flash of about 6×10^{10} ergs, roughly equivalent to 6,000 tons dropping through a height of 100 m. Considering this enormous energy, one could only wonder that lightning did so little damage. The thunder was produced by the expansion and subsequent contraction of the air. To demonstrate this a spark discharge

* "Proc." Royal Soc., 92, pp. 555-574, Sept. 1, 1916.

Digitized by Google

was passed in a bulb connected to a U tube containing only a little liquid; the spark jerked the liquid in the gauge up.

In the third lecture Sir Joseph said he had been asked how Wilson's estimate of the energy in a lightning flash could be reconciled with Faraday's statement that it might all be got out of a thimble full of water. Now, the charge on a hydrogen atom was $1{\cdot}5\times10^{-19}$ coulomb; to get 30 coulombs, therefore, $30/1{\cdot}5\times10^{-19}=20\times10^{19}$ atoms, or 10×10^{19} molecules of hydrogen were required. 1 cm.^{3} of a gas contained $2{\cdot}75\times10^{19}$ molecules; hence a volume of $10/2{\cdot}75$ =less than 4 cm.^{3} would contain that charge. The difficulty was, of course, to separate those, equal and opposite, charges which in the molecules were intimately bound up; for that reason so much work was needed. One could also roughly estimate the size of the thundercloud giving the flash. The charge on 1 cm.^{2} of surface required to send a spark was $\frac{8}{3}\cdot10^{-9}$ coulombs. To get 30 coulombs a surface of $30/\frac{8}{3}\cdot10^{-9}$=roughly $11\cdot10^{9}=10^{10}$ cm.^{2} would be required, or a cloud of dimensions of about 1 km.

The problem how the enormous charges could accumulate had only recently found an explanation. That water, not necessarily as rain, was mainly concerned had never been doubted. But which of the properties of water? Lenard had observed that water when splashed against a solid surface became electrified. That was demonstrated by forcing a jet of water from a tube through a hole (in a wider tube surrounding the former and charged with compressed air) against the plate of an electroscope. The wet plate assumed a positive charge, so that the splashed water itself was positive and the air surrounding it negative. But the electrification was, both as to intensity and to sign, extraordinarily sensitive to minute impurities in the water; methyl violet, *e.g.*, could be traced before its colour became visible. It was historically interesting that Lenard first made these experiments in Heidelberg, where he had a pure water, and then failed to confirm them when he went to Bonn, where the water was less pure. There was, further, another waterfall effect. When a big drop fell it split up into positively charged smaller drops. The drop was probably coated with negative electricity, which prevented the escape of negative particles from the interior; but when the surface was increased and split, the escape was possible until a new coating was formed. On the other hand, the falling drops of a fountain became bigger and heavier when a rubbed rod of ebonite was held near it, and steam rushing out from the nozzles of a T formed, in the beam, a dark cloud of big globules when small wires projecting into the nozzles were electrically charged.

Referring to G. C. Simpson's* recent researches on atmospheric electricity, the lecturer stated that rain drops rarely exceeded, fortunately, a size of 5·5 mm.; if larger they flattened out and broke up. Now a thunderstorm seemed to be preceded by a strong upward current of warm, moist air; when the air cooled higher up, drops were formed and grew, until they broke up and became positively electrified, these drops still being buoyed up by the upward current (grains of hail would likewise grow, but not break up); thus a layer of positive electricity would accumulate at the bottom of the cloud, whilst the very small globules of moisture would assume the negative charge of the air, and be carried higher up. A strong field would then be created between the top and bottom of a cloud, until a discharge took place within the cloud or to the earth. A horizontal wind might further shift the layers, so that positive and negative layers floated over different portions of the earth and acted inductively. If that explanation were correct, the first heavy rain of a thunderstorm should, as a rule, bring down positive electricity, and the fine, light rain following later be negatively charged. That agreed with observations all over the world, and also with Wilson's experiments; there might also be downward (positive) and upward (negative) lightning discharges as observed.

As regards globe lightning, Prof. Thomson distinguished between the very slowly falling ball of fire, which vanished near the earth, and the more frequent brush discharges running along conductors in houses; the latter had successfully been imitated. The former, globe lightning, proper was the more difficult to explain. It seemed to occur only when an ordinary flash had provided a conducting path for the current (though the wind might have shifted that path), after the manner of the continuous discharge through low-pressure gas: but there was too little observational evidence. Two experiments were shown in this connection. In the one a jar discharge was first sent through a tube, which showed a luminous column; then an induction coil was joined to the terminals, and the column became striated. In the other experiment an upward kathode stream struck the anti-kathode at the top of a vacuum tube. When the water resistance in the circuit was increased, a glowing ball seemed to drop from the anti-kathode, so that two stationary glows were seen, one round the electrode, the other below it. In both these cases the discharge was locally concentrated.

(To be continued.)

* Phil. "Trans.," Vol. CCIX.

CORRESPONDENCE.

CITY AND GUILDS EXAMINATIONS.

TO THE EDITORS OF THE ELECTRICIAN.

I feel that Dr. Ashton, in his letter of last week, let the City and Guilds examiners down too lightly.

In addition to the omission in question 9 of the examination paper in Grade II. A.C. working, important faults occur in two other questions.

Question 10 reads:—

Why must a choking coil with an iron core have an air space? How must the total loss of power be distributed between iron and copper in order to obtain a maximum of choking effect with a minimum of total loss?

I find fault with this question first because, as a matter of fact, a choking coil with iron core *need not have an air space*, although, of course, the ordinary cases in which choking coils are used are best suited by chokers with air spaces, and next because an answer to the second part of the question is impossible without further explanation.

Question 7 reads:—

What is meant by the V curve of a synchronous motor? A three-phase 60 H.P. motor intended for a 500-volt 50 frequency circuit gives when running as a generator with full excitation 150 amperes on the short circuit test. The armature is star coupled and each phase has a resistance of 0·15 ohm. To what voltage must the motor be excited to give full output at unity power factor? What will be the armature current in this case? Take the armature efficiency as 92 per cent.

A question thus loosely drafted is likely to confuse a student and cause loss of time. What is to be understood by "full excitation"? Does this mean that excitation which, when the machine is run as a generator at synchronous speed, produces 500 volts on open circuit, or does it mean the excitation required when, as a synchronous motor, the machine gives out 60 H.P. and takes current at unity power factor? Or does it mean something else? "To what voltage . . . . at unity power factor?" Does this mean what excitation must the motor have in order that, when on full load, its electrical input shall be at unity power factor, or does it mean what excitation must the machine have, when run as a generator, in order to give 500 volts at its terminals whilst delivering full electrical output at unity power factor? And what, precisely, has the 92 per cent. "armature efficiency" (whatever this may mean) to do with the armature current?

Everyone knows that at best, examinations, though unavoidable, are evil. Careless drafting of questions makes them futile as well as evil.

London, May 15. F. M. DENTON.

PHYSICAL SOCIETY.

A meeting was held on Friday, April 27, at the Imperial College of Science, Prof. C. V. BOYS, F.R.S., President, in the Chair.

A Paper, entitled

"A Note on the Derivation of the General Equation for Wave Motion in an Elastic Medium,"

was read by Prof. J. A. FLEMING, M.A., D.Sc., F.R.S.

The Paper explains a simple method of arriving at the general differential equation for wave motion—viz.,

$$\frac{d^2\varphi}{dt^2}=c^2\left(\frac{d^2\varphi}{dx^2}+\frac{d^2\varphi}{dy^2}+\frac{d^2\varphi}{dz^2}\right),$$

where c is the velocity of propagation of the wave. A wave motion consists in the propagation of some form of strain through an elastic-dense medium or one having comparable qualities. Corresponding to this strain there is an analogous stress in the medium, and we can express this stress mathematically in two ways—viz., kinetically, as the product of the density, and the time rate of change of the strain, or by $m\frac{d^2\varphi}{dt^2}$ per unit of volume, and also statically as the space increment of the expression $e\frac{d\varphi}{dr}$, where e is a

Digitized by Google

coefficient of elasticity and r is a vector denoting direction of propagation. Hence, for plain waves we can write the equation

$$m\frac{d^2\varphi}{dt^2}\delta r=\frac{d}{dr}\left(e\frac{d\varphi}{dr}\right)\delta r,$$

or if m and e are independent of distance, we have

$$\frac{d^2\varphi}{dt^2}=\frac{e}{m}\frac{d^2\varphi}{dr^2},$$

which is the known differential equation of wave motion for plane waves. Its solution is $\varphi=F\left(x\mp\sqrt{\frac{e}{m}}t\right)$, where F is some function.

In the same manner for spherical waves originating in a point source we can write the stress equation

$$4\pi r^2 m\delta r\frac{d^2\varphi}{dt^2}=\frac{d}{dr}\left(4\pi r^2 e\frac{d\varphi}{dr}\right)\delta r,$$

which at once gives

$$\frac{d^2\varphi}{dt^2}=\frac{e}{m}\left(\frac{d^2\varphi}{dr^2}+\frac{2}{r}\frac{d\varphi}{dr}\right);$$

or if $r^2=x^2+y^2+z^2$, we have

$$\frac{d^2\varphi}{dt^2}=\frac{e}{m}\left(\frac{d^2\varphi}{dx^2}+\frac{d^2\varphi}{dy^2}+\frac{d^2\varphi}{dz^2}\right).$$

The solution of this last equation is

$$\varphi=\frac{1}{r}F\left(x\mp\sqrt{\frac{e}{m}}t\right).$$

where F is some function.

The general equation for electromagnetic wave propagation in a pure dielectric may also be obtained in the same manner. In this case the strain on the medium is the electric displacement D, and, if E is electric force, then on a system of rational units $1/K$, where K is the dielectric constant, is the electric elasticity. Hence we can consistently assume that the magnetic permeability μ corresponds to density, and then the kinetic measure of the electric stress is $\mu\frac{d^2D}{dt^2}$, and this must be equated to the space variation of the static measure of the electric stress.

For the spherical wave from a point source this leads to the equation

$$\frac{d^2D}{dt^2}=\frac{1}{\mu K}\left(\frac{d^2D}{dx^2}+\frac{d^2D}{dy^2}+\frac{d^2D}{dz^2}\right),$$

with the solution

$$D=\frac{1}{r}F\left(x\mp\frac{1}{\sqrt{\mu K}}t\right).$$

The wave is, therefore, propagated outwards without change of wave form; but the amplitude varies inversely as the distance from the source.

Since the Laplacean operator $\frac{d^2}{dx^2}+\frac{d^2}{dy^2}+\frac{d^2}{dz^2}$ is an invariant, and is not altered in form by a shift of origin; and since we can by Huyghen's principle consider a wave of any kind as the resultant of a set of spherical waves originating at various point sources, we can apply the above method to the case of wave motion generally.

The method above described may be epitomised by saying that we obtain the differential equation by equating the product of strain-acceleration $\frac{d^2\varphi}{dt^2}$ and density to the static measure of the stress expressed as the space variation of the product of the elasticity and the strain slope $\left(e\frac{d\varphi}{dr}\right)$, which is the proper measure of the stress at the point considered.

Mr. F. W. J. WHIPPLE thought that the validity of Prof. Fleming's application of Huyghen's principle might be questioned. In the first place, he thought that the principle itself required proof just as much as the property that it was used to establish. Further, the secondary wavelet from each point in a wave front was assumed to be spherical. Was it not the case that the phase of these disturbances was a function of the direction, relative to the main wave front as well as of the distance from the origin of the wavelet? Another interesting question was how the equations would have to be modified in the case of the energy reflected at the boundary surfaces of the medium.

Prof. C. H. LEES did not quite see how Prof. Fleming's treatment of the problem differed from that given in Love's "Elasticity," for example.

Prof. J. A. FLEMING, in reply, said that the criticisms of the two speakers in the discussion rather missed the point of the Paper. The validity of the Huyghen's principle is not in question. Most writers on physical optics have resorted to it, and he (Dr. Fleming) had never seen any explanation of the phenomena of diffraction which did not rest upon it. The proof given in the Paper that the characteristic equation proved for spherical waves with origin at the centre may be applied to waves however originating is made to rest upon the fact that the Laplacean operator is invariant with regard to origin. The object of the Paper was not to write a complete theory of wave motion, nor of elasticity, but merely to give a method, which seems valid, for arriving immediately at the characteristic equation in a manner which would appeal to students not very well versed in hydrodynamics or the theory of elasticity. Prof. Lees asks how far the treatment differs from that given, say, in Love's "Theory of Elasticity." The answer is not at all in the result; but the method used in the Paper enables us to arrive by simple considerations at the characteristic differential equation, and then to elucidate the physical meaning of its solution. It seems better for a physical and engineering student to have some approach to such conception rather than none at all. The treatment of the subject of wave motion is generally very difficult to follow in advanced text-books, whereas the practical applications of sound, water and electromagnetic waves make some theoretical knowledge of the subject necessary.

A Paper, entitled

"The Effect of Stretching on the Thermal Conductivity of Wires,"

by A. JOHNSTONE, B.Sc., was read, in the absence of the author, by Prof. C. H. LEES, F.R.S.

In the experiments carried out, the wire to be tested was fixed at each end between the jaws of screw clamps joined to brass cylinders, through which water could be circulated. Attached to one clamp was a rod passing through a framework, enabling tension to be applied by a nut working on a thread.

Heat was supplied to the centre of the wire by passing a current of electricity through a manganin coil wound on the wire, and the temperature difference between two points on the same side of the centre was ascertained by two platinum coils, also wound on the wire.

The resistances of the coils were determined by means of a Callendar-Griffiths bridge, enabling a temperature difference of 0·01° C. to be read, and making it possible to detect a difference in conductivity of 0·05 per cent. If R_1 is the resistance of the platinum thermometer nearer the heating coil, and r_1 is that of the other platinum coil when both are at the jacket temperature; and if R_2 and r_2 are corresponding values when a temperature difference exists, then it may be shown that the conductivity

$$K \text{ is proportional to } \left(\frac{R_2}{R_1}-\frac{r_2}{r_1}\right)^{-1}.$$

For all the wires used (copper, steel, nickel, aluminium, brass, zinc), stretching produced a slight increase in thermal conductivity. The most satisfactory experiments showed an increase of about 0·5 per cent. for a tension of about 0·7 of the elastic limit.

After the tension was withdrawn the conductivity returned approximately to its original value.

Mr. F. E. SMITH suggested that it would have been of interest if the author had made simultaneous observations of electrical conductivity on the same apparatus. Had any experiments been made on liquids, such as mercury, for example?

Prof. BOYS asked if the coefficient would be reversed if compression were applied instead of extension. He realised there would be some practical difficulties in making the experiments.

Prof. LEES, in reply, said that there would have been electrical measurements included in the Paper but for the author's absence in the Army. He thought compression measurements could be made, though they had not so far been carried out.

A Paper on

"Cohesion"

(Third Paper), by Prof. HERBERT CHATLEY, D.Sc., was taken as read.

The objects of the Paper are:—

(*a*) To re-state and add further evidence in favour of an electrical theory of cohesion.

(*b*) To provide tentative empirical formulæ for the expression of inter-molecular forces.

The author defines cohesion as the net attraction (*i.e.*, balance of attraction over repulsion) between molecules which are relatively chemically saturated, at distances not greatly exceeding the molecular diameters, and the following formula is proposed for this attraction:

$$f_2=Gm^2/d^{(2+4d_0/d)},$$

where G is the Newtonian constant of gravitation, m the molecular mass, d the molecular interval (centre to centre), and d_0 is the molecular diameter.

Dr. R. S. WILLOWS (communicated remarks) pointed out that the statement that an electrified liquid evaporated more quickly than a neutral one is not true in all cases. C. T. R. Wilson's fog experiments show, for small drops, that evaporation is most rapid when the drops do not contain an electric ion.

Digitized by Google

WAYLEAVES.

In our last issue we published a communication from Mr. W. A. Chamen on suggested Parliamentary action in regard to wayleaves. We have now received from Mr. C. Vernier some criticisms on these suggestions, which will be published in the "Journal" of the Institution of Electrical Engineers in due course. They are here given in abstract.

Mr. VERNIER remarks: The importance of these proposals merits special consideration in that they are the considered conclusions of a committee whose competence is indubitable. But there are limitations to these proposals. Briefly, these proposals may be summarised as follows:—

1. The undertakers may apply to the Board of Trade for a certificate of the public utility of a main.

2. On receipt of such an application the Board of Trade will notify the landowners and invite them to forward their observations within one month.

3. The Board of Trade may thereafter decide to issue or withhold a certificate of public utility, either with or without a local inquiry.

4. The amount of the compensation and all other questions arising in respect of the lines, unless mutually agreed between the parties, shall be fixed by a single arbitrator appointed by the Board of Trade. This same arbitrator shall sit continuously.

The first three of these proposals are closely in agreement with the views I have given in the Paper and in my reply to the discussion. The fourth is also on the lines of one of my proposals. In this case, however, I made certain stipulations adopted from recent Acts, such as the Housing and Town Planning Act, 1909, designed to reduce the costs of arbitrations. Unless the cost of arbitrations is minimised, the powers contained in the Committee's clause can seldom or never be exercised to limit exorbitant rents, but will only be useful in the most obstinate cases of a complete refusal to allow the grant of a wayleave. An ordinary Board of Trade arbitration is by no means an inexpensive method of settling disputes, and taking into account the costs of the arbitration and legal expenses in connection therewith will seldom be less than £50, and may easily run into three figures. To this must possibly be added the cost of a Board of Trade inquiry before a certificate of public utility is granted, which would have to be borne by the undertakers.

As I mentioned in my reply, on account of the numerous landowners commonly encountered on a route, the amount of wayleave rent involved in any particular case is often under £10, and seldom exceeds £20, per annum, which means that recourse to arbitration will usually absorb the utmost possible saving on rentals for many years.

I would here make the suggestion that if arbitration is the method adopted, all landowners, tenants and occupiers on the route of a main declared by the Board of Trade to be of public utility, and desirous of having the question of compensation determined by arbitration, should be convened at one and the same hearing of the arbitration in order to reduce expenses. I assume, of course, that the arbitrator would have in his discretion the awarding of the expenses of the arbitration. This is very important, as unless the arbitrator can exercise discretion in the award of costs, landowners who wished to secure exorbitant rents might refuse to quote reasonable terms, so as to compel the undertakers to go to arbitration, knowing full well that the terms they demand are not less good than the terms the undertaker would be likely to secure in an arbitration, plus the expenses and trouble of the arbitration.

Further, it is suggested that the same Board of Trade arbitrator sitting continuously shall hear and determine "all" questions arising in respect of the line or lines authorised by any certificate of the Board of Trade.

As the questions which an arbitrator will be called upon to decide will be chiefly compensation questions, the arbitrator should be an expert practical surveyor, preferably not in private practice. Engineering questions should be excluded from all matters of reference to the arbitrator, and should be decided on an appeal by the Board of Trade.

The suggestion that all questions in respect of a line should be determined by a single arbitrator sitting continuously must be considered from the point of view that, as no provision has been made in the draft clause for an appeal to some judicial body—*e.g.*, the Railway Commissioners, the various awards of the arbitrator must be accepted in all cases as final and binding upon the parties. It further presupposes that the awards given by the arbitrator will generally be in a sense favourable or acceptable to the undertakers: but if this should not turn out to be the case the promoters having deliberately secured by their Act, assuming this is granted, that matters in dispute must be determined by the same arbitrator sitting continuously, and having made no provision for an appeal, there is no appeal from his decisions unless these are ultra vires or improperly secured, and the undertakers cannot call for his removal except on the ground of misconduct. For my part I do not consider this at all satisfactory, and I suggest that this matter requires further consideration and amendment by inserting a right of appeal to the Railway Commissioners.

The least satisfactory feature of these proposals is the absence of any provisions designed to limit the total time which must elapse between the date when the undertakers make an application and that when the work can actually be commenced.

This period will, even in the most favourable of cases, be made up as follows:—

(*a*) Time for the Board of Trade to consider the application and notify landowners.

(*b*) One month allowed to the landowners to reply and make their observations.

(*c*) Time taken up by the Board of Trade in considering these replies and deciding whether to issue a certificate or hold a public inquiry.

(*d*) Time taken up by a local inquiry (if any).

(*e*) Time taken by the Board of Trade to consider their officials' report of the local inquiry (if any) and to issue the certificate of public utility.

(*f*) Time taken up by the arbitrator in holding the arbitration proceedings and considering and making his award.

Of these periods only two have any limit placed upon them—viz. (*b*) and (*f*). The latter is restricted in any case by the provisions of the Arbitration Act, 1889, to three months. These two periods may therefore together extend to as much as four months. This last period could be very satisfactorily reduced if suitable powers were granted. This leaves the time which the Board of Trade would require to carry out the various stages of the procedure outlined in paragraphs (*a*), (*c*), (*d*) and (*e*). From my own experience I estimate that this could not be laid down at much less than from eight weeks for each stage, or, say, between four and six months in all, provided no local inquiry is held, to which must be added certainly one month for the landowner's reply, and possibly not less than three months for arbitration, if compulsory powers for entry are not provided. The total time absorbed in an ordinary straightforward case in securing expropriation is, therefore, not likely to be less than eight months, and may easily run into one year and more.

I do not believe that the electrical industry will ever secure those facilities under a private Bill to which it is justly entitled, and in a matter so vitally essential to the economic life of the nation it is the duty of the Government to initiate and carry through legislation which will remove present obstacles and difficulties.

The prospect opened up by the recent appointment of a Board of Trade Departmental Committee offers an opportunity for a much bolder policy which should be pressed unflinchingly. As, moreover, the electrical industry cannot reasonably expect to secure greater facilities from Parliament than it considers essential to its best and freest development, our claims to this Committee should not be vitiated by any thoughts of pre-war prejudices or fettered by any such considerations as hampering precedents. I am here referring not merely to the question of compulsory wayleaves, but also to the larger questions referred to this Committee, with which the subject of this discussion is so intimately bound up.

I think it would be well if I recapitulate the several points which I would consider essential to a really useful practical scheme for compulsory wayleaves.

(*a*) That a certificate of the public utility of a proposed main be granted or, alternatively, an order for the compulsory acquisition of easements, be issued by the Board of Trade on the application of statutory undertakers in suitable cases.

(*b*) The total time allowed from the date of application to the issuing of a certificate or of an order not to exceed three months.

(*c*) Compulsory powers to be allowed for entry upon the land in urgent cases before the determination of the compensation.

(*d*) The method adopted for the fixing of compensation to be in the first instance of the cheapest and most readily accessible description supplemented by a right of appeal to some judicial body.

The determination of all technical questions to be in the hands of the Board of Trade.

(*e*) The terms of tenure to be in perpetuity (or for at least 50 years), subject to the landowner's right to the reasonable use and development of his land, and for this purpose to require the removal or diversion of a main on giving sufficient notice at the cost of the undertakers. A right of appeal to the Board of Trade to be allowed in case of dispute. The wayleave rents to be subject to revision at periodical intervals, as this is essential if the terms of tenure are to be in perpetuity or for a long term of years.

(*f*) Wayleave rents to bear some relation to the rentals which are received by the owner for the ordinary use of his land.

(*g*) Compensation to be given and apportioned equitably by the tribunal duly appointed to all beneficially interested in the land.

(*h*) All persons beneficially interested in the land on a given route, in the event of disagreement, to be convened at one and the same proceedings for the determination of the compensation if this is an arbitration or an appeal.

(*i*) Damages occasioned in the execution of the work to be settled separately from the amount of compensation for the wayleave.

(*j*) Compulsory powers to be granted for the cutting and trimming of trees.

(*k*) Special provisions to be made for the grant of a compulsory wayleave in the case of owners who either cannot be found or are absent from the country, as in the Lands Clauses Consolidation Act, 1845.

The second part of Mr. Chamen's communication deals with the abolition of the local authority's power of absolute veto on the question of the erection of overhead wires. The suggested clause, except in one respect, could not be improved, and should finally remove all doubts as to the power of a local authority to prevent and obstruct the development of overhead transmission and distribution lines mainly on private property. There should, however, be some limit to the time allowed to the Board of Trade for a decision as to whether the consent of a local authority is being unreasonably withheld, which I suggest in such a simple matter should not exceed two months, and preferably only one month.

Digitized by Google

PATENTS IN 1916.

We give below an abstract of the thirty-fourth report of the Comptroller-General of Patents, Designs and Trade Marks, Mr. W. Temple Franks, C.B. :—

Proceedings Under Emergency Legislation.—During the year 96 applications were made under the Patents, Designs and Trade Marks Temporary Acts and Rules for the avoidance or suspension of patent rights. In 56 cases the licences have been, or will be, granted, and in 3 cases the patents have been suspended in favour of the applicants. Of the remaining applications, 12 have been withdrawn or abandoned, 6 have been returned as not being required by reason of the patents having expired, or for some other cause, and the rest have not yet been decided. Ten applications for the avoidance or suspension of the registration of trade marks were received. In 2 cases registration was suspended in favour of the applicants, 5 applications were withdrawn, and the other 3 are pending. In addition, the registration of 3 trade marks was avoided by the Board of Trade under the powers given by the last paragraph of rule 1 of the Trade Marks (Temporary) Rules, 1914. There was 1 application in respect of a registered design, and in this case the registration was suspended in favour of the applicant. Under sec. 6 of the Trading With the Enemy Amendment Act, 1916, 17 applications were made for the vesting in the custodian of the benefit of applications for patents made by or on behalf of enemy subjects, and for the grant of licences thereunder. Seven applications for patents have been vested in the custodian, and the letters patent sealed to him, and 5 licences have been granted. One application for a licence has been abandoned, and the remainder are still undecided.

Deposit of Documents Relating to Foreign Patents, &c.—Arrangements were made at the beginning of the war by which notifications and documents relating to foreign patents, designs, and trade marks could be deposited in the Patent Office. The number of notifications deposited in 1916 was 290, against 286 in 1915, and the fees received with such deposits amounted to £36. 5s.

General Business.—The number of patent applications was 18,602, against 18,191 in 1915, and 24,820 in 1914; the provisional specifications were 13,641, 13,242 and 16,590, and the complete specifications 10,700, 10,461 and 16,443 respectively. The patents sealed were 8,424, against 11,457 and 15,036 in 1915 and 1914. There were 15,399 design applications, of which 14,766 were received, the corresponding figures for trade marks being 5,837 and 2,878 respectively. The total receipts from patent fees were £268,140. 5s., the designs' fees amounted to £4,683. 16s. 10d., and the trade marks' fees to £13,046. 2s., miscellaneous fees and sale of publications making a total of £6,809. 0s. 11d. There was an increase of £11,417 in receipt from patents fees, but there was a further decrease in the receipts from designs' fees and sale of publications, the total receipts (£292,731) being £10,260 more than in 1915.

Free Library.—The number of readers who made use of the library was 75,150, compared with 87,625 in 1915. The number of volumes added was 3,510, of which 603 were volumes of patent specifications or patent journals, and 117 were trade catalogues. The remaining 2,790 volumes were scientific text-books or periodicals, 1,814 being obtained by purchase and 976 by gift or exchange. The number of works in the library at the end of the year was 53,636, and the approximate number of volumes (exclusive of duplicates) was 162,500, The new "relative" shelf classification has been extended from QA Naval Science to QC Marine Engineering, and from TW Yeast to UA Brewing; O Architecture has been completed, and further progress has been made with V Agriculture.

Sale Branch.—During the year 163,243 patent specifications, 5,098 abridgment volumes, 44,315 "Illustrated Official Journals," and 26,288 "Trade Mark Journals" were sold, compared with 174,836, 4,472, 46,930 and 28,827 respectively in 1915. The number of deposit accounts is now 544. Of the depositors, 50 live in London, 153 in other parts of the United Kingdom, and 341 abroad. The number of specifications of expired patents reprinted at the cost of the Office under the arrangement recommended by the Departmental Committee of 1900 was 205. In addition to these, 1,229 specifications were reprinted for official purposes.

Patents.—The renewal fees amounted to £198,981, an increase of £15,052 over 1915, and the largest amount received in any one year. On the other hand the sealing fees fell to £8,805, compared with £12,837. There was a slight increase in the number of applications and specifications filed in 1916, the total number of applications being 18,602, an increase of 411. The proportion of applications accompanied by complete specifications was again small, being only 27 per cent. of the total number of applications. The applications received from women inventors numbered 238, compared with 268. The applications made by way of communication from abroad numbered 835 against 948. Under the provisions of the International Convention for the Protection of Industrial Property 1,400 applications were made in this country, compared with 1,555 in 1915. The number of applications post-dated in consequence of disconformity between the complete and provisional specification was 175 and the number of applications for patents of addition 386 compared with 200 and 401 respectively in 1915. The number of cases in which complete specifications were filed in respect of cognate provisional specifications was 402, compared with 305. Typical specimens were furnished in connection with applications for 7 chemical inventions.

Renumbering Specifications on Publication.—At the beginning of the year the practice was introduced of giving new numbers to applications for patents when their complete specifications were accepted or became open to public inspection before acceptance. To avoid confusion with the original application numbers the new series commenced with No. 100,001. The main advantage of the system is that it enables abridgments of specifications to be published to date without destroying their numerical sequence, and thereby gives the most recent information to the public without impairing the facilities for search and reference. The procedure was applied only to applications made during the year 1916, those of earlier date being allowed to retain their original numbers. Of the 1916 applications, 2,811 were renumbered, and have been abridged in the "Illustrated Official Journal (Patents)." These abridgments are so arranged that they can be bound together in a separate volume, which, if used with the corresponding name and subject-matter indexes, will be of great value to searchers. The series of abridgments for 1915 ran concurrently with the new series in the "Journal" until April, 1917, when it was entirely superseded. In connection with the new procedure, the numerical list of applications for patents formerly published in the "Journal," has been replaced by an alphabetical list of applicants, and the former indexes of applicants and subject-matter of applications have been abandoned. The number of applications made for the restoration of patents which had lapsed in consequence of the non-payment of renewal fees was 42, of which 7 are still pending. In each of the remaining 35 cases the patent was restored. There were 38 hearings before the Comptroller. The final figures for 1915 are as follows: Applications 26, patents restored 25, applications withdrawn 1. Under the provisions of sec. 26, which empowers the Comptroller to revoke a patent upon application made within 2 years from the date of the patent by any person who would have been entitled to oppose its grant, there were 9 applications. Three of these were dismissed, in 4 cases orders were made requiring an amendment of the patentee's specification, 1 was withdrawn, and 1 is still pending. There were hearings before the Comptroller in 10 cases. Of the 5 cases shown as outstanding in the last report, 3 are still undecided, and in 2 cases orders for an amendment of the patentee's specification were made. One offer to surrender a patent under the provisions of sec. 26 (3) was received and the patent was revoked.

Hearings and Appeals.—The number of hearings upon oppositions to the grant of patents was 69, compared with 57. There were 19 appeals to the law officer, with the result that in 11 cases the Comptroller's decision was supported, and in 1 varied. Two appeals were withdrawn or abandoned and 5 are outstanding. There were 2 hearings in connection with oppositions to the amendment of specifications. In 1 case there was an appeal to the law officer, but this was subsequently withdrawn. Under sec. 73 of the Act there were 103 hearings, compared with 122. There were 4 appeals to the law officer, with the result that in 3 cases the Comptroller's decision was supported and in 1 reversed. The hearings fixed under secs. 7 and 8 of the Act numbered 1,979, but 1,153 of these were rendered unnecessary by reason of the abandonment of the application or amendment of the specification by the applicant. In all of the remaining 826 cases formal decisions were given by the Comptroller. There were no appeals to the law officer.

Extensions of Term of Patent.—Four petitions for extension of term, 2 relating to patents of the year 1902, and 2 to patents of 1903, were lodged during the year. One of these was abandoned, and of the others, in 1 case the term of the patent was extended for 3 years, in another for 7 years, and in the remaining case for 7 years, but not to exceed 5 years from the termination of the war. There are now 6 patents (including the Lodge patent of 1897, the Ritchie patent of 1899 and the Creed and Coulson patent of 1902) in force which have been prolonged beyond the normal period of 14 years.

Designs.—The number of applications to register designs was 15,399 including 295 sets, compared with 18,130, including 582 sets, in 1915. Of the above-mentioned 15,399 applications, 9,921 were applied for in classes 13, 14 and 15 (printed or woven designs on textile goods), compared with 9,535. During the year 1,013 applications for registration of designs were objected to by the Comptroller. The applicants in in 508 cases acquiesced in the objections raised by the Comptroller without applying for a hearing. In 184 cases the applications were allowed after correspondence to proceed, and of these, 164 related to classes 13, 14 and 15, in which the applications were allowed to proceed on a disclaimer that the public right to the use of the applicants' own earlier registrations, after the expiration of the copyright, was not prejudiced. In 3 cases the applications are still under consideration. In 318 cases the applicants were accorded hearings, with the result that 8 applications were accepted without alteration; 115 were refused, 188 were accepted subject to modification, and 7 are still under consideration. There were no appeals from the Comptroller's refusal. There were 6 applications by registered proprietors to cancel their registrations under Designs Rule 53. The number of designs of which the copyright was extended for a second period of five years was 1,740, and the number of which the copyright was extended for a third period of five years was 337.

Trade Marks.—The number of applications made in 1916 for the registration of trade marks (including 76 applications made to the Cutlers' Company of Sheffield) was 5,837, compared with 6,057. Of the trade marks registered in 1902 the registration was renewed for a second period of 14 years in 1,839 cases, and of those registered in the year 1888, for a third period of 14 years in 2,540 cases. During the year 3,212 trade marks were advertised and 2,878 registered. There were 825 hearings

Digitized by Google

under sec. 53 of the Act. The notices of opposition to the registration of trade marks under sec. 14 of the Act numbered 81, and 22 cases were heard. There were 4 appeals to the Court. In 3 cases the Comptroller's decision was upheld, and in 1 reversed. There was also 1 appeal to the Board of Trade, in which the Comptroller's decision was upheld. There were 4 appeals to the Court and 26 to the Board of Trade from the decision of the Comptroller under sec. 12 of the Act. Of the appeals to the Court, the Comptroller's decision was reversed in 1 case, in 2 cases upheld, and the other case has not yet been determined. Of those to the Board of Trade, 23 were heard, 7 being allowed, 8 dismissed, 1 withdrawn, 1 cancelled under sec. 18 of the Act, and 6 have not yet been determined. The 3 remaining cases were referred to the Court, and have not yet been heard. There were 17 special applications made under sec. 9 (5) of the Act. Of these, 8 were reported to the Board, who authorised the advertisement of 2 applications, and the remaining 6 are under consideration. Of the other 9 applications, 2 were deemed to be withdrawn under Rule 38, owing to the failure of the applicants to state a case, 5 were altered to ordinary applications, and the remaining 2 are not yet ready for report to the Board. There were 2 applications for special trade marks under sec. 62. One of these was reported to the Board of Trade, and is under consideration, and the other was altered to an ordinary application.

PARLIAMENTARY INTELLIGENCE.

BOARD OF INVENTION AND RESEARCH.

In the House of Commons on Monday, Dr. MACNAMARA stated, in reply to a question, that the functions of the Board of Invention and Research are: (*a*) To concentrate expert scientific inquiry on certain definite problems, the solution of which is of importance to the Naval service; (*b*) to encourage research in directions in which it is probable that results of value to the Navy may be obtained by organised scientific effort; (*c*) to consider schemes or suggestions put forward by inventors and other members of the general public.

The Board considered all inventions relating to naval warfare and acts in an advisory capacity to the Admiralty. It had funds at its disposal for carrying out trials and experiments and possessed full facilities for arriving at a decision whether an invention was worthy of adoption or not; but the adoption of an invention was subject to the approval of the Board of Admiralty. The general superintendence of the Board of Invention and Research was reserved to the First Lord, to whom it had direct access. The Central Committee met once a week; the panel once every six weeks; and the sub-committees held meetings at frequent intervals as the circumstances required. The President had attended 54 sittings during the last 12 months.

The members of the Board who received remuneration for their services were the President, £1,350 a year, in addition to retired pay; Vice-Admiral Sir Richard H. Peirse (Naval Member of Central Committee), £1,530 a year; Prof. W. H. Bragg (Member of Panel), whilst occupying the post of Resident Director of Research at an Admiratly experimental station, professorial salary of £1,000 a year at the University of London is refunded by the Admiralty to the university authorities; Dr. Dugald Clerk (Member of Panel), as Director of Engineering Research at the Admiralty Engineering Laboratory, City and Guilds Engineering College, South Kensington, was entitled to repayment of out-of-pocket expenses to an amount not exceeding £600 a year.

Royal Assent.—On May 17 the Royal Assent was read to the West Kent Electric Power Act, 1917.

LEGAL INTELLIGENCE.

Bosch Magneto Patents.

In the Patents Court on Friday the Chesham Supply Co. (Ltd.) applied for licence to use eleven Bosch patents for magnetos.

Mr. IMRAY (for the patentees) opposed the application, and said the patents had been worked in this country by the Bosch Magneto Co. The goodwill of the business and the premises and effects had been sold to Messrs. Vickers (Ltd.), who were going to carry on the business through the Wolseley Car Co. He thought the hearing should be adjourned to give Messrs. Vickers an opportunity to attend.

The Controller of Patents (Mr. TEMPLE FRANKS) observed that the sale of the Bosch Magneto Co.'s premises and goodwill was made explicitly without the patents.

Mr. IMRAY replied that he believed that was in order that the purchaser might apply for a licence, and he suggested they should have a prior claim, as they had bought the goodwill. He was not acting for Messrs. Vickers, and added that the Bosch Company was not in a position to transfer the patents, because all the patents stood in the name of the German company.

Mr. CARPMAEL (for applicants) said the company was all British, and had a manufacturing branch at King's Cross (known as Motormeters), which would manufacture the magnetos. There was a large demand for magnetos, and, besides supplying the public, applicants had private demands from cab companies, &c. In the main these patents stood in the name of Robert Bosch, but there had been assignments in several cases. The enemy Bosch Co. held an extraordinary number of patents, about 80 or 90. Patent No. 23,132, of 1905, applied only to motor cycles: Nos. 24,288, of 1907, 24,686, of 1910, and 25,880, of 1911, were contact-breakers. Then there were patents for adjusting the ignition, or the period of ignition—24,687, of 1910, 26,928, of 1911, and 4,692, of 1913. No. 8,224, of 1911, was a carbon holder.

Mr. P. C. MIDDLETON, managing director of applicant company, gave particulars of its capital, &c. Applicants' private demand before the war was 2,500 a year. They wanted them for the Unic taxicabs, of which there were 4,000 on the streets at present. It was proposed to put up works to manufacture the magnetos. In the past a number of chassis and magnetos had come over together from France. When the war broke out the French Government commandeered the Bosch magneto factory in that country, and made applicants an allowance for chassis which arrived without magnetos. The Bosch factory in France was close to applicants' works. While there were other magnetos in the market, everybody appeared to insist on having Bosch's. A great many of the Bosch patents were really patents of the ideas of Ri hards, the inventor of the Unic cars, and the ideas that were Richard's in the magneto applicants wished to use. They proposed to pay a royalty of 5s., or 5 per cent., on each magneto made.

The CONTROLLER asked how it was that Bosch appeared to dominate the magneto market.

Mr. MIDDLETON: I could talk for hours on the subject. It is clever trading. It is not the question of the patents. In my opinion there is no patent in it. He had been in the electrical business for over 30 years, and had seen it right from the start, and there was not a patent in the case, that was not used nearly 30 years ago in some instrument or other. It was the combination that seemed to supply "new matter."

The CONTROLLER: If what you say is right, you do not need a licence. You may infringe.

Mr. MIDDLETON: I do not think I will take the risk. The thing that frightens the manufacturers of this country is that there is no protection for the manufacturer.

Mr. J. A. LINNEY (manager of Motormeters) also gave evidence. They did not propose to meet the public demand immediately. The authorities had advised them to apply for those patents, since they were applying for contracts, and they promised to give them permits to get machinery.

The CONTROLLER found that a case had been made out for granting the licence. The Court had been somewhat surprised that other applications for licences to use those patents had not been forthcoming during the three years of the war. If other applicants came forward, it might be that the Court would have to go into the question of royalty again.

Claim for Commandeered Plant.

Last week the Defence of the Realm Losses Commission considered a claim by Wallasey Corporation for the loss of a new turbine owing to the action of a Government Department.

Mr. GORE BROWNE, K.C. (for the Council), said the claim was in respect of the taking over under the Defence of the Realm Act of a large turbine which his clients had just erected at their electric light works. A scheme was approved in 1913 for the erection of new electricity works, there having been an old works where reciprocal engines were running at their full capacity. Sanction having been obtained from the L.G. Board, the Corporation installed two large turbines, and the work had just been completed in 1915 when an intimation was received that the new turbines might be required for munition works. The Corporation therefore put themselves at the disposal of the Government and started to dismantle one of the new turbines. As a matter of fact it was not taken away for some time afterwards. As the remaining machinefy was liable to a breakdown, it was necessary to provide a "stand-by." That "stand-by" had to be secured by continuing the old works and there were several breakdowns. The total claim was £6,203, but there might be a further claim to come during the year, as a contract for the sale of the machinery at the old works had had to be broken, and that might involve damages.

The CHAIRMAN said they would allow certain fees of the Town Clerk in connection with the matter, and also the expenses of three witnesses. Eventually the commission announced an award in favour of the Corporation for the full amount.

John Walsh (Ltd.) v. Webster.

This action, which was brought by John Walsh (Ltd.) to recover money alleged to be due for electrically fitting defendant's house, came before Justices Rowlatt and Shearman on the 17th inst. in a motion by plaintiffs to set aside an award made by Mr. Wm. B. Woodhouse.

Mr. HUME WILLIAMS, K.C., for appellants, said the appeal arose out of the interpretation of the law by the arbitrator, he having come to the conclusion that if the contract was not completed defendant was at liberty to repudiate it in its entirety. It appeared that Mr. Webster, a solicitor, was desirous of having an electric light installation put into his private house, and a contract was entered into between him and John Walsh (Ltd.) in March, 1915, under which appellants were to do the work for £588. 8s. 6d. It was a lump sum contract. Defendant alleged that the work was done improperly and was incomplete. Messrs. Walsh

Digitized by Google

brought an action to recover the amount of the contract price, and the matter was referred by Master Bonner to Mr. Woodhouse as arbitrator. The latter gave his award on Oct. 25, 1916, in which he stated that in his opinion the work under the contract was unfinished and incomplete, and in certain particulars insufficient and unsatisfactory, and not in accordance with the specification, and that being so, defendant ought not to be required to accept it. If, however, defendant were to accept it in its then condition, the arbitrator was of opinion that £50 would be a reasonable sum to be allowed from the total sum to make it complete and satisfactory. Thereupon defendant intimated that he would not accept, and called upon plaintiffs to take away the installation they had put up and to pay for the damage done to his house. Counsel submitted the defendant was not entitled to repudiate the contract. He could only do that where the contractors had failed to do a substantial part of the work or had neglected it to such an extent that it could be said there was nothing like a fair execution of the contract. That was not the case here, as the arbitrator had found that there was only a failure as to a small part, which £50 would put right. Under those circumstances he submitted Mr. Webster was not entitled to repudiate the whole contract.

Mr. GREER (for respondent) said the real issue between the parties when before the arbitrator was that the contractor was suing too soon for his money, especially when the employer was ready and willing at that time that he should complete the work. Mr. Webster was at first quite willing that Messrs. Walsh should finish their contract.

Mr. Justice ROWLATT, in giving judgment, said the real question was what was the meaning of the words unfinished and incomplete in the award. They felt they did not know one way or another. It was, of course, possible that £50 might put the whole thing right; but, on the other hand, something vital to the installation might be missing, or it might only be bad workmanship. The arbitrator had, however, not told them, and therefore the award must go back to him to state whether the installation was still incomplete in the sense that some substantial part had not been done, or whether it was only incomplete in the sense that some of the work was badly done.

Mr. Justice SHEARMAN concurred, and the matter was referred back accordingly, the costs of the application being reserved.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

4,780 MARION, P. Process for the electrolytic deposition of zinc on metallic surfaces. (31/3/16.) 105,255.

4,827 TURNBULL, A. P. Electri-magnically operated switch. (1/4/16.) 105,257.

5,325 WESTERN ELECTRIC CO., DEAKIN, G., & POLINKOWSKY, L. Semi-automatic telephone exchange systems. (11/4/16.) 105,266.

5,875 DUNGEY, J. W. Inter-communication telephone systems. (25/4/16.) 105,272.

8,736 CASOTTI, T. P. Electric switches. (21/6/16.) 105,291.

9,608 DEUTSCHE GASLUHLICHT AKT. GES. (Auerges.) Method of and apparatus for evacuating the bulbs of electric incandescent lamps and other glass vessels. (27/9/15.) 101,621.

Relates to a method of exhausting electric incandescent lamp bulbs and other glass vessels within a receiver adapted to be evacuated and communicating during the exhausting operation with the interior of the bulbs, consisting in exhausting the air through the short nipples on the bulbs and sealing off, electrically, the free ends of these nipples after the desired vacuum is established.

16,144 COOKE, G. F. Construction of magneto-electric machines. (10/11/16.) 105,310

17,206 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (Westinghouse Electric & Mfg. Co.) Electric circuit interrupting systems. (30/11/16.) 105,314.

Comprises the combination in an electric circuit with a source of constant potential and a constant-potential load circuit, of a constant-current circuit interposed between the source of constant potential and the load circuit, and means for short-circuiting the constant-current circuit when the load on the load-circuit exceeds a predetermined value to thereby prevent current from traversing the load circuit.

18,553 JAUBERT, G. F. Electrolytic production of oxygen and hydrogen. (29/12/15.) 102,974.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

March 2, 1917.

3,091 RUTHERFORD. Carrier for electric, &c., shades, reflectors, &c.

3,102 EALES & GRIMSTONE Holders or adapters for arc lamp carbons.

3,113 HUTCHINS. Carbon manufacture for electro-chemical, &c., services.

3,125 GARIN. Electrolytic production of copper.

3,127 PICKETT WEST & WISE. Electro magnetic switches or contactors.

3,128 WEST. Electro magnetic switches or contactors.

3,131 ETAB. DE DION-BOUTON S.A. Electric ignition for engines. (22/4/16, France.)

March 3, 1917.

3,155 SHEPHERD Electric generators and motors.

3,157 GOLDSTONE & WARD. Flexible cords and cables.

3,160 ALLEN. Manufacture of clay, &c., articles by electro-deposition on metal moulds.

March 5, 1917.

3,235 & 3,236 ELLISON & ANDERSON. Electric controllers, &c.

3,250 SULLIVAN. Use of relays for telegraphy, &c.

3,253 CAUNTER. Electric heating elements.

3,258 OLDHAM. Miners', &c., electric safety lamps.

March 6, 1917.

3,274 LANCASHIRE DYNAMO & MOTOR CO. & MASON. Dynamo-electric machinery.

3,285 GRIFFITH. Electrochemical treatment of metallic ores.

3,290 GRANT. Electric controlling of locks.

3,295 B.T.-H. CO. (G.E. Co.) Control of electric motors.

3,318 BROWN, BOVERI & CO. & GRAY. Control and regulation of electric furnaces.

March 7, 1917.

3,360 FLEMING. Telegraphic relays.

3,368 SWINSON. Electrical marine depth indicator.

3,394 ELECTRIC & ORDNANCE ACCESSORIES CO. & ETCHELLS. Regulation and contro of electric motors.

3,400 GORDON. Electric lighting systems for motor vehicles.

3,401 GORDON. Electric lamps for miners, &c.

March 8, 1917.

3,422 INSULL. Welding or sintering tungsten ingots, &c.

3,423 INSULL. Production of compressed tungsten powder.

3,425 INSULL. Electrical contacts.

3,426 INSULL. Electric furnaces.

3,437 B.T.-H. Co. (G.E. Co.) Electric motor control.

March 9, 1917.

3,464 CONNER. Magneto-electric machines for ignition in engines.

3,476 TAYLOR. Regulating voltage of alternating-current system.

3,485 & 3,486 QUASI ARC CO. & TWEEDALE. Electric welding or soldering.

3,486 COLE. Electric welding or soldering of metals.

3,494 B.T.-H. Co. (G.E. Co.) Electric furnaces.

3,524 CAUNTER. Electric heating elements.

March 10, 1917.

3,531 WESTERN ELECTRIC, MCBERTY & POLINKOWSKY. Machine switching telephone system.

3,534 PRATT. Trolley pole head.

3,546 GREEN. Signalling systems.

3,549 W. T. HENLEY'S CO. & MOOR. Disconnecting boxes for electric cables.

3,551 YOUNG. Direct conversion of energy of motion of water or other dielectric into electrical energy, and conversion of electrical energy into the motion of mass.

3,558 SELECTIVE SIGNAL CO. & LYONS. Apparatus for reception and utilisation of electric current impulses.

March 12, 1917.

3,579 NAAMLOOZE VENNOSTSCHAP HAARLEMSCHE MACHINEFABRICK. Inspection glasses for magnetic brakes. (14/3/16, Holland.)

3,581 & 3,582 SCHUSTER. Diaphragms for galvanic cells, &c.

3,583, 3,584 & 3,585 SCHUSTER. Galvanic cells.

3,604 BEAVER & CLAREMONT. Electric cables.

3,610 HENLEY'S TELEGRAPH WORKS CO. & MOOR. Electric switch boxes.

3,615 LA VALETTE. Electric couplings. (31/3/16, France.)

3,618 STONE & DARKER. Electromagnetic switches for train lighting, &c., installations.

March 13, 1917.

3,652 GRINSTED. Electric circuits linked by relay or repeater.

3,657 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Systems of control. (13/13/16, U.S.)

3,658 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Transformation of single-phase to polyphase currents. (13/13/16, U.S.)

3,664 STONE & DARKER. Electric switches.

3,665 STONE & DARKER. Brush and terminal contact mechanism of dynamo-electric machines.

March 14, 1917.

3,686 GREEN. Insulated brush-holders and terminals for magnetos.

3,687 BENT. Electric heaters.

3,709 WESTERN ELECTRIC CO. Signalling and sound detecting systems.

3,717 GREEN & MAY. Electrical couplings or connections.

3,719 & 3,720 VULKAN MASCHINENFABRIKS A.G. Electromagnetic clutches. (22/10/13, Austria.)

3,727 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (Westinghouse Electric & Mfg. Co.) Electric control apparatus.

March 15, 1917.

3,748 DUGGAN. Rollers for tramway overhead equipment.

3,767 TROUP, CURTIS & CO. & WICKETT. Brushes for dynamo-electric machinery.

3,768 TROUP, CURTIS & CO. & WICKETT. Brush gear for dynamo-electric machinery.

3,780 LANGDON-DAVIES & SOAMES. Electromagnetic friction clutches.

3,798 SOC. LORRAINE DES ANCIENS ETAB. DE DETRICH ET CIE DE LUNEVILLE. Driving mechanism for magnetos. (3/4/16, France.)

3,802 BEAVER & CLAREMONT. General and electrical joint-making washer.

3,807 SVENSKA ACKUMULATOR AKTIEBOLAGET JUNGNER. Electric batteries. (8/8/16, Sweden.)

3,811 HURM. Crystalline, &c., detectors for electric waves. (21/3/16, France.)

3,815 NORSK AKTIESELSKAB FUR ELEKTROKEMISK INDUSTRI. Manufacture of pigments from titanium compounds. (8/3/16, Norway.)

March 16, 1917.

3,864 JONES. Electrically depositing metals.

3,865 BETULANDER. Electrical selectors. (17/3/16, Sweden.)

3,874 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Rheostats.

3,881 TAYLOR TUNNICLIFFE & CO. & COOPER. Appliances for shaping telegraph, &c. insulators.

March 17, 1917.

3,884 FEARNCHOUGH. Commutators or switchboards for field telephone systems.

3,914 IMRAY. (Bosch Magneto Co.) Magneto-electric ignition machines.

3,916 STERLING TELEPHONE & ELECTRIC CO., BELL & DAVEY. Electic bells.

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. S. Clay, V.D.

Orders for the week :—

Officer for the Week.—Platoon Commander C. Campbell.

Next for Duty.—Platoon Commander A. Gerard.

Monday, May 28th.—See special orders.

Tuesday, May 29th.—Lecture 6.30, Physical drill and bayonet fighting, 5.30 to 6.30.

Wednesday, May 30th.—Drill, No. 1 Company, Right Half Company, 6.15.

Thursday, May 31st.—Drill, No. 3 Company, Right Half Company. Ambulance class by M.O., 6.30. Signalling class.

Friday, June 1st.—Technical for No. 2 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' Drill at 6.30 to 7.30.

Saturday, June 2nd.—Commandant's Parade, 2.45. Uniform for drill.

Sunday, June 3rd.—Parade Clapham Common Station (Tube Railway), 9.45 a.m., for work at Bombing School. Uniform. Rations must be carried.

Armlets.—Members are warned that armlets must be worn at all plain clothes parades.

Musketry.—For all Companies, see Notice at Headquarters.

NOTE.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street, W.)

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Export Standardisation Rules. We have received the following communication from the secretary of the British Electrical & Allied Manufacturers' Association :—

The recent announcement in the technical Press to the effect that the Council of this Association have issued a set of British export standardisation rules for electrical machinery having unfortunately given rise to misapprehension, I am desired to state that these rules are in no way intended to replace the British standardisation rules for electrical machinery which are issued by the Engineering Standards Committee to cover British made plant for home and export trade, and in the drafting of which the Association is closely and cordially co-operating.

* * * *

The State and Commerce. The demand for the creation of a Ministry of Commerce is being insisted upon by commercial and trade organisations, and resolutions in its favour continue to be passed by Chambers of Commerce and other public bodies.

At the recent annual meeting of the Association of Trade Protection Societies the President (Mr. G. M. Chamberlin) said he was able to report, from inside information that not only were Chambers of Commerce going to be taken into far closer collaboration with the Government than before in all matters connected with trade and commerce, but that the work which that association was doing was to be fully recognised.

In a discussion on a resolution (which was adopted) in favour of the creation of a Ministry of Commerce, Mr. W. Field, M.P., suggested that the president and two other members of the association should wait on the Prime Minister, and draw his attention to the urgency of this matter. He thought that such a Minister should be a member of the Cabinet.

A resolution urging the adoption of systems of apprenticeship for fixed periods, with rising remuneration, combined with technical instruction during business hours, was agreed to.

* * * *

British Trade Corporation. The criticism to which the scheme for the formation of a British trade bank has been subjected has caused the Government to reconsider the question, and Mr. Bonar Law has promised that an opportunity will be given after the holidays recess to discuss the matter again in the House of Commons. There is a strong opinion in favour of the creation of a trade bank (or banks), which would assist in financing and in developing our foreign trade and commerce; but there seems to be a fear that the powers proposed to be conferred on the British Trade Corporation are too wide and too exclusive, and that it might be in a position to compete unfairly with British merchants and exporters. As there is no need to rush the matter, it is well that the whole of the powers of the projected institution should be carefully scrutinised from every point of view, so that a start may be made on the right lines and that the greatest good may be rendered to our export trade and business.

The chairman of the Corporation (Lord Faringdon) has given an emphatic assurance that his board has not at any time intended to enter, and that it will not enter, into any business beyond the scope of the transactions contemplated in the report of the Departmental Committee which recommended the creation of the "British Trade Bank." This statement should disarm many of the critics, but we think the charter should be so amended as to make the position quite clear.

Mr. A. G. M. Dickson has been appointed manager of the Corporation.

* * * *

Labour Exchanges. At the recent meeting of the Ironmongers' Federated Association the Council, reporting on the past year's work, severely criticised the administration of the labour exchanges.

Attention was directed to the fact that the Labour Exchanges were costing the country an enormous amount of money, and the leading officials were constantly striving still further to increase their powers. As far as their trade was concerned they preferred to be unfettered and free to engage their workmen and assistants in the ordinary way, which in the past had proved so satisfactory.

* * * *

The Decimal System. In the report of the Decimal Association for 1916 it is stated that of the replies received in answer to a questionnaire sent out to 25,000 of the largest firms in the United Kingdom, asking if they were in favour of the decimalisation of the coinage and the adoption of metric weights and measures, 99 per cent. were in favour. Of the replies received in answer to a similar questionnaire sent out by the British Engineers' Association, 90 per cent. were in favour of the early adoption of a decimal system of coinage, and 85 per cent. in favour of the compulsory use, after a short transition period, of the metric system of weights and measures.

The above figures prove that the great majority of the business and commercial houses are in favour of the decimal system, and another sign of the altered state of public feeling on the subject is the statement in the report of the Executive Committee of the Association that Manchester, which was formerly a stern opponent of the projected reforms, is rapidly becoming a decimal stronghold, and possesses a decimal association of its own.

* * * *

Pre-War Contracts. The Committee, under the chairmanship of Lord Buckmaster, which was recently appointed by the Board of Trade

"To consider and report on the position of British manufacturers and merchants after the war in respect of contracts entered into by them prior to the war with persons or companies in the United Kingdom or in Allied or neutral countries, the fulfilment of which has been prevented or impeded by the war, and as to the measures (if any) which are necessary or desirable in this respect," has begun its sittings and is ready to receive evidence. Those who desire to tender evidence should communicate with the secretary, Mr. L. F. C. Darby, at the Board of Trade, 7, Whitehall-gardens, S.W.1. It is requested that, where possible, such communications should be made through their Chamber of Commerce or trade association.

Speaking generally, the Committee desires to hear witnesses who can give evidence of general application to large bodies of traders or who speak to contracts of magnitude. The duty of the Committee is not to advise on or to redress personal grievance or remedy individual loss, but to consider broad principles by the application of which difficulties of general application may be overcome.

* * * *

German Preparations for Peace. It would appear from an article in a recent issue of the "Frankfürter Zeitung" that German manufacturing firms are making careful preparations for dealing with the conditions which will prevail during the period of transition from war to peace and for carrying on a commercial warfare when circumstances permit.

In striking contrast to what is being done in this country, where the excess profits duty has recently been increased from 60 to 80 per cent., special reserve funds are being created by many German companies, while some of them are increasing their capital by large amounts, although for the present they are only calling up a small percentage of the new capital. According to "The Times," the Frankfort paper states: "The fact that the companies are now, while the war is still proceeding at full pace, making such large additions to capital, shows confidence concerning the future and the definite expectation of adequate activity not only during the war, but also in the coming time of peace."

* * * *

Post-War Industrial Conditions. We are pleased to see that at a meeting of the General Committee of the National Alliance of Employers and Employed on Tuesday the Alliance was formally constituted. It must be obvious to our readers that the post-war industrial conditions will be very different from what they have been, and that if strikes and industrial strife prevail then the war will have been fought in vain. Consequently any means of bringing both sides together and of abolishing or minimising the causes of strife must be welcome.

Mr. F. HUTH JACKSON, who presided, referred to the gravity of the prevailing unrest, not only among workmen, but equally among employers and business men. There had been a better relationship growing up between employers and employed, but he thought it had to be admitted that in a good many cases workmen had in the past not received a due proportion of the results of their industry. Employers must recognise that workmen in the future must be better paid, better housed and better educated. The workman, on the other hand, must recognise that a full wage carried with it the obligation of a full day's work, and that where a full day's wage was paid interference with the productivity of industry must not be allowed.

The CHAIRMAN then moved the adoption of the constitution, the main objects of which are to secure the active co-operation of employers and employed in the discussion and treatment of questions affecting labour and employment, with the special object of securing that these should be dealt with before they have reached the stage of acute controversy: to promote generally the welfare of the industrial workers and the efficiency of the country's industries.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Poplar (London).—The Electricity Committee has had under consideration the provision of additional generating plant to meet next winter's demand.

Negotiations are proceeding for linking-up with the L.C.C. generating station, but it is unlikely that arrangements can be completed in time for next winter's load. Alternative proposals are the installation of a 5,000 kw. to 6,000 kw. generating set or a supply from the Charing Cross, West End & City or the South Metropolitan companies. The Director of electric power at the Ministry of Munitions has satisfied himself that the best course to adopt is to sanction the erection of a new generating set at Poplar, provided an additional cable is laid to Stepney. The installation of a 5,000 kw. set would raise the total capacity to 14,000 kw. normal, or 11,250 kw. effective, if the largest set were out of commission. Having regard to all the circumstances, the engineer (Mr. J. Horace Bowden) is of opinion that the decision of the director of electric power is correct, and the Committee has, therefore, approved of the provision of an additional 5,000 kw. set and the laying of an additional e.h.t. cable from the generating station to Stepney boundary, at a total estimated cost of £30,500.

The negotiations for linking-up with the L.C.C. station will be continued, as such linking-up will be of mutual benefit.

Shoreditch (London).—On Tuesday the London County Council agreed to sanction a loan of £41,000 for extensions of the electric supply undertaking.

The Finance Committee reported that in September, 1913, the Borough Council asked for sanction to a loan of £98,850 for a large extension of its electricity undertaking. By agreement it was arranged that the extension should not be proceeded with in its entirety, but in the following week the Council gave its approval to Shoreditch expending £23,045 for the purchase of land for additional coal storage and for mains and plant required for linking up with Stepney. The original scheme of extension was not abandoned and in March, 1915, it renewed its application to borrow £99,906. Owing to the war the application was not then proceeded with and since that time the Committee on London Electricity Supply had endeavoured to arrange for further supplies of electricity to be furnished by another undertaking to Shoreditch and had also considered whether any other source of supply was available. The Borough Council now stated that it realised that under present national conditions, the original scheme could not at present be proceeded with. The arrangement for receiving a bulk supply terminates in September, 1917, and there is no prospect of its renewal. The provision of additional plant could not, therefore, be deferred, and it applied for sanction to borrow £41,000 for one of the two 5,000 kw. turbo-alternator sets, which it was originally proposed to instal. To enable this to be done it would be necessary to dispose of one of the 800 kw. marine-type reciprocating-engine sets, the space thus vacated being sufficient to accommodate the large turbo set. Rotary converting plant, h.t. switchgear, extension of steam pipes, pumps, &c., were also included in the estimate as well as h.t. cables to connect the Whiston-street station and Coronet-street sub-station.

Southampton.—The Electricity Committee has been asked to report upon a proposal to acquire additional siding accommodation for the electricity works.

Wednesbury.—The Midland Electric Corporation for Power Distribution proposes to lay a main from the borough boundary at Lea Brook to the borough boundary at Bull Stake.

GENERAL.

Coventry.—At the Council meeting on Tuesday the Electricity Committee submitted its annual report.

The profit on the past year's working was £27,814. 18s. 3d., and the committee recommended that £6,000 be applied in aid of the rates, £11,500 in part payment of various commitments already made, and £10,314. 18s. 3d. carried forward.

Ealing.—There is an over-draft of about £9,000 on the electricity undertaking.

Ald. Peal, chairman of the Electricity Committee, explained last week that, in consequence of the shortness of staff, the meter readings had been late and the payments of consumers were, therefore, somewhat behind-hand. They had a reserve fund of £11 000 and they were taking some of that money to meet the contingency which had now occurred.

Glasgow.—The Corporation announce that, acting on instructions from the Ministry of Munitions, they will be unable until further notice to connect up to their electricity mains the premises of new consumers, unless the supplies are required by persons or firms engaged on war work or munitions work.

Hornsey.—The Council has authorised the Electricity Committee to prepare a scheme for purchasing coal "in bulk" and distributing it at reasonable prices to the poor during next winter.

Itchen.—Last week the Council were asked by Mr. W. H. Angell to pass a resolution inviting Messrs. May & Hawes to meet them as early as possible to consider a scheme for supplying electric current in the district.

Mr. Angell said the subject had been before the Council for the past six years and they had got the necessary order. The importance of the town justified its claim to have an electricity supply system. If they did not pass the resolution their opportunity would be lost and their efforts and trouble in getting the order would have been wasted.

After discussion the resolution was passed, but it was agreed nothing would be spent until after the war. Preparations might be made to commence work soon after peace was proclaimed.

Rawmarsh.—The Corporation are recommended to enter into negotiations with the Mexborough & Swinton Tramways Co. for the purchase of their Rawmarsh and Swinton electric supply undertaking.

St. Pancras (London).—The Electrical Engineer has been authorised, in view of a shortage in the future, to store as much coke as possible.

Salford.—In submitting the annual estimates to the Corporation last week Ald. Jenkins said that the Tramways Committee were not able to make their promised contribution to the rates, but, by careful management, the electricity undertaking had had the best year in its history.

Willesden.—The Vicar has given permission, on payment of £2. 2s. per annum, to lay a cable in the St. Monica recreation ground, in order to supply current to a factory at Neasden.

ELECTRIC TRACTION.

Electric Vehicles in the U.S.A.—The progress of the electric vehicle in the United States of America seems to be phenomenal. Already there are over 35,000 electric vehicles in the States. In Greater New York there are over 2,500 commercial electric cars, which is stated to be 43 per cent. of the total number of vehicles used for commercial purposes.

Hull.—The death took place suddenly on the 16th inst. of Councillor Wheatley, chairman of the Corporation Tramways Committee.

L.C.C. Tramways.—On Tuesday the London County Council were recommended by the Highways Committee to suspend the halfpenny fare stages and the issue of ordinary return tickets.

The committee reported that it had appointed a special sub-committee to consider whether any alterations should be made in the working of the tramways, with particular reference to services and fares and methods of collection of fares. The heavy additions to the working costs and the possibility of a greater deficiency on the undertaking, are given as reasons why steps should be taken to secure, if possible, a substantial improvement in revenue at the earliest possible time. The general manager estimates at about £60,000 the increase in yearly revenue as a result of the suspension of halfpenny fare stages, and with regard to the suspension of return tickets, he is of opinion that the consequent additional yearly revenue may be about £45,000.

There is no doubt that the undertaking is suffering considerable loss of revenue through non-collection of fares, owing to missed fares, avoidance of payment of fares, and over-riding before and after payment of fares. Under present conditions conductors are unable to perform their duties with the required degree of efficiency. Their difficulties are increased owing to the greater average number of passengers carried on cars, overcrowding, and (for a considerable percentage of running hours in the course of the year) poor lighting. A large percentage of the regular conductors are serving with H.M. forces; and 54 per cent. of conductors at present are women, most of whom have only recently entered the service.

It is pointed out that halfpenny fare stages have been discontinued on all the municipally-worked tramway systems adjacent to London, and in conjunction with which through running arrangements have been operative, "and a decision by the Council on the question of halfpenny fare stages is now a matter of some urgency in connection with the revision of these arrangements." The suspension of halfpenny fare stages will not, however, affect the present arrangements under which children are charged half fares for penny stages. The greater length of the routes on the south side of the Thames, and the many transfer stages involve the use of three or four varieties of return tickets on some of the routes, and the suspension of return tickets will be of material assistance in simplifying the work of the conductors.

The recommendations caused some discussion, but on a division they were approved by 40 votes to 27.

Digitized by Google

Railless Traction in Shanghai.—At the recent meeting of the Shanghai Electric Construction Co. (Ltd.), the chairman (Sir A. Dent, K.C.M.G.) said that their railless tramcar service had been slightly extended to Honan-road Bridge and the route continued to be well patronised. A scheme has been laid before the Council for an extension of this form of traction, which, if sanctioned, would later on be gradually introduced on some of the narrow streets.

Tramway Workers' Policy.—At the annual conference of the Amalgamated Association of Tramway & Vehicle Workers last week the Executive Council submitted a resolution embodying the several points of a national policy, which included a standardised rate of wages for all grades of labour in the union; a working week of not more than 54 hours, Sunday labour to be paid time and a half; 10 days holiday with pay; overtime rates for Bank Holidays; the suspension of Christmas Day service, the abolition of "spread over" time, &c.

An amendment by Highgate substituting a 48 hours week for 54 was carried. The recommendation of 10 days' annual holiday (with pay) after 12 months' service was amended to 14 days' holiday. It was also decided to request that all men required to work overtime, who are due off on Bank Holidays or local holidays, shall be paid double the overtime rate. The executive's recommendation to suspend the Christmas Day service was approved. It was also decided that the association should seek to abolish all long "spread overs" by suggesting that where a duty is spread over more than 12 hours all time over 12 hours shall be paid at time and a quarter.

The Executive Council recommended that the period of qualification from minimum to maximum rates of pay be two years in the case of motormen and one year for conductors. An amendment that shed men be included was, however, carried.

It was decided that all employees (men and women) passed for service should be guaranteed a full week's pay at the minimum rate for that grade.

MISCELLANEOUS.

Board of Trade Electric Power Committee.—The Municipal Tramways and Urban District Councils Associations have passed resolutions of protest against the inadequate representation of municipal undertakings on the Board of Trade Electric Power Committee.

The following additional local authorities have passed similar resolutions: Battersea, Stepney, Clacton, Croydon, Huddersfield, Keighley, Kettering, Luton, Newport, Norwich, Redditch, Southend, Swansea, Walsall, Watford, Wednesbury and York.

Coke Supplies.—The London Coke Committee have consented, upon the request of the Controller of Coal Mines, to their engineer and fuel expert, Mr. E. W. L. Nicol, Assoc.I.E.E., assisting and advising him in the matter of coke supplies and use, with a view to realising the greatest possible advantage through it in furthering the cause of coal economy.

Contracts With Enemies.—At the meeting of the City Corporation last week the General Purposes Committee suggested the adoption of two new standing orders.

(1) No contract shall be entered into with any person of German, Austrian, or other enemy nationality; and (2) no contract shall be entered into with any firm or company whose subscribed capital is held or controlled to the extent of one-third or upwards by persons of German, Austrian, or other enemy nationality.

The Court, while favourable to the object of the new orders, referred them back to the Committee for reconsideration and revision, so as to define more clearly the term "enemy."

Diesel Engine Users' Association.—We have received a brochure giving particulars of this association, including the officers for the year 1917, list of members, &c.

Electricity in Gold Mining.—The report of the Government Gold Mining Areas (Modderfontein) Consolidated for 1916 states that there was a large amount of development work in anticipation of the increased reduction plant.

Delay had occurred in the importation of part of the underground equipment. The two electric hoists for the north-west and north-east incline shafts were shipped in an unfinished condition and were being completed locally. They would soon be ready for erection. The big 250,000 cubic ft. fan was completed and ready for shipment. During the latter part of the year some trouble was experienced with the electrically driven turbo-compressor, resulting in considerable disorganisation of the work underground. In view of this, and especially as the last 100-drill unit had not been shipped, it was decided to purchase two 35/40-drill compressors locally. These were in course of erection.

Electricity Supply Tables.—The 1917 edition of THE ELECTRICIAN Electricity Supply Tables of Great Britain (including all electric supply and power undertakings) and also the Colonial and Foreign Tables of Electricity Supply Works and Tramway Undertakings are now ready, and can be obtained at 5s. (post free, if prepaid) from Messrs. Benn Bros. (Ltd.), 8, Bouverie-street, Fleet-street, London, E.C. 4.

Engineers and Official "Jargon."—The following characteristic letter from Mr. Sydney Evershed (dated May 18) appeared in the "Times" of Saturday last:—

Sir,—In the course of Dr. Addison's speech in the House of Commons last night, Mr. Wardle interposed with the opportune remark that the strikers did not know that fit men who had been introduced into engineering works by way of dilution would be called up before any skilled men in the same area were taken for the Army. The Minister of Munitions thereupon announced that he would have the explanatory notice still more widely placarded throughout the country, "because it is important that it should be understood." Of course it is. Yet we find that in far too many of these explanatory statements which are so plentifully showered upon us in controlled establishments, the language is just that peculiar official jargon which leaves the mind of the reader a blank; and although there is not a man of us in any engineering works, from the lofty shop steward to the humblest managing director, who does not struggle to find a meaning, it is not altogether surprising that we sometimes fail to grasp it. We engineering folk are plain men accustomed to plain speech, and for the lack of it we see a number of men idle when they ought to be at work, and the Ministry of Munitions hard at work with explanations. Let the Minister of Munitions look to it, and before we have any further issue of explanatory statements let us have them translated into lucid English.

Enemy Firms Wound Up.—The Board of Trade have up to date ordered the winding up of 448 businesses controlled by alien enemies.

The latest list includes the Cedes Electric Traction (Ltd.), 112, Great Portland-street, London, W.1. (Controller: H. E. Burgess, 33, Carey-street, W.C.2.)

Engineers' Strike.—We are pleased to be able to announce that an agreement was arrived at on Saturday for the settlement of the engineers' strike, and at the time of going to press the majority of the men had returned to work. Among the terms of the settlement were the following:—

The members of the unofficial strike conference were to return to their districts and advise the men to return to work at once. The Executive Council of the Amalgamated Society of Engineers was to conduct negotiations with the Government in regard to existing differences and should use their best endeavours to secure the continuance of this practice, with a view to the avoidance of any stoppage of work in the future. The Executive Council was also to issue an instruction to the men on strike to return to work immediately.

The Government will not authorise the arrest of further men in connection with the present strike in addition to the 10 men against whom warrants have been issued.

That there should be no victimisation in consequence of the present strike in any Government or controlled establishment.

Hull Corporation Employees.—On the 17th inst. Mr. Charles Doughty, on behalf of the Industrial Commission, presided over arbitration proceedings between the Corporation and the employees of the electricity department.

The latter had made an application to the Corporation for an increase of 12s. a week, in accordance with an award of the Committee on Production.

Mr. H. A. Learoyd (Town Clerk) represented the Corporation and Councillor Pybus (Chairman of Hull Electricity Committee), Mr. J. F. Magoris (Acting City Electrical Engineer) and Mr. T. G. Milner (City Treasurer) also attended. Mr. P. J. Tevenan, general secretary of the Municipal Employees' Association, and Mr. J. M. Gibson, district secretary, put the case for the men, who are in a certified occupation.

It was stated that if the amount were awarded the cost would represent £2,000 a year.

Mr. Doughty expressed appreciation at the way the case had been put on both sides. The award will be made in due course.

The King's Northern Tour.—During his recent tour in the North of England His Majesty visited several engineering works and other industrial establishments, and at Manchester, Liverpool and other places he received an enthusiastic reception. During the visit to the Manchester district on the 14th and 15th inst. the King took the opportunity of visiting the British Westinghouse Works at Trafford Park.

The company kindly allowed the whole of the employees an opportunity to see their Sovereign. His Majesty has become a familiar figure in industrial establishments since the war and it is well known that he takes a great personal interest in the work of munition and supply which must be carried on to an ever increasing extent if victory is to ensue, but we have not yet heard that he has ever before "clocked on" on arrival and "clocked off" on departure as he did on the occasion of this visit. The incident was typical of the up-to-date methods used in the Westinghouse works, and the modern aspect of the buildings may have impressed His Majesty, as it certainly did some of the Press representatives, with the fact that industrial work can be conducted in light, healthy and cheerful surroundings. The works occupy 160 acres, of which 40 acres are roofed in. Building operations were commenced early in 1901, the manufacture of goods commencing early in 1902, since when the volume of business handled by the company has steadily increased, extensions of buildings having been made from time to time and further extensions being now in progress. The entire works is now busily engaged at highest pressure, the number of employees being over 10,000. In this number are included a large number of women workers, and it is interesting to know these number approximately 2,500 more than in pre-war

Digitized by Google

times. A number of special canteens have been provided for their use, and their general welfare is cared for by a lady superintendent of women workers. Over 2,600 men have left the company's employ since the outbreak of war to join the colours, and of these approximately 200 have given their lives in their country's service. In August, 1914, the Employees War Relief Fund was started, and since that date up to the end of 1916 no less a sum than £36,394 has been contributed. Out of this over £20,000 has been paid to dependents and over £10,000 has been set aside for investment, besides which Christmas gifts have been sent to every man and donations made to national and local funds.

An interesting innovation made by the company is a school within the works for the instruction of apprentices. Two grades of apprentices are accepted, one consisting of graduates in engineering and other technically trained men who are allowed to take two or three years' course of a varied character in the shops, testing departments and offices of the company; the other consists of boys who enter the works, between the ages of 14 and 16, and remain until they are 21. During this time boys are given experience in various departments in the shops and also are provided with instruction in the works trade school. The whole of the lecturing work is undertaken by members of the company's staff, the lectures numbering about 40 in all. Details of this scheme were explained to His Majesty by Mr. Fleming.

An interesting development, due to existing conditions, has been the attempt to train educated women to enable them to fill posts of intermediate responsibility in the company's office staff. As an indication of the complexity of the work done it may be mentioned that the number of blue prints printed every day in the works reaches between 3,000 and 4,000. The average wages per week paid at present time are over £21,000.

The following gentlemen were presented to His Majesty during his visit to the works:—Messrs. Annan Bryce, M.P., W. W. Blunt, Norman B. Dickson, A. Spencer, P. A. Lang, Sir Edward Goulding, M.P., A. E. Scanes, H. Mensforth, M. A. Maclean, J. H. Tearle, P. N. Rand, J. S. Peck, G. H. Woods, A. G. Seaman and F. M. Rogers.

Tramway Workers' Wages.—On Tuesday the Committee on Production heard evidence in connection with the claim made on behalf of the employees of the London Electric Tramway Company for the London & Provincial Union of Licensed Vehicle Workers for a war bonus of 10s. to drivers and conductors and for an advance of 5s. per week to other employees of the companies.

Last week the Lancashire District Council of the Workers Union gave 21 days' notice to Bolton Tramways Committee on behalf of the male and female members to withdraw their labour unless their application for an increase of 10s. per week be granted or the matter be referred to the Committee on Production.

At Blackpool there was a demand that the war bonus should be increased to 7s. 6d., but after negotiations an offer of 7s. to all receiving 30s., and 5s. 6d. to those being paid under that sum was accepted. The female workers and others under 21 years of age are to have 2s. extra war bonus. The increases represent £6,500 per year.

Tribunal Cases.—At Westminster Tribunalon Thursday last week the position of 144 men in the L.C.C. tramways department was considered.

Mr. F. W. BROCK (for the County Council) said he could not spare a man. The Ministry of Munitions had been pressing them to put on 25 per cent. more cars.

In reply to a question as to what would be done if the men went on strike, Mr. Brock said that after the last strike about 1,300 men went straight into the Army, as the Council refused to take back any man of military age unless he was rejected.

Eight men were given up by Mr. Brock, and the others were protected as being in certified occupations.

Unemployment Insurance.—The Umpire has decided that contributions are payable in respect of the following:—

Enamellers and lacquerers of brass and other metals in connection with the manufacture of electric light fittings.

Workmen engaged wholly or mainly in fitting up, finishing ready for sale, or in repairing (including cleaning) electric stoves, cooking apparatus and similar electric appliances.

Contributions are not payable in respect of—

Slate enamellers employed in connection with the manufacture of domestic electric light fittings which are not intended for use in war.

Workmen employed by an electric lighting authority and engaged in the work of (1) cleaning arc and incandescent lamps not in connection with repair of lamps; (2) making by hand removable wooden meter brackets; (3) fixing removable meters and brackets; (4) fuse hands; (5) boiler cleaning; (6) fitting up temporary wires and appliances in show rooms and carrying out experiments and tests.

Utilisation of Irish Peat.—In our issue of the 11th inst. we announced the appointment of a joint engineering committee in Ireland for the purpose of investigating and reporting upon the utilisation of Irish peat. We learn that this committee has not, however, any official status; it was really formed at the instance of the Dublin section of the Institution of Electrical Engineers, and not by the Reconstruction Committee as stated in our note. The members of the committee were nominated by the Institution of Electrical Engineers, the Institution of Civil Engineers of Ireland and the Engineering & Scientific Association of Ireland, and the Hon. Sec. is Mr. R. N. Eaton, 12, College Green, Dublin.

TENDERS ACCEPTED.

BEDFORD.—The following tenders have been accepted by the Council:—

United Water Softeners (Ltd.), water-softener and feed-heater plant, £357; Lea Recorder Co., water measuring apparatus, £293; H. Morris (Ltd.), hand travelling crane, £310; W. Moss & Son, buildings, £5,921.

BRADFORD.—The Corporation have placed an order with E. Green & Son for supplying a fuel economiser at the Valley-road electricity works at £2,085.

GLASGOW.—The Corporation have accepted the tender of the India Rubber, Gutta Percha & Telegraph Works Co., for ozokerite tape; that of F. Smith & Co., for trolley wire; and that of Brown-Bayley's Steelworks, for axles and steel tyres.

LEYTON.—The Council has accepted the tenders of the Electrical Apparatus Co. and the Reason Mfg. Co. for the supply of meters.

ST. PANCRAS (LONDON).—The following tenders have been received for the supply of 50,000 pairs of carbons for open arc lamps:

General Electric Co. (*accepted*), £505; Crompton & Co., £562. 10s.; British Central Co., £630; W. Geipel & Co., £693. 15s.; Wells Electrical Co., £768 15s.; Engineering & Arc Lamps (Ltd.), £798 15s.

STEPNEY (LONDON).—The Council has accepted the following tenders:—

Davidson & Co., for three Sirocco high-pressure centrifugal fans and one sheet steel vertical duct, with accessories, &c., for Limehouse generating station, at £484, less 2½ per cent. for cash within 30 days; and Mawdsleys (Ltd.) for four motors and starters in connection with the erection of new fans at £994. 6s.

WOOLWICH.—The Borough Council have accepted the tender of the Western Electric Co. for the supply of 1,742 yds. of cable, at £1,260. 16s. 10d.; that of Siemens Bros. & Co. for a feeder pillar, at £64; and that of Ferguson, Pailin & Co., for two d.c. switchboard panels, at £128. 16s.

APPOINTMENTS VACANT AND FILLED.

An assistant electrical engineer is required in connection with large three-phase colliery plant in China. Three years' agreement. Applications to Mr. Arthur Hassam, consulting engineer, Newcastle, Staffs. *See advertisement.*

For the position of electrical engineer in the Tramways Department of the London County Council (at £1,200, rising to £1,500 a year) 45 applications were received.

The applications were reduced to 12, and the Highways Committee interviewed six of the candidates. After careful consideration of their respective merits, the following three names, arranged in order of merit, were submitted to the Council: Mr. P. L. Riviere (on staff of Messrs. Kennedy & Donkin), Mr. A. E. McKenzie (deputy chief electrical engineer of Manchester), and Mr. J. P. Hodges (chief electrical engineer to Bolckow, Vaughan & Co.). The committee recommended the appointment of Mr. Riviere, and at the meeting on Tuesday this recommendation was confirmed.

Mr. F. J. Cheshire is recommended as director of the new technical optics department of the Imperial College, at a salary of £1,000 a year.

Mr. T. Gerrard has been appointed electrical engineer to Holmfirth Urban Council.

BUSINESS ITEMS.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of June 14. ***Further particulars are set out in an advertisement.***

Plant for Sale.—Messrs. M. Hingley & Sons (Ltd.), Netherton Ironworks, Dudley, advertise for sale two electric capstans for railway works use.

LIQUIDATIONS, &c.

Michael Pal & Co. (Ltd.) is being wound up voluntarily, and Mr. A. E. Hunt, 44 and 45, Tower-chambers, Moorgate-street, London, E.C., has been appointed liquidator.

A meeting to receive an account of the winding-up of the Kent Electric Power Synd. (Ltd.) will be held at 7, St. Helen's place, London, E.C., on June 21.

Digitized by Google

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Birmingham.—The accounts for the year ended March 31 were approved by the Tramway Committee on Friday last, and they will be presented at the next meeting of the Council.

Owing to the heavy cost of maintaining the tramway service, due mainly to the advanced prices of materials and increased wages, the committee is considering the question of a revision of the fares. The general opinion is that some advance will be inevitable, but a decision was postponed to a future meeting of the committee.

The total receipts for the year were £838,725. The surplus was £76,290 (against £107,749), of which £66,205 was added to reserve fund and £10,085 was applied in writing off expenditure on motor omnibuses. The falling off in receipts is mainly due to the frequent stoppages of the tram services occasioned by the failure of the electric supply department to maintain an adequate supply of current. The number of passengers carried during the year was 171,445,020, compared with 163,258,584 in the previous year, an increase of 8,186,436.

Leeds.—The revenue account of the electricity department for the year ended March 31, which was presented to the Electricity Committee on Monday, shows net surplus of £4,161 (compared with £8,716 for the previous year).

Total receipts were £242,589 (against £187,724), of which £141,099 (£91,885) was for supplies for power purposes. Working expenses were £109,454 (£75,143), leaving gross profit £133,135 (£112,581). Allowances to dependents of officers and workmen on active service absorbed £1,752, income tax £2,926 and interest £41,177 : total £45,856 (£39,860), leaving net profit £87,278 (£72,720), from which have to be deducted redemption fund charges £69,992 (£55,630) and contributions to capital expenditure £13,125 (£8,373), leaving the net surplus above-mentioned.

COMPANIES' MEETINGS AND REPORTS.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The report for the year ended March 31 states that three quarterly interim dividends of 15s. per cent. on the ordinary stock and £1. 10s. on the preferred stock have been paid, absorbing £157,500, and in February last the directors paid the final dividend for the year 1916, amounting to £1. 10s. per cent. on the ordinary, the preferred and the deferred stocks. These payments absorbed £262,500, being the rent paid by the Western Union Telegraph Co. for the year, equal to 3¾ per cent. on the ordinary, 6 per cent. on the preferred and 1½ per cent. on the deferred stock. The balance at credit of revenue account (£69,456) includes £3,831 interest received, and the balance of £65,625 is available for payment of dividends for the quarter to March 31, 1917.

BRITISH EVER READY CO. (LTD.).—The report for the year ended March 31 states that the amount available after writing off depreciation, paying excess profits tax for 1914-15 and 1915-16 and after providing for the excess profits tax for 1916-17 amounts to £28,655. The directors recommend final dividends at rate of 10 per cent. per annum for the half-year to March 31, 1917, on the ordinary shares, and a bonus of 5 per cent. on the ordinary shares, making 15 per cent. for the year, leaving to be carried forward £2,905.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—At an extraordinary meeting on Monday the chairman (Mr. J. Annan Bryce, M.P.) explained the proposals for transferring the control of the company to Great Britain. It was remarkable that the desire for the independence of British industry originally manifested itself strongly in the overseas dominions, especially in Australia. It was remarkable that the sense of the necessity of the self-sufficiency of the British Commonwealth should have been at first more strongly felt by the more distant of the British peoples, but it was only another illustration of the spirit shown all through by them in ungrudging sacrifices of life and money. The lead given by Australia was followed by India, and the strong sentiment produced by their example eventually induced the Home Government to take action in the same direction. The directors had for some time been desirous that the control of the company should be transferred to Great Britain. It was only after lengthy negotiations that a basis of settlement was reached, taking the form of an agreement of option exercisable on or before the 1st prox. to purchase the whole of the American company's holding in this company of preference and ordinary shares, together with their debenture stock, of which also they held a majority.

After the chairman had replied to some questions a resolution was passed authorising the directors forthwith to increase the capital to £1,395,000 by the creation of 110,000 additional preference shares of £2 each and of 500,000 deferred shares of 1s. each ; and a similar resolution was also passed at subsequent separate meetings of the holders of the preference and ordinary shares.

The Metropolitan Carriage, Wagon & Finance Co., which is providing the money for the above scheme, proposes to increase its capital to £3,000,000 by the creation and issue of 1,000,000 new ordinary shares of £1 each.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—The report for 1916 states that the accounts show a balance at credit of profit and loss of £117,597, and with the amount from 1915 (£207,347) the total is £324,944. After deducting interest on debenture stock, dividend on preference shares and depreciation the available balance is £284,207. It is proposed to pay a dividend on the ordinary shares at the rate of 10 per cent. per annum (less tax), being 10s. per share, whereof 5s. (less tax) was paid in November, a bonus of 5s per share (less tax), and a special bonus of 5s. per share (less tax), making together a total return for the year of 20 per cent., carrying forward £249,207. During 1916 the war has seriously hampered the operations of the company, and regular business has continually decreased owing to the restrictions and regulations of the Minister of Munitions, to increasing difficulties in manufacture and to the more stringent curtailment of shipping facilities. The general home trade in electrical wires and cables, together with the export trade to branches and customers overseas, had therefore practically come to an end at the close of the year. On the other hand, the special work which the company has undertaken has largely increased, so that the workshops were well employed on contracts either for warlike stores or directly concerned with their production.

ELECTRIC CONSTRUCTION CO. (LTD.)—The net profit for the year ended March 31, after providing £6,596. 19s. 8d. for debenture interest and £10,000 for depreciation, is £51,503. 14s. 9d. Adding £16,839. 1s. 1d. brought forward and deducting excess profits duty paid for year (£3,301. 10s.), a sum of £65,041. 5s. 10d. is available for distribution. The interim dividend of 7 per cent. per annum on the preference shares, paid in November, absorbed £2,197. 6s., leaving £62,843. 19s. 10d. The directors now recommend payment of a dividend at rate of 7 per cent. per annum on the preference shares for 6 months ended March (£2,197. 6s.) and a dividend at rate of 7½ per cent. per annum on the ordinary shares for year (£16,815), the transfer to general reserve fund of £12,389. 7s. 3d., leaving to be carried forward (subject to liabilities under the Finance and Munitions of War Acts for two years) £31,442. 6s. 7d. During the past year the company has been almost entirely engaged on electrical war work. Prices of materials and rates of wages have continued on the upward grade. The increased net profit is due once more to a larger turnover, which the directors have pleasure in again testifying has been accomplished through the redoubled efforts of the staff and workmen.

GENERAL ELECTRIC CO. (U.S.A.)—The accounts for the past year show that the value of orders received for electrical machinery and supplies was $167,169,058, or 70 per cent. greater than in 1915 and 50 per cent. greater than the corresponding orders for the best pre-war year (1913). The orders for special war munitions ($2,416,000) were merely supplementary to previous contracts. The amount of sales booked was $134,242,289. The net profit was $15,294,091, to which was added income from other sources ($3,866,881), making a total of $19,160,973. Interest on debenture bonds absorbed $571,444, dividends on stock $8,121,646 and amount carried to surplus was $10,467,882.

MERTHYR ELECTRIC TRACTION & LIGHTING CO. (LTD.)—The revenue for 1916 amounted to £27,179, compared with £26,235 for 1915. After deducting all expenses (including £3,456 for debenture and other interest) and providing £2,000 for renewals, the surplus was £4,501. With £907 brought forward the available balance was £5,408. A dividend at rate of 6 per cent. per annum has been declared on the ordinary shares and £507 carried forward.

MIRRLEES, BICKERTON & DAY (LTD.)—For the year ended March 31 the net profit, after providing for depreciation and directors' fees and excess profits duty, was £16,947 ; with £2,038 brought forward the total is £18,985. The directors recommend a dividend at rate of 7½ per cent. (tax free) on the ordinary shares ; to transfer £5,000 to reserve and to carry forward £1,266.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—Mr. G. Parker Ness, who presided over the meeting last week, referred to the loss suffered by the death of the company's chairman (Sir Geo. Franklin) and announced the appointment of Sir H. Babington Smith, K.C.B., as his successor. They had difficulty in obtaining the indispensable equipments for the maintenance and development of their plants in exporting machinery when obtained. In each of their branches there was an advance in results which even in pre-war time would have been considered satisfactory. The company paid the usual final dividend of 6 per cent., making with the interim dividend 10 per cent. for the year (tax free). The gross revenue from their own exchanges in Singapore, Mauritius, Rangoon, Moulmein and Madras was £64,811, against £55,336 in 1915, and the net profit £30,012 (against £26,466). In Mauritius they had to look forward to considerable expenditure in laying down trunk lines and otherwise extending their operations. In Singapore they had, unfortunately, to report that a fire broke out in December last and destroyed the exchange and the greater part of the buildings. They were fully insured and the claim had been paid. The company are utilising the opportunity to instal an improved and more extensive exchange and to reconstruct the building in a superior way. The second of their sources of income was their interest in the Bengal and the Bombay Telephone companies, in each of which their company held approximately half the issued share capital. The Bombay Co. increased its capital by converting its Rs.25

Digitized by Google

shares into Rs.50 shares, this being effected by transferring the difference from the reserve fund to its capital account. The previous year the dividend was 20 per cent. on the old capital and this year 12 per cent. on the converted capital. The Bengal Telephone Co. increased its capital by issuing at par Rs.500,000 of its unissued capital. The dividend paid was 7 per cent. on the increased capital. The third branch, namely that conducted in Hongkong and Kowloon under the name of the China & Japan Telephone & Electric Co., Ltd., and that carried on under the name of the Telephone Co. of Egypt. The China company earned a gross revenue of £5,275, and a net profit of £1,687, in excess of the 1915 figures, and it paid a bonus of £2. 3s. per share and increased its capital by £25,000. The dividend in 1915 was 10 per cent. on the then issued capital and the same in 1916 on the increased issue. In Hongkong the business had outgrown its accommodation, and there, also, it would be necessary shortly to rebuild the premises and make preparation for more numerous subscribers. In Egypt, where the most important part of our business existed, there was a considerable increase in the profits. The gross revenue had risen to £193,418 from £177,715 in 1915 and the net profits from £81,007 to £91,921. The increased working expenses had been felt more than elsewhere, because of the greater need for new equipments. In the infancy of the telephone the grantors of the necessary permission to work the system gave no indication of a desire for the future acquisition of the businesses. Later it became usual to reserve in the concessions (those of the Indian Government, for instance) the right of purchase at given dates and on certain conditions which assured to the grantee the actual value of his plant at the time of its transfer and a certain measure of goodwill. But in Egypt neither their original authorisations nor the numerous subsequent agreements with the Government under which they carried on business made any allusion to the subject of purchase. In 1913, however, the Government came to the conclusion that the working of the telephone system should be in their own hands, and proposed to purchase their Egyptian undertaking. Negotiations were opened, but no agreement was come to. The Government thereafter gave notice of its intention not to renew certain agreements when their periods came to an end, and although correspondence has since continued no understanding has yet been reached.

POTTERIES ELECTRIC TRACTION CO. (LTD.)—The capital expenditure during 1916 amounted to £2,699. The revenue for the year was £150,481. The traffic and parcel receipts, which amounted to £135,120, exceed those of 1915 by £13,993. The working expenses, although many repairs and practically all renewals have had to be postponed, increased by £12,278. After deducting all expenses chargeable to revenue, including £11,025 for debenture interest, and a provision of £10,000 for renewals, there remains £33,152, compared with £30.872. Adding £4,935 brought forward, the balance available for distribution is £38,086. The directors recommend that £10,000 be placed to reserve and that a dividend at rate of 5 per cent. per annum be paid on the preference shares (£12.250) and a dividend on the ordinary shares at rate of 3½ per cent. per annum (£8,575), leaving £7,261 to be carried forward. In order to provide against the cost of carrying out the deferred repairs and renewels when conditions again become normal, the directors have carried a larger amount to reserve than last year and have increased the amount carried forward. A fresh draft agreement providing for a postponement by the Corporation of Stoke-on-Trent of the date of purchase of the tramways in the borough has been submitted and is now before the Council.

SOUTH STAFFORDSHIRE TRAMWAYS (LESSEE) CO. (LTD.)—The revenue for 1916, including dividend received from the S. Staffordshire Tramways Co., amounted to £72,368. After payment of expenses, providing £9,000 for renewals and adding £2,699 brought forward, the surplus is £10,788. Of this £3,000 has been appropriated to reserve £3,500 to dividend on preference shares (at 7 per cent. for year), leaving £4,288 to be carried forward.

WEST LONDON & PROVINCIAL ELECTRIC SUPPLY CO. (LTD.)—Mr. Hy. Kahn, who presided over the annual meeting last week, stated that their income was derived from their investments in the Chiswick Electricity Supply Corporation, and that they had received £225 more for management expenses. The total available was £2,963, and they were paying the dividend on the 6 per cent. cumulative preference shares; the balance would be carried forward. The gross revenue of the Chiswick Corporation, which supplied Aberystwith and Chiswick with electric current, has increased by £897 to £20,523, and the number of consumers by 31 to 2,809. The net revenue account, after payment of debenture interest, trustees' fees and premium on sinking fund policy, showed a balance of £4,046 against £3,575, an increase of £471, but last year £1,431 was written off for depreciation against £933 this year. Out of the £4,046 the Corporation had declared a dividend of 5 per cent. and carried to depreciation reserve account £907 against £435. The only items calling for notice were the increase of coal and fuel (£744) and the increase of management expenses (£330), the latter chiefly owing to the increased management fees paid to the West London Co. There had been a further considerable rise in the price of coal and oil fuel, and the lighting regulations had not been relaxed. Besides this the Summer Time Act had caused a further diminution in the demand for current for lighting. To make up for the loss the Corporation had been using every effort to obtain consumers of current for power, and they had met with considerable success, although naturally the price obtained for power units was very much smaller than that for lighting. To meet part of the increased cost of coal and oil fuel the Corporation had further raised their price for current in Chiswick by 10 per cent. during the year under review and in the case of Aberystwith to the full charge allowed by statute. The new Diesel engine at Chiswick was working very satisfactorily, and in spite of the high cost of oil fuel showed a considerable saving compared with the ordinary steam driven sets.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

BRITISH MAGNETOS (LTD.) (147,495)—Private Company. Reg. May 18, capital £100 in £1 shares, to carry on the business of designers, manufacturers, exporters and importers of and dealers in magnetos, motors, carburettors, batteries and ignition and other electrical appliances, &c. Reg. office: 8, Breams-buildings, Chancery-lane, W.C.

C. S. B. ELECTRIC BLEACHING CO. (LTD.) (147,947)—Private Company. Reg. May 8, capital £6,000 in £1 shares, to take over from W. R. Cooke and A. E. Coleman certain patents relating to improvements in electrolytic apparatus for producing liquor for bleaching and other purposes, &c. First directors are: H. Spray and W. R. Cooke (both permanent). Reg. office: Croydon-road Mills, Croydon-road, Radford, Nottingham.

IRISH ARC WELDING CO. (LTD.) (147,435.)—Private company. Reg. May 10, capital £20,000 in £1 shares, to take over a process of electrical welding under licence from the British Arc Welding Co. (Mersey) Ltd., and to carry on the business of ship repairers, shipwrights, &c., in Ireland. Reg. office: 44, Chapel-street, Liverpool.

RAPID DISTILLATION & POWER CO. (LTD.) (147,423.)—Private company. Reg. May 9, capital £1,000,000 in £1 shares. Objects: Engineers, electricians, machinists, chemists, importers, exporters and manufacturers of and dealers in oils, chemicals, &c.

RUSSELL BROS. (WALSALL) (LTD.) (147,444.)—Private company. Reg. May 11, capital £20,000 in £1 shares, to take over the business of tube maker carried on as Russell Bros., at Walsall. Governing director J. B. Russell.

SILENT GUIDES (LTD.) (147,403.)—Private company. Reg. May 7. Capital £10,000 in £1 shares, to carry on the business of electrical and mechanical engineers and contractors, manufacturers of and dealers in electrical and other apparatus. Reg. office: 119, London-wall, E.C.

SOCIETE ANONYME DES ATELIERS DE CONSTRUCTIONS MECANIQUES. ESCHER. WYSS & CIE. (also known as **AKTIENGES. DER MASCHINENFABRIKEN ESCHER, WYSS & CIE.**) (1,570F)—Particulars filed May 15 1917. Reg. in Switzerland in 1912. Original capital 6,500,000 fr., in shares of 500 fr. each. British address: 109, Victoria-street, S.W. F. M. Jeboult (solicitor, 9, Walbrook, E.C.4) is authorised to accept service. Directors: Dr. H. Zoelly, J. Muller-Staub, D. Gauchat, T. Kach, H. von Schultess-Rechberg-Bodner, M. Zullig, Dr. F. Wegmann, K. Schafer, O. R. Ustern-Pestalozzi and Morel Vischer (all of Swiss nationality), and C. von der Herberg and C. Zander (both of German nationality).

THERMOPHONE CO. (LTD.) (147,405.)—Private company. Reg May 7, capital £1,000 in £1 shares, to manufacture and deal in electrical, telephonic, telegraphic and other apparatus, to erect factories, laboratories and experimental stations, &c.

MORTGAGES AND CHARGES.

BRILLIANT ARC LAMP & ENGINEERING CO. (LTD.)—Assignment of proceeds of munitions contracts, dated April 26, 1917, to secure all moneys due or to become due from company to London & South Western Bank.

T. BROOKER & CO. (LTD.)—£1,100 debentures created May 9, 1917, whole amount being now issued. Property charged: Company's undertaking and property, present and future.

ELECTRICAL CONTRACTS & MAINTENANCE CO. (LTD.)—Memorandum of satisfaction in full (*a*) on Feb. 24, 1916, of re-issue in 1913 of debenture dated 1910, securing £100, (*b*) on Dec. 30, 1916, of re-issues in 1913 of debentures dated 1910-11, securing £100, and (*c*) on Dec. 30, 1916, of debentures dated 1909 and 1911, securing £300 and £100, have been filed.

LEON CORNELIS (LTD.)—Debenture for £1,000, dated May 8, 1917, charged on Company's undertaking and property, present and future. Holder: A. R. Robert, 265, Strand, W.C.

CITY NOTES.

MEMORANDA.—(May 22).—Consols, 55 5/16. Consols Pay Day, June 1. Stocks and Shares Ticket Day, May 29. Pay Day, May 30. Price of Silver, 38d.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—The directors propose to make up the ordinary share dividend for the past year to 10 per cent. A 100 per cent. scrip bonus was recently declared.

LEWES & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The total revenue for the year ended Dec. 31 last was £3,338 and expenses were £2,078, leaving £1,259. After providing £440 for debenture interest and adding interest and amount brought forward, the available balance was £1,195. The directors recommend to place to renewals fund £600 and to carry forward £595.

WESTERN TELEGRAPH CO. (LTD.)—The directors have to-day declared the third quarterly interim dividend of 3s. per share (tax free) for the year ending June 30, 1917, being at rate of 6 per cent. per annum. The transfer books will be closed from June 15 to 22, inclusive, and the dividend will be payable on June 23.

Digitized by Google

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—Capt. F. W. Purse, Borough Electrical Engineer, Carlisle, is presented to His Majesty the King; the first time, I believe, that a municipal electrical engineer has thus been honoured.

* * * *

BON MOT OF THE WEEK.—"A Mere Ratepayer" in the "Glasgow Herald": "I merely wish to point out that if, besides the humdrum duties that belong exclusively to the administration of the tramway service it is desirable and appropriate that this department should also act as Army recruiting officers, weekly lottery promoters, food missionaries, and general publicity agents, then the Tramways Department ought to be officially reconstituted and renamed accordingly."

* * * *

The food question at the moment is the great obsession. Even the writers of electrical signs cannot put it away from them. I saw a large painted sign for a well-known brand of lamps in the show room of the manufacturer this week, where it was awaiting approval. Probably the man who made the sign had just finished painting "plum duff," for he wrote "for direct and alternating *currant*."

* * * *

The following is an extract from a letter on "Draughtsmen and Foremen" which "Engineering" reproduces over the nom-de-plume "Staff." Is it the writing on the wall, or the spring thunder?

Since the beginning of the war many selfish employers have, after repeated requests, even now withheld the demand for any increase in the salaries of their technical staffs or even offered to pay them for their largely increased overtime hours, curtailment of holidays and services, which they have been willing to give, and have given without any but the thought of doing their best in the present critical position. Legislation and the trade unions have looked after the interests of the men in the shops; but the staff, not so much out of snobbishness, as often is asserted, but from professional instinct and loyalty towards their employers, have held back from using aggressive trade union methods to enforce their well-merited demands.

* * * *

I am reminded by Mr. Orchard, the artist of the little sketch of a very large man eating a large dinner and reproduced in the Round Table last week, that the electrical term which it represented was not an "'am eater," but "a magnetic blow out." I gladly make this correction, and am sorry for the mistake. Of course, a "magnetic blow out" must be as much a bête noire to Lord Devonport as an ammeter, but I hope he will not prohibit the use of either or both these necessities by the electrical industry, even if the food situation becomes desperate.

* * * *

I hear that in the United States the public are so well educated up to the use of portable electric utensils, known as "socket-hole" apparatus, that in sheer desperation hotel proprietors either lock in the lampholders or put meters on each bedroom circuit. You see my lady brings her own little lace iron and hot plate, curling tongs, toaster and "tea-ball" teapot, and it comes hard on the hotel to have to provide free juice for these. If this is true, and I think it may be believed, it speaks well for the "other uses" of electricity "over there." When will such things be possible in war-stricken Europe?

I can conceive of nothing more disconcerting to our great rival industry than Sir J. J. Thomson's lectures before the Royal Institution on "The Electrical Properties of Gases." I doubt if even the British Commercial Gas Association would have thought such a phenomenon possible.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, May 22, 1880.]

TELEPHONE CENTRAL OFFICE SWITCHBOARD.—A patent has been taken out in America by Mr. T. C. Ellsworth for an improved switchboard. The new board is provided with a number of longitudinal bars by which the wires of the different subscribers are connected. In use these bars are turned to indicate they are occupied, allowing the attendant to see at a glance which circuits are in use.

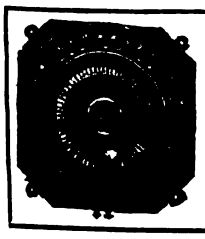
THE ELECTRIC LIGHT ON BOARD SHIP.—The use of the electric light on shipboard, both as a means of interior illumination and for the prevention of accidents at night and during foggy weather, is, says the "Operator," steadily on the increase. The Sound steamers "Massachusetts" and "Rhode Island," of the Providence Line, have recently been fitted up with Brush lights, by which the halls, cabins and dining saloons are lighted by electricity. The contract includes an electric headlight, which it is expected will prove extremely valuable in foggy and stormy weather. An exhibition of the use of the new light was given last week on board the steamer "Massachusetts." Six lights were used, each light being nominally of 2,000 c.p., and although the saloons were nearly as brilliant as in the daytime, the light was soft and pleasant to the eye. The comparative cost of this light is about equal to that of gas at 30 cents per 1,000 ft.

Manchester Steam Users' Association.—The 62nd annual report of the Committee of Management states that the results of the past year's working have been quite satisfactory and that the number of boilers under inspection and the revenue were the highest on record.

In comparison with the previous year, there was an increase of 430 in the number of boilers enrolled, as well as a substantial increase in the income. The net surplus, after making allowance for various items of exceptional expenditure, was £758. During the year the Association superintended the construction and witnessed the hydraulic test of a large number of new boilers, economisers, &c., at the works of the makers, a considerable part of these being on behalf of H.M. Government. The periodical inspection department also experienced an exceedingly busy year, resulting in a very heavy demand being made upon the staff. Attention has been paid not only to the ordinary "thorough" examinations required of members' boilers, but, owing to the war conditions a large number of second-hand boilers and steam or air vessels were also examined. In justification of the need for inspection it is mentioned that during the year out of 200 second-hand boilers examined the inspectors discovered defects in 26 of them, which led to their being rejected.

The Committee desire to point out that the conditions which have prevailed for some time owing to the exigencies of the war, have led to a number of boiler accidents, due in most part to reliable firemen having been replaced by careless ones, of whom one, at least, continued to fire his boiler for a few hours although it contained neither water nor steam. Further, the long working hours involved at various establishments and the necessity thus created for the more continuous use of the boilers than in normal times, without the opportunity of internal cleaning, has also been responsible for many of the boiler troubles. It is the Association's invariable practice with all boilers under periodical inspection to compare their present with their past condition, and undesirable changes in treatment or condition are thus detected and reported upon to the owners.

Some years ago the Association established a chemical laboratory where boiler feed waters are analysed by a practical chemist and advice given as to necessary treatment. Analyses are also made of fuels. Outside its ranks the Association has noted throughout the United Kingdom during the year the occurrence of 54 explosions, killing 24 persons and injuring 55 others. Of these, 20, killing 13 persons and injuring 18 others, might be termed "boiler explosions proper," while the remaining 34, killing 11 persons and injuring 37 others, may be termed "miscellaneous" explosions, *i.e.*, those arising from steam pipes, stop valves, kiers, stills, drying cylinders, hot water and kitchen boilers, &c. During the year 10,680 "internal," "flue" and "entire" examinations of boilers were made, this being the highest number yet reached in any one year.



IGRANIC FIELD REGULATORS

Over 300 Standard Ratings

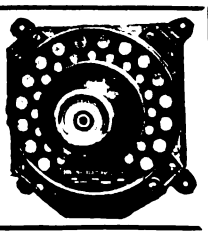
Amply rated resistance enclosed in insulating base. Convertible for front or back of board mounting. Large stocks for quick despatch.

No. 350-1.—Open plate type Field Regulator.

IGRANIC ELECTRIC Co LTD

147, QUEEN VICTORIA STREET, LONDON.

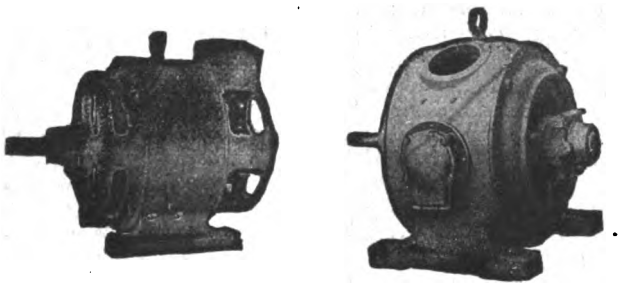
No. 350-2.—Protected plate type Field Regulator.



Digitized by Google

SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current. For Three-phase Current.

for

ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
Head Office: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: Western 6349. Telegrams: "Siembralos, Kens, London."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: City 5350. Telegrams: "Siemotor, Cent., London."

HOME BRANCH ADDRESSES:

Birmingham—Central Ho., New St.
Bristol—30, Bridge Street.
Cardiff—89, St. Mary Street.
Glasgow—66, Waterloo Street.
Manchester—196, Deansgate.
Newcastle—64-68, Collingwood Buildings.
Sheffield—22, High St.
Southampton—46, High Street.

Branches in Principal Towns Abroad.

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite—Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1912 to 1917.

ATTWATER & SONS,

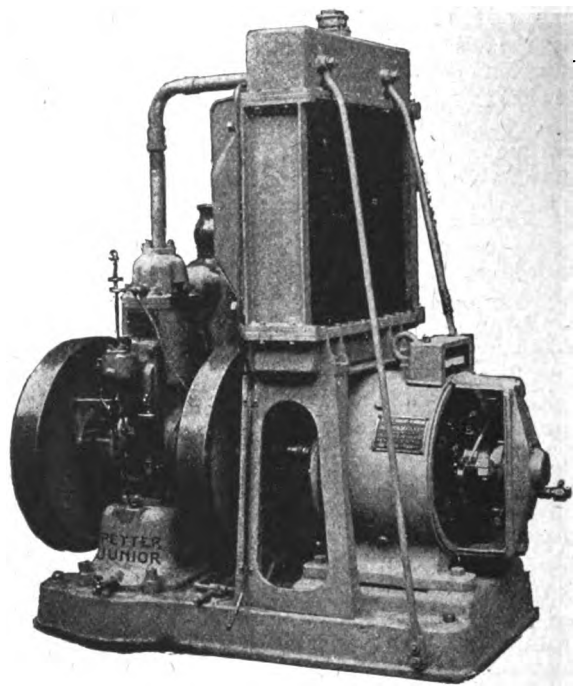
Telegrams: Attwaters, Preston. Telephone No. 1046 (2 lines).

Hopwood St. Mills, PRESTON.

Established 1868. Codes: 5th Edition A B C & Western Union.

OIL DRIVEN ELECTRIC GENERATOR.

Messrs. Petters, Ltd., of Yeovil, who are specialists in the manufacture of independent electric plants for country houses, hotels, mansions, small factories, &c., have recently placed on the market a self-contained, direct coupled, paraffin driven electric generating set. The dynamo is made in two sizes—2 kw. and 5 kw., and there are three engines in the series, having outputs of 2 B.H.P., 5 B.H.P. and 8 B.H.P., which are known as the "Petter Junior" series of engines. The illustration shows one of these sets. By the regulations



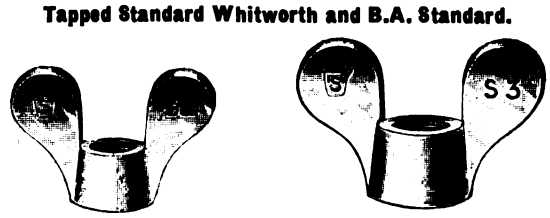
agreed upon at the International Conference on Safety of Life at Sea (held in 1914), an independent source of electrical energy capable of being put into operation rapidly, and placed high up in the ship, is demanded for both the wireless apparatus and lighting in all ocean-going passenger vessels. These self-contained generating sets are admirably gifted for this class of work and there should be a big demand for these plants in future not only for ships but for country house lighting, farm work, &c. Under the Board of Trade regulations it is necessary to have emergency generating sets on board ship, high up above the water-line. For ordinary lighting the generating sets are generally placed in the engine-room, and on many recent occasions this has proved disastrous, owing to the ex-

SEARCHLIGHTS

The Hospitaller Electric Co. CROYDON

E. SHOWELL & SONS, LTD.,
STIROHLEY, BIRMINGHAM.

SOLID FORGED BRASS WING NUTS.
Tapped Standard Whitworth and B.A. Standard.



Made from No. 1 tapped ¼" to No. 9 tapped ½".

Sole Agent for the Electrical Trade:—
LIONEL ROBINSON, 3, STAPLE INN, LONDON, W.C.
Telephone: *Holborn* 6323.

Digitized by Google

The Senior Service

NAVAL MEN are proud that theirs is the Senior Service; and we are proud that Simplex Service is the Senior Service in the Conduit and Fittings World.

Simplex Service has an honourable tradition, the outcome of early engineering initiative and constant vigilance. War conditions have not found us wanting, but have confirmed our prestige.

Every War Department: Admiralty, War Office, and Ministry of Munitions purchase Simplex Conduits, Fittings and Accessories when the best is required.

Simplex Conduits, Limited,

Works: Garrison Lane, Birmingham.

LONDON—113-7, Charing Cross Road.
NEWCASTLE—61-5, High Bridge.
LEEDS—6, White Horse Street.
MANCHESTER—16, Corporation Street.
SWANSEA—14, Heathfield Street.
BRISTOL—10-11, Denmark Street.
GLASGOW—72A, Waterloo Street.
CARDIFF—4, Westgate Street.
LIVERPOOL—96, Whitechapel.
SHEFFIELD—281-3, Attercliffe Common.

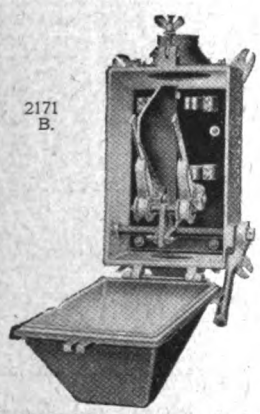
IRONCLAD SWITCH & FUSE GEAR

"BRITISH-MADE" M.E.M. Switchgear is guaranteed to excel in EFFICIENCY in the most "testing" power and lighting situations.

Advanced Design-Simplicity—on approved-practical scientific lines—constitutes the main assurance for this—and all our varied products are priced to please.

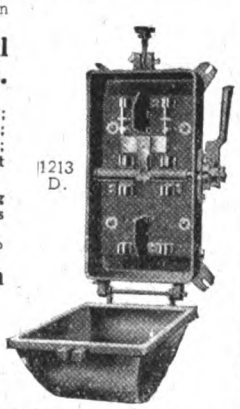
We can give PROMPT DELIVERY from stock of all standard lines for War-work Factory requirements.

Just study below two of these:—



2171 B. Improved "GLASGOW" Ironclad Switch. Made to H.O. Regulations; Standardised and Interchangeable Units; breaks to Glasgow Corp. Rules; High insulation; Parts easily renewable; Contacts undamageable by quick closing; Detachable glands tapped for standard conduit, &c.; D. or T.P., with or without Fuse, 30 to 300 amps., 600 volts.

1213 D. "MEMCO" Ironclad Changeover Switch. Base of special insulating material with high insulation test; Standard drilling; other features above noted; D. or T.P., 60 to 200 amps., 600 volts.



Why not write us regarding your current needs—and ask for descriptive Catalogue?

Midland Elec. Mfg. Co., Ltd., Head Office and Works: **Barford St., Birmingham**

Phone Mid. 671 & 672. 'Grams: "Kilowatt, B'ham."

M·E·M

The QUALITY products

BRANCHES: London: 2, Gresham Bdgs., Basinghall St., E.C. 'Phone: London Wall 723. Manchester: 4, Carr St., Blackfriars. 'Phone City 1391.

BRANCHES: Glasgow: 40, West Campbell Street. 'Phone: Central 4187 and 4188. Newcastle-on-Tyne: Millburn House. 'Phone: Centra 2524.

Digitized by Google

LOAD AND EXPERIMENTAL
RESISTANCES
MADE TO ANY SPECIFICATION.
Particulars of Standard Types will be found in our List, to be had on application.
RAPID DELIVERIES GUARANTEED.
ISENTHAL & CO., Ltd,
(DEPARTMENT 4)
Denzil Works, Willesden, London, N.W. 10.
Contractors to the Admiralty, War Office, India Office Colonial Office, Postmaster General, etc.

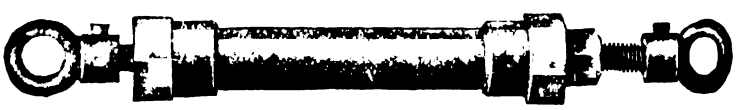
J. P. DEVINE CO., BUFFALO.
MANUFACTURERS OF
Vacuum Drying and Impregnating Plant.
(PASSBURG SYSTEM.)
The Devine Co. are well known in the United States and Canada as the leading manufacturers and experts in Vacuum Drying and Impregnating Plant and have over 1,500 such plants in successful operation.
AIR PUMPS, COMPRESSORS, VULCANISERS, CONDENSING PLANT.
Solvent Recovery and Derisinating Plant a Speciality.
Sole Representative:
JAMES LIVINGSTON, LTD.,
IMPERIAL HOUSE, KINGSWAY, W.C.
Telegrams and Cables: "CINERARY, LONDON." Telephone: GERRARD 2300.

tinguishing of lights when the engine-room was flooded. All new ocean-going passenger vessels should have a suitable auxiliary lighting set, and the type of plant made by Messrs. Petters answers the purpose admirably. It is also obvious that there should be an alternative source of electricity supply for wireless apparatus, for if a vessel is in danger of foundering it is of supreme importance to supply current to the wireless telegraph installation up to the last possible moment. The engine, dynamo and fan-cooled radiator are all mounted on a common bedplate, and the engine is a vertical, two-cycle paraffin motor of the makers' usual design. It is started from cold on petrol, and after running on this fuel for two or three minutes is turned on to paraffin. The sets are made in two sizes. In the smaller the engine develops 5 B.H.P. at 600 revs. per min. and the electrical output is 2 kw., the total weight being 14 cwt. The larger machine develops 8 B.H.P. and runs at 550 revs. per min., generating 5 kw., the complete weight being 22 cwt. In the 2 kw. sets magneto ignition is adopted, while for the larger a battery and induction coil are used for electric starting and then the ignition becomes automatic by means of the hot surface of the combustion chamber. The cooling water is circulated through the cylinder jacket by means of a pump driven by a belt from the main shaft. A second belt on the same shaft drives the fan behind the radiator. The firm report that they are experiencing a great demand for sets, and that orders are in hand for nearly 300 sets. These are being despatched at the rate of 10 per week.

COLLIERY HAULAGE ROAD SIGNALLING.

In a pamphlet recently issued by the General Electric Co., 67, Queen Victoria-street, London, E.C., particulars are given of their patent system of haulage road signalling in coal mines, which is claimed to be a material advance upon all previously designed systems for underground use for colliery haulage, being entirely operated by one line wire, which serves as a pull wire and at the same time carries the current of the line circuit. This has a maximum of 0·02 ampere at 6 volts, the former varying in accordance with the number of relays in circuit.

Where an efficient "earth" can be obtained, it is only necessary to use a single line wire, either of the special insulated type supplied by



the company for the system, or bare galvanised iron, but the former is specially recommended for making a thoroughly efficient system. Where it is difficult to obtain an efficient "earth" it is advisable to use a bare wire run anywhere along the road for the return circuit. The main feature is the closed circuit principle adopted, commencing from "earth" to a battery of four Carsak Leclanché or ordinary type (wet) Leclanché cells, and continuing through the patent interrupters inserted at various points in the line, and in series with all the relays in the system, finishing

BELLING
FIRES
GRILLERS
BOILERS
OVENS
ALSO ALL KINDS OF SPECIAL ELECTRICAL APPARATUS FOR MUNITION WORKS & MANUFACTURING PURPOSES
BELLING & CO.,
ELECTRIC HEATING & COOKING SPECIALISTS,
Derby Road Works, Montague Road,
UPPER EDMONTON, LONDON, N.

For Effective Impregnation
use "LACWATT"
Black or Golden Brown.
JENSON & NICHOLSON, Ltd.,
Insulating Varnish Department.,
Goswell Works, Stratford, E.15.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

Some there are who tell of the Switch of the Prime—two nails on a board and any old piece of wire, and how there came along a pioneer of the Safety First campaign, making for progress according to his lights, who clapped a sardine tin over it, and shortly afterwards, passed, prematurely, to Valhalla.

So, step by step, the Switch Cut-out was evolved, until to-day we have that finished engineering product with its high electrical, mechanical, and protective qualities,

THE PRESCOT

MISTAKE-PROOF SWITCH CUTOUT.

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED SECOND HAND

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.

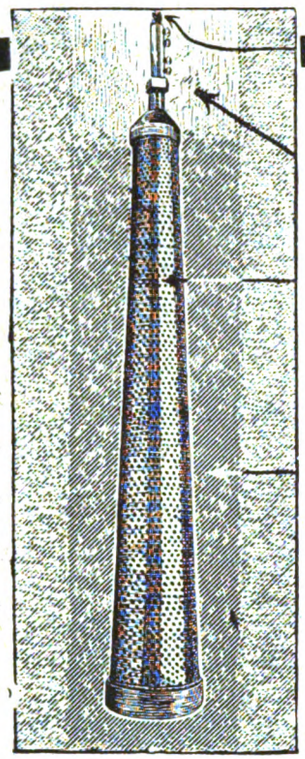
Phone: Victoria 4026. Grams: Vicmaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh. *See our Illustrated Advt. May 11th.*

Digitized by Google



ALTHOUGH the Earth Plate is in many ways satisfactory—the absolute reliability of the

PARAGON EARTH CONE

under all conditions makes it by far the safest and most dependable. It is made of pure copper—perforated—and filled with charcoal. This attracts the moisture and prevents the earth around from drying up or shrinking away from the cone. Thus the contact can never be destroyed. Cost of installation reduced to a minimum. Thoroughly substantial. Once installed no further trouble.

Write for Illustrated Pamphlet & Quotation.

The Paragon Earth Cone

SCHOLEY & CO., LTD.,

56, Victoria Street, London, S.W.1

with an efficient "earth" point or returning through the return wire if such be found necessary, the latter very rarely occuring except in very dry pits. The apparatus consists of specially designed mining type bells combined with relay and interrupter push (the latter for use at the bell or indicator stations), patent interrupters fixed at intervals in the line, cable (pull wire), cells and insulators. The illustration shows the patent interrupter used for the system, for which special advantages are claimed, including safety, economy, reliability, simplicity, no leakage, low voltage, increased output, and faults indicated.

CANADIAN INDUSTRIAL RESEARCH WORK.

The following are extracts from a statement issued by the Honorary Advisory Council on Industrial and Scientific Research which was appointed by the Dominion Government in December.

Some forty projects, each bearing on vital phases of scientific conservation and development of Canada's natural resources, have been submitted to the Council. Each one is being carefully considered, with a view to applying the scientific and well-considered principles of technical research to the solution of the industrial problems of Canada, both present and future. Among the larger projects in view are the creation of technical laboratories at the great industrial centres to give free help to manufacturers in solving their problems, the utilisation and development of fuel resources, particularly those of the Prairie Provinces; and the preservation of the diminishing timber resources of Eastern Canada.

In order to provide a body of men who have been thoroughly trained in science and its application to industry, the Council will recommend the establishment of 20 or more studentships and fellowships in Canadian universities and technical schools. Arrangements will also be made by which, after graduating, men will be placed in one or other of the great manufacturing establishments. The Council are recommending the establishment at great industrial centres such as Toronto, Montreal and Winnipeg, in co-operation with the Provincial Governments or other bodies, of industrial research bureaux, where technical staffs with suitable and properly equipped laboratories, will assist manufacturers in solving problems which present themselves in factories and works. The Council have decided to examine carefully a number of specific projects which have been submitted to them, and have decided to recommend that work should be at once started upon a scheme for the provision of an adequate supply of good fuel for the western plains, more especially in the Provinces of Saskatchewan and Manitoba. There are in the former Province large supplies of lignite. The Council believe that by a special treatment there may be produced from this lignite two grades of briquetted fuel, one similar to anthracite or hard coal, the other resembling soft coal, and that at the same time very valuable by-products may be secured.

Electrical Engineers and Manufacturers

The House for Electric Heating.

Special Offer of "Quead" and "Ensign" Fires from Stock. Be Patriotic and Save Coal.

Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.

Telephone: Gerrard 7601 (2 lines)

Petrol Engine Sets.

F. HUSBAND Ltd
CRAVEN HOUSE KINGSWAY LONDON

Manufactured in sizes from 2 kw. to 20 kw.

Quotation for larger sizes on application.

FOR

High and Low Tension

SWITCHGEAR

THE

NEW SWITCHGEAR CONSTRUCTION CO., Ltd.

SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

It isn't the slightest use

installing high speed machinery and tools if they are not driven to their full capacity. Whether you use clutches on your line shafts or on individual machines, unless they engage perfectly, there must be a serious loss in transmission, and consequently the output is lowered. The only efficient lining is "**Ferodo**" fabric, which supersedes all other materials owing to its high co-efficient of friction and durability. It is not affected by oil, water or acid; it engages smoothly and never "seizes." If you have any clutch troubles, write us—our twenty years' experience is at your service.

FERODO

CLUTCH AND BRAKE LININGS.

Contractors to the War Office and Admiralty, London General Omnibus Co. and Underground Electric Railways of London and Paris. List "X" from

The Herbert Frood Company, Ltd.

Works: CHAPEL-EN-LE-FRITH.

'Phone: 19 and 20 Chapel. Wires: "Friction, Chapel."

We hold stocks at London, Birmingham, Belfast, Bristol, Cardiff, Edinburgh, Glasgow, Liverpool, Manchester and Newcastle.

C1.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,037. [Vol. No. 9 LXXIX.] FRIDAY, JUNE 1, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES	337
Arrangements for the Week	339
The Theory of Armature Windings. By S. P. Smith, D.Sc.—*Concluded*	340
The Resistance of Earth Connections. By L. Birks and E. Webb. Illustrated	343
A Self-Recording Electrometer for Atmospheric Electricity. By W. A. Douglas Rudge, M.A. Illustrated	345
The Standardisation of Resistors. Illustrated	346
The Protection of Telephone Circuits Used in Electric Power Distribution. By E. K. Shelton. Illustrated	349
THE WASTING ASSET	350
REVIEWS	353
Electricity Supply in Russia. By P. Gurewitsch	354
CORRESPONDENCE	356
Charging Apparatus for Electric Omnibuses. Illustrated	357
Women in Industry	358
Factory Inspector's Report	359
LEGAL INTELLIGENCE	360
Volunteer Notices	360
Patent Record	360
COMMERCIAL AND INDUSTRIAL SECTION	363
Electricity Supply	364
Tenders Invited and Accepted	366
Financial Matters	367

NOTES.

Standardisation of Resistors.

ELSEWHERE is given an account of the recent practice of a number of firms in the construction of resistors for heavy industrial purposes. From this account it will be seen that an attempt is being made in the United States and at home to standardise such resistors on sound engineering lines. Boxes all of the same size, each box containing grids of one size, and the grids connected in one of three ways without intermediate tappings, is better engineering from every point of view than that represented by boxes of all sizes containing grids of all sizes connected in an endless variety of ways with a multiplicity of intermediate tappings. At one time we believe it was thought to be clever to make complicated connections. Nowadays every effort is made to simplify the connections, and it is worth the user's while to pay for such simplification at the outset, since in the long run he will save money by so doing. At home it is to be hoped that the more robust stamped-grid and wire-wound unit will be used for low-current ratings in preference to the cast-grid, as the latter has to be heavy in order to secure the necessary mechanical strength. A further point to which attention should be given is the question of safe temperature rise. The function of a resistor is to dissipate heat, and the higher the temperature difference the greater is the specific dissipation. The idea of a low-temperature rise resistor is in nine cases out of ten fundamentally wrong, and we hope that manufacturers will take up a very firm stand when consulting engineers and others call for a maximum temperature rise of 200°F. for a resistor which the manufacturer knows could easily do its work with a 300°C. rise and at a fraction of the cost.

Women in Industry.

THE discussion on this subject before the last meeting of the Circle of Scientific and Technical Journalists was opportune. The meeting was intended as a general survey of the employment of women, both in munition work and in other fields. Mr. G. H. BAILLIE gave an account of his experience in the organisation of women's work at the Ministry of Munitions, and Miss ANDERSON (H.M. Chief Lady Inspector of Factories) and others dealt with non-munition work of various kinds. The chairman (Mr. L. GASTER), in opening the meeting, explained that the object was to ascertain the real facts regarding such labour, to ascertain the kinds of work for which women were best fitted, and to consider their training for special vocations with a view to the future. It was pointed out, what some people are in danger of forgetting, that the employment of women in industry is no new thing. What has chiefly happened since the war is that large masses of women labour have been drafted from one field into another, though it is, of course, also true that many women have turned to munitions or agricultural work who were never industrially employed before. The problem of the redistribution of such labour after the war will be a difficult one. Some of the women will return to their old occupations. Many, too, will no longer desire to be kept at work in factories (for it is idle to assume that the work which has been freely undertaken in the present emergency will continue to attract many women who have homes and domestic duties). We agree, however, that it would be well to study the special fields of occupation for women after the war. If, as we hope, the released energy of the country is applied to the building up of industries which have been allowed to wither in the past, there should surely be some opportunities for women here. With our minds free from the pre-occupation of war, such processes as the making of electric lamps and incandescent mantles, and the working of glass and optical instruments might be considerably extended, and here the deftness of hand and manipulative skill of women would find an excellent opportunity. It seems probable, too, that in many other sections of fine electrical and scientific instrument manufacture women would be of service.

The Educated Woman.

ONE particularly important point touched upon in the discussion was the future of the more highly-educated woman. We sincerely hope that the idea will be dispelled that women are only to be employed on purely mechanical processes and not in the higher fields of work. The dearth of young men who in normal times would be undergoing training for some profession, but who are now entering the war, will be felt for many years, and the gifted and highly-educated woman, who besides has often more freedom to take up a serious occupation, may be able to step in and fill some of the gaps. Hitherto, women have not, in any number, sought scientific work, but there is no reason to suppose that they could not "make good." For example, there will, we hope, be a great demand for chemists, and in much of this work the patience and manipulative skill that come naturally to many women would be an advantage. In the medical profession, too, they will doubtless find greater future opportunities. And in commerce, especially salesmanship, where tact, personality and powers of persuasion go for a great deal, the educated woman may find another congenial field.

Digitized by Google

The Patriotism of the Engineers.

A CONTEMPORARY makes out a good case in favour of no preference being shown to the highly-skilled engineer as regards military or national service. With this view most of our readers will agree. But we protest against the very poor use that has been made of the skilled engineering and other talent during the past three years. If the war were going to be the end it would matter little whether gun-turret designers fell fighting in line regiments in Gallipoli or not. Were there to be no to-morrow we could afford to turn our instrument makers into motor mechanics and our trained physicists into searchlight operators. On the last day it will matter little what useful work man does, but the thought that to-morrow the country will stand urgently in need of men now being improperly used is a disquieting one. Under no conditions and at no time would we single out a class for preferential treatment, but we would leave no stone unturned in endeavouring to fill the position of bootmaker in the Army by a trained bootmaker. A striking and an isolated example of the success of this method is the wonderful work recently carried out by the road engineers on the Western front. The road engineers were mobilised in earnest when the country had been at war more than two years. With this example before us is it too much to hope that it will be followed in other and equally important matters connected with war? An inspection of the Rolls of Honour of the engineering institutions negatives the idea that engineers as a class are unpatriotic, but it would be comforting to know that the men were helping under conditions of maximum efficiency.

City and Guilds Examinations.

FROM recent correspondence in these columns on the questions set at the last examination in electrical engineering held by the City and Guilds of London Institute it is evident that insufficient care was taken by the examiners. It would be regrettable if what we deliberately call dilettanteism so discouraged teachers and students that the examinations had to be abandoned owing to there being no candidates. Wretched as are the methods of the Board of Education, of the latter body it may be said that at one time they held examinations which appealed strongly to the rank and file of engineering students. In order to save expense, these examinations were, to all intents and purposes, abandoned and local examinations substituted. The latter were farcical, and the only examinations open to the bulk of the engineering students in the country were, and are, those held under the auspices of the City and Guilds of London Institute. These facts are well known to all those whose teaching experience extends back 10 or 15 years, and we say it would be regrettable if students got the idea that it was utterly hopeless trying to prepare for these examinations. For several years we have studied the questions set, and, apart from their narrow range, the outstanding feature is the difficulty of the questions in all grades. The examination either is, or should be, of an elementary character, so as to pave the way to much higher ones held by the Universities. At present, large numbers of students take the City and Guilds examinations in electrical engineering, and few subjects year after year show a higher percentage of failures. The fault is not due entirely to the teacher or to the candidate, and those having the interests of engineering students at heart would do well to lay their very strong case before the Institute. We shall be glad to publish further correspondence on the subject.

Growth of Electricity Supply.—ERRATUM.—We regret to find that there is an error in our note on this subject in our last issue. In dealing with the power companies the figures we gave referred to total connections, not to maximum load. In the other undertakings the figures for maximum load stand as given.

New Japanese Government Laboratory.—According to "Engineering," the Emperor of Japan has headed the list of subscribers to the new Government laboratory in Japan, and has given 1,000,000 yen.

The rich have consequently subscribed in regal fashion, and the money collected has reached over 6,000,000 yen. Probably it will not be long before it reaches £1,000,000. This shows that the Japanese do not intend in future to be behindhand in scientific research. Branches of all scientific work will be taken up, and the best men will be engaged. The plan is that anyone can get work done by the staff at a very reasonable fee. The founders of the Laboratory of Scientific Investigation met in conference at the Tokyo Chamber of Commerce in April, and elected Baron Mitsui, Baron Iwasaki, Mr. Hara, Mr. Yasuda, Baron Shibusawa, and Baron Furukawa advisers. The offices of the institute were installed in the Chamber of Commerce Building.

Standard Specification for Street Lighting.—The annual report of the Institution of Gas Engineers reprints *in extenso* the draft standard specification for street lighting prepared by the Lamp Committee, comprising representatives of the Institutions of Gas and Electrical Engineers, the Illuminating Engineering Society and the Institution of Municipal and County Engineers. It has been decided to publish the specification as it now stands, in the hope that it will be useful after the war. A minority report is, however, added, expressing the view of the Council of the Institution of Gas Engineers that street lamps should be rated in terms of the mean candle-power, measured at two or three defined angles, instead of in terms of the mean horizontal illumination secured.

The Testing of Materials for Aircraft Construction.—A Paper read before the Aeronautical Institute of Great Britain on May 24th by Mr. E. A. Allcut gives a summary of the various tests imposed since the outbreak of war on materials for use in aircraft. The tests include tensile, compression, bending and torsion, a special item being the subjection of materials to impact shock (the "Izod" test). Hardness is also investigated by various tests (such as the Brinell test), but, as is well known, this quality has not yet been really satisfactorily defined. Special tests are also prescribed for the fabric, the tensile strength of a specimen of given width and length being examined by a special electrically operated machine. In conclusion, the author emphasised the supreme importance for the future of careful standardisation of materials used for aircraft construction.

Electrochemistry and the Automobile.—"Electrochemistry made the automobile possible." This was the consensus of opinion at the close of a very successful and interesting meeting of the American Electrochemical Society recently held at Detroit.

Without such products as high-speed steel, chrome-vanadium steel, aluminium, magnesium and the artificial abrasives, carborundum and alundum—all products of the electric furnace—the modern petrol car would never have been evolved. Were we to eliminate the electric furnace products and substitute steel and other materials that were used 30 years ago, the cars would be far too heavy for the engine to drive. A series of interesting electric furnace Papers were presented by Messrs. J. A. Mathews, R. F. Flinterman, J. L. Dixon, C. A. Buck and C. H. von Baur. Visits were also made to several steel plants so as to afford the members and guests an opportunity of seeing the electric furnaces in operation. At the Dodge Bros. and the Ford automobile factories the substitution of electric enamelling ovens for the old style gas and coke-fired ovens has greatly improved the quality of the product. One of the afternoon sessions of the convention was devoted to the automobile storage battery, a product which has been the subject of extended research of a number of the foremost electrochemists in America.

The following officers of the American Electrochemical Society were elected: *President*: Colin G. Fink; *Secretary*: Joseph W. Richards; *Treasurer*: P. G Salom.

High-Frequency Resistance of Multiple-Stranded Insulated Wire.—A paper on this subject was read recently before the Royal Society by Prof. G. W. O. Howe.

The author points out that the object of such wires in high-frequency circuits is two-fold, viz., to make the inductance independent of frequency and to reduce the resistance at high frequencies. It is shown in this paper that the second object is rarely achieved because of the eddy currents induced in the wires by the magnetic flux within the conductor. It is shown that the loss due to this cause is so great that the effectiv]

Digitized by Google

resistance of the stranded conductor is, in many cases, greater than that of the solid wire which could be put in its place. In the first part of the paper formulæ are deduced on the assumption that the eddy currents in the fine wires do not appreciably affect the distribution of magnetic flux within them. In the second part this assumption is not made and formulæ are deduced which take into account the screening effect of the eddy currents. It is proved, however, that the assumption is permissible in nearly all the cases considered. A number of tables are given showing the ratio of the high frequency to the continuous current resistances of straight and coiled conductors of different sizes made up of fine wires of three alternative diameters. These formulæ and tables enable one to see at once if any advantage is to be gained by using such a stranded conductor in any given case, and if so, the best number of wires and space-factor to employ. The paper shows conclusively, however, that the extended use of such conductors in radio-telegraphy for the purpose of reducing the resistance has no scientific justification.

Works Organisation and Efficiency.—In a lecture on this subject before the Royal Society of Arts on May 9th, Prof. W. Ripper, Vice-Chancellor of Sheffield University, referred to the general belief that it was impossible after the war to continue the present high wages and yet make a profit. This pessimistic view Prof. Ripper disbelieved. By improved relations between master and man, better training for apprentices, proper works organisation and elimination of waste the productive power of workshops might be enormously increased. He quoted the remark of an American, who, after walking through certain works, was asked what he thought of them. His remark was that "they required a match." An important point in cheap production was specialisation. Great changes in this direction were taking place, a notable instance being the Machine Toolmakers' Association, which had divided up work between certain firms so that each could become a specialist in a certain type of machine. The chairman (Dr. Dugald Clerk) illustrated Prof. Ripper's contentions by some statistical figures. In England if the total net production per annum was divided between the whole of the work-hands it gave £102 per head. If, therefore, every workman received £2 a week there would be no profit. But in America the corresponding figure was £147 per head per annum, so that many American manufacturers could and did pay their men an average of £2 a week, and yet made a profit.

OBITUARY.

R. W. GAUNTLETT.—We regret to have to record the death of Mr. Reginald Wilson Gauntlett, late London Office manager for Messrs. Bruce Peebles & Co. (Ltd.), of Edinburgh, which took place on Monday, the 28th ult., at his residence at St. John's Wood. Mr. Gauntlett's large circle of friends will learn of his death with regret, and will extend their sympathy to his widow and children. Our sympathy is also offered to Messrs. Bruce Peebles on the loss of a valued servant who during his lifetime deservedly earned the esteem and respect of all who came in contact with him.

WILLIAM HARPUR.—We regret to announce the death of Mr. William Harpur, city engineer of Cardiff, which occurred on May 28. He was responsible for the construction of the permanent way of the local tramways.

W. H. MUNTON.—We also regret to record the death on the 16th ult. of Mr. Walter H. Munton, who was electrical engineer of the Bristol Tramways & Carriage Co. for the past 18 years.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported :—

We referred briefly in our last issue to the death of the late Capt. John Chamberlain. The deceased was the son of the late Mr. Arthur Chamberlain and nephew of Mr. Joseph Chamberlain ; his elder and only brother, Arthur, is chairman of Kynochs. John Chamberlain was at school at Rugby, and afterwards spent some months in France, mastering the language. In matters of commerce and factory organisation he had the inestimable advantage of being trained under his father, who had little short of genius for such affairs. In process of time he took the management of three important companies, viz., Tubes Ltd., Smith's Stampings, Ltd., and Chamberlain & Hookham, Ltd. In every case he vastly improved the position of these undertakings, turning those that had been less successful into striking successes ; and in the case of the last mentioned more than doubling the profits. Mr. Geo. Hookham writes :—

"Of the personal loss I can hardly trust myself to speak at all—we were all so fond of him. Of an affectionate nature himself he everywhere attracted affection. In the office and factory he was simply worshipped. In saying this I am conscious of using a hackneyed expression, and one that is often used in exaggeration ; but it is no exaggeration here. Being engaged in such important affairs at home, and with a wife and young family, his friends, with one voice, advised him that it was no duty of his to join the army, at any rate at that time. His own conscience, however, advised him differently ; and there was no more to be said. He volunteered in the first few weeks of the war. He had once before been severely wounded, and on recovery had returned to the front. He was at last struck down and instantly killed by a stray shell at Brigade Head Quarters."

Lieut. H. D. S. Stooks (M.G.C.), 23 years of age, who died of wounds on April 25, was in the service of the Eastern Telegraph Co. from 1900 to 1915, when he returned home from Gibraltar to enlist.

Sec.-Lieut. Robert Lancaster (Norfolk Regt.), who was killed on April 28, was a partner in the firm of Whittaker & Co., technical publishers.

We are informed that Gunner G. Grainger (R.F.A.), formerly of the India Rubber Co. (Silvertown), has been killed.

PERSONAL.

Our readers will sympathise with Dr. Horace Field Parshall on the death of his wife, which occurred on May 23, after a long illness.

Eng. Rear-Admiral G. G. Goodwin, C.B., has been appointed Engineer-in-Chief of His Majesty's Fleet, with the rank of Engineer Vice-Admiral, in succession to Engineer Vice-Admiral Sir H. J. Oram, K.C.B., F.R.S.

In connection with the recent Admiralty changes, the following appointments and promotions are announced :—

Vice-Admiral Sir Eric Geddes, as controller, will be responsible for meeting the combined requirements of the Admiralty, the War Office, the Ministry of Shipping and other Government departments in respect of the design, construction, alteration and repairs of warships and other vessels of all classes.

Sir Eustace H. Tennyson D'Eyncourt, K.C.B., continues to hold the office of Director of Naval Construction in the new organisation. Mr. Thos. Bell, late managing director of Messrs. John Brown & Co.'s Clydebank establishment, has been made Deputy-Controller for Dockyards and Shipbuilding. Major-General A. S. Collard, C.B., R.E., Director of Inland Waterways and Docks in the Department of the Director-General of Movements and Railways, is Deputy-Controller for Auxiliary Shipbuilding, and will be responsible for all matters connected with the design, construction and purchase of merchant ships, transports, oilers, &c. Sir Vincent L. Raven, Chief Superintendent of Ordnance Factories, becomes Deputy-Controller for Armament Production.

Mr. W. J. Berry, Assistant Director of Naval Construction, becomes Director of Warship Production, and will be responsible for dockyards and shipbuilding, the economical and expeditious construction of warships by contract, including hull, armour, machinery, electrical apparatus, equipment and fittings. Rear-Admiral Laurence E. Power, C.B., M.V.O., is Director of Dockyards and Repairs, and will be responsible for dockyards and shipbuilding for the general management of the dockyards, including the construction, repair and alteration of warships and machinery, electrical apparatus, equipment and fittings.

Col. H. Livesey, R.E., will act as Director of Contracts during the absence of Sir Frederick W. Black, K.C.B., who is now serving as Director-General of Munitions Supply.

WAR CASUALTIES.—The following casualties have been reported :

Sec.-Lieut. V. C. Russell (Suffolk Regt.), younger son of Mr. Stuart A. Russell, works manager of the India Rubber Co.'s Silvertown works, is in hospital in this country having been wounded a second time. He has been twice mentioned in despatches.

Pte. Arthur J. Cheetham (London Regt.), manager of the India Rubber Co.'s tyre department at Silvertown, has also been wounded a second time (on May 15).

Pte. W. T. Bonser (Essex Regt.), formerly an employee of the India Rubber Co., is a prisoner of war in Germany, and Pte. H. Edgecombe (Argyll & Sutherland Highlanders) and Rflm. E. S. Smith (Rifle Brigade), also formerly employees of the same company, have been wounded.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, June 2nd.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, Piccadilly, W. Lecture on "The Electrical Properties of Gases," by Prof. Sir J. J. Thomson, O.M. (Lecture V.)

TUESDAY, June 5th.

RÖNTGEN SOCIETY.

8.15 p.m. At the Cancer Hospital (Free), Fulham-road, S.W. Discussion on "The Future of the British X-ray Industry" (adjourned from last meeting) will be continued by Capt. R. Knox.

FRIDAY, June 8th.

ROYAL INSTITUTION.

5.30 p.m. At Albemarle-street, Piccadilly, W. Lecture on "Industrial Applications of Electrons," by Prof. Sir J. J. Thomson, O.M.

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, S.W.

Digitized by Google

THE THEORY OF ARMATURE WINDINGS.*

BY S. P. SMITH, D.SC.

(*Concluded from p.* 301.)

Summary.—In this Paper an attempt is made to outline the theory of armature windings in machines with alternate north and south poles.

(II.) *Connecting Rules for Closed Winding.*—Whereas single-layer windings are solely used for obtaining an N-phase system of pressures, the double-layer winding finds its chief application on continuous-current machines, though its use as a polyphase winding is also quite general. When used as a polyphase winding in conjunction with a commutator, a closed winding is employed, and the N pressures are obtained by means of tappings. When no commutator is needed, an open winding with a narrow phase-spread is used, and though it is customary to have the same winding pitches as with a closed winding this is not necessary.

There are two common modes of connecting up the coils of double-layer windings—the lap type of connections being used when successive coils a and b lie under the same pole-pair, and the wave when they lie under adjacent pole-pairs (*see* Fig. 3). In order to obtain a closed winding, the total displacement in the field must be a multiple of 2π radians (*see* equation 2). In cases where the number of coil-sides per slot u is greater than 2, for the purpose of connecting up the coils we can imagine there are as many slots as there are coils or commutator setments—*i.e.*, we make $S=C$. Equation (2) then becomes—

$$\left.\begin{aligned} C\psi &= 2\pi a \\ \text{and}\quad \psi/\gamma &= a/p \end{aligned}\right\}, \quad \ldots\ldots\ldots \quad (6)$$

where ψ is now the phase displacement between successive coils when $u=2$ and γ the angular pitch of the commutatior segments (or joi its) or of the slots when $u=2$.

The number of joints or segments between successive coils in the winding is called the commutator pitch, and will be denoted by y_c; thus y_c must contain an exact number of commutator-bar pitches γ.

Though this formula enables us to deduce the rules for closed lap and wave windings, *i.e.*, windings in which $\Sigma e=0$, so that no circulating currents of fundamental frequency can flow, it does not follow that such windings will have similar parts. When we apply the conditions for obtaining a similar circuits per phase with the actual number of slots $S=2C/u$—for either a continuous or alternating pressure—we shall find that the number of symmetrical windings obtainable is much smaller than the number of closed windings.

(*a*) *Closing Rule for Lap Windings.*—With the lap connection the finish of one coil is joined to the start of another under the same pole-pair, so that the angle $y_c\gamma$ between successive coils on the armature is equal to the phase displacement ψ between them. Applying $y_c\gamma=\psi$ to equation (6), we get

$$\left.\begin{aligned} y_c &= \psi/\gamma = a/p \\ \text{or}\quad a &= y_c p = p,\ 2p,\ 3p,\ \&c. \end{aligned}\right\}. \quad \ldots\ldots \quad (7)$$

Thus a closed lap winding can be obtained by making a a multiple of the number of pole-pairs p.

(*b*) *Closing Rule for Wave Windings.*—With the wave connection the finish of one coil is joined to the start of another under the next pole-pair, so that the angle $y_c\gamma$ between successive coils on the armature is equal to $2\pi\pm\psi$. Applying $y_c\gamma=2\pi\pm\psi$ to equation (6), we get

$$\left.\begin{aligned} y_c &= (2\pi\pm\psi)/\gamma = (2\pi/\gamma)\pm(\psi/\gamma) \\ &= (C/p)\pm(a/p) = (C\pm a)/p \end{aligned}\right\}, \quad \ldots\ldots \quad (8)$$

where $C\gamma=2\pi p$, when we make $S=C$.

Hence in a closed wave winding, $a=py_c-C$, so that a can be greater than, equal to, or less than p.

It is easy to see that the H.C.F. of C and y_c determines the number of independent windings on the armature with either lap or wave connections.

(III.) *Conditions for Obtaining Symmetrical Lap and Wave Winding.*—The conditions for obtaining closed lap and wave windings are set forth in equations (7) and (8), whilst the conditions for obtaining a similar circuits are given in equation (3). We must now combine these to find the conditions for obtaining symmetrical lap and wave windings. To get a closed winding, the resultant of the vector diagram is merely a closed figure subtending $2\pi a$ radians at the centre, whereas in a symmetrical winding there are a similar polygons in the resultant diagram, each subtending an angle of 2π radians at the centre. It is only when the winding is symmetrical that there are a coils which are always at the same potential, and which therefore can be properly joined together by means of an equalising or slip-ring or by a commutator brush.

(*a*) *Symmetrical Lap Windings.*—In equation (7) it is seen that a can be any multiple of p in a closed lap winding, whilst in equation (3) it is seen that p/a must be integral in order to get a like parts. The only value of a which satisfies both these equations is obviously $a=p$. Further, since the number of slots in each of the a parts must also be integral, we must have $S/a=S/p$ a whole number, *i.e.*, there must be a whole number of slots per pole-pair.

Hence it is only possible to obtain a symmetrical lap winding with as many similar parts (or circuits) as there are pole-pairs and with a whole number of slots per pole-pair, or

$$\left.\begin{aligned} a &= p, \quad \text{or} \quad p'=1 \\ \text{and}\quad S' &= S/p, \text{ or } \quad S=pn \end{aligned}\right\} \quad \ldots\ldots \quad (9)$$

where $n=S'=$any integer.

The number of coil-sides per slot in a symmetrical lap winding is not restricted in any way, provided that we make $C=\frac{1}{2}uS$, *i.e.*, avoid idle coils.

The $a=p$ equipotential joints or segments to be connected together at an equalising or slip-ring are equidistant from one another on the periphery, and the potential pitch $y_p=C/p$.

The above particulars are summarised in Table II.

(*b*) *Symmetrical Wave Windings.*—In equation (8) the commutator pitch in a closed wave winding $y_c=(C\pm a)/p$, whence we get the possible number of coils $C=py_c\pm a$. Since there are to be no idle coils, *i.e.*, the segments per slot $C/S=u/2$, we can write for the number of slots in a closed wave winding

$$S=\frac{C}{u/2}=\frac{C}{C/S}=\frac{py_c}{C/S}\pm\frac{a}{C/S}.$$

Dividing throughout by a, we get

$$\frac{S}{a}=\frac{p}{a}\cdot\frac{y_c}{C/S}\pm\frac{1}{C/S}.$$

Introducing the conditions of symmetry from equation (3) to obtain a identical S'-phase systems, we must have $S'=S/a$ and $p'=p/a$, that is, S/a and p/a must both be integers, or

$$S'=p'\frac{y_c}{C/S}\pm\frac{1}{C/S}.$$

Now by the ordinary rules of division we can write

$$\frac{y_c}{C/S}=n+\frac{x}{C/S} \text{ or } y_c=n\frac{C}{S}+x,$$

where n is any integer and x is an integer less than C/S.

Substituting for y_c, we then get

$$\begin{aligned} S' &= \frac{p'}{C/S}\left(n\frac{C}{S}+x\right)\pm\frac{1}{C/S} \\ &= p'n+p'\frac{x}{C/S}\pm\frac{1}{C/S} \\ &= p'n+\frac{1}{C/S}(p'x+1) \quad \ldots\ldots\ldots \quad (10) \end{aligned}$$

* Abstracted from an Original Communication in the "Proceedings" of the Institution of Electrical Engineers, Vol. LV., p. 18. For the parts showing the arrangement of windings and illustrative examples, the original Paper must be consulted.

PERMISSIBLE NUMBER OF SLOTS AND COIL-SIDES PER SLOT IN LAP AND WAVE, DOUBLE-LAYER WINDINGS TO OBTAIN (i) "a" SIMILAR PARTS OR CIRCUITS, (ii) N=3, 4, OR 6 SYMMETRICAL PHASES.

Table II.—LAP WINDINGS.

Pole-pairs. p'.	Slots S'.	No. of similar parts in winding a.	No. of pole-pairs in machine $p=p'a$.	No. of slots in machine $S=S'a$	No. of slots, S, in machine when $N=3$	$N=4$	$N=6$	Coil sides per slot u.	No. of coils in winding C.
1	n	p	p	pn	$3pn$	$4pn$	$6pn$	Any even number.	$uS/2$

Commutator pitch: $y_c=1$; potential pitch: $y_p=C/p$; phase pitch: $y_{pA}=C/(pN)$; no idle coils permissible; n=any integer.

Digitized by Google

To obtain a symmetrical wave winding, then, this expression must be a whole number. Now clearly $p'n$ is an integer; hence, for S' to be an integer, $p'x\pm1$ must be exactly divisible by C/S. This will be obviously impossible if either p' or x and C/S have a common factor greater than unity, for then $p'x/(C/S)$ would have a smaller denominator than $1/(C/S)$.

The condition that $p'=p/a$ and C/S must have no common factor greater than unity at once restricts the number of segments per slot C/S that can be used with given numbers of poles as shown below.

Segments per Slot in Symmetrical Wave Windings.

Pole-pairs p'.	1	2	3	4	5	6	7	8	9	10	11	12
Segments per slot (C/S) ...	Any.	1, 3, 5, 7	1, 2, 4, 5, 7, 8	1, 3, 5, 7	1 to 4 6 to 8	1, 5, 7	1 to 6, 8	1, 3, 5, 7	1, 2, 4, 5, 7, 8	1, 3, 7	Any.	1, 5, 7

The above table, then, shows the number of coil-sides per slot, $u=2C/S$, up to 16, possible with any number of poles up to 24 in a symmetrical wave winding.

To examine the restriction that x and C/S must have no common factor >1, let us write

$$\frac{1}{C/S}(p'x_1+1)=A \text{ and } \frac{1}{C/S}(p'x_2-1)=B,$$

where x_1 and x_2 must be values of x which have no common factor with C/S greater than unity, and which make A and B whole numbers. We can now determine A and B and x_1 and x_2 as follows:

Since A and B are integers, $A+B=\frac{p'}{C/S}(x_1+x_2)$ must be integral.

Now p' and C/S have no common factor >1, therefore x_1+x_2 must be divisible by C/S. But, by assumption, x_1 and x_2 are each less than C/S, so that their sum must be lss than $2C/S$; hence it is only possible to have $x_1+x_2=C/S$. Substituting for x_1+x_2, we get $A+B=p'$.

Inserting A and B in equation (10), and disregarding any difference between n and $n+1$ (since n can be any integer),

$$\begin{aligned} S' &= p'n+A, \text{ or } p'n+B \\ &= p'n+A, \text{ or } p'(n+1)-A \\ &= p'n\pm A \\ &= p'n\pm B \end{aligned}$$

Since $p'n+A$ gives the same series of numbers as $p'n-B$, and $p'n-A$ the same series as $p'n+B$, we can write for the number of slots in a symmetrical wave winding

$$S'=p'n\pm K, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

where $K=A$ or B, according to which value we choose to give it. In what follows, for the sake of simplicity we shall always make K equal to the smaller of these two integers.

We now draw up the following table for x_1 and x_2 for given values of C/S.

The potential pitch, $y_p=C/a$. Each tapping forms the start of one phase and the finish of another. With diametral tappings, these two phases are equal and opposite, so that the current divides equally between them. In this way each tapping represents two parallel circuits, so that tapping a points by means of a commutator brush or a slip-ring makes connection with $2a$ circuits. This only holds, however, for the case when the phases are taken over 180°, as with diametral tappings or in a continuous-current machine, and corresponds with the case of a single-layer winding, where a 3-phase winding with $2a$ circuits per phase is obtained by joining in parallel the equal and opposite phases of a 6-phase winding.

(IV.) *Conditions for obtaining Symmetrical N-phase Lap and Wave Windings.*—The conditions for obtaining a symmetrical N-phase system of pressures given in equation (4) show that we must have a symmetrical winding where S' is exactly divisible by N and $p'=nN\pm1$.

(*a*) *Symmetrical N-phase Lap Windings.*—In a symmetrical lap winding, $p'=1$, so that $p'=nN\pm1$ is always satisfied in a symmetrical N-phase lap winding.

Further, in a symmetrical lap winding, $S'=S/p$ (equation 9), hence to obtain a symmetrical N-phase winding, $S'/N=S/(pN)$ must be a whole number, or the number of slots

$$S=Npn \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

This condition for three-, four- and six-phase lap windings is entered in Table II.

Though this condition is apparently so simple, it is easy to leave it unsatisfied by ignoring it. For example, if we have a rotary converter with $C/p=96$ segments per pole-pair and $u=6$ coil-sides per slot, we shall have $S/p=2C/(pu)=96/3=32$ slots per pole-pair. This is not exactly divisible by 6, so that the six-phase pressure will not be symmetrical. With two or four segments per slot ($u=4$ or 8), however, a symmetrical six-phase pressure is obtained.

(*b*) *Symmetrical N-phase Wave Windings.*—With wave windings, both p' and S' are subjected to restrictions when we require an N-phase system.

(i.) *Number of Poles.*—The only symmetrical wave windings from which a symmetrical N-phase system of pressures can be obtained are those where $p'=nN\pm1$. These are shown in Table I., and the impossible cases are denoted by a dash in Table III. The same result can be obtained from the condition that S'/N must be integral, for obviously,

$$\frac{S'}{N}=\frac{p'}{N}\cdot\frac{y_c}{C/S}+\frac{1}{N}\cdot\frac{1}{C/S}$$

Values of x_1 and x_2 where $x_1+x_2=C/S$, and x_1, x_2 and C/S have no Common Factor Greater than Unity.

C/S	1	2	3	4	5	6	7	8
x_1 and x_2	0 and 1	1 and 1	1 and 2	1 and 3	1 and 4 2 and 3	1 and 5	1 and 6 2 and 5 3 and 4	1 and 7 3 and 5

This enables us to evaluate K for given values of p' and C/S, for we have only to work out A and B and tabulate the lower value.

Having found S' in this way, $S=S'a$ for any value of a.

Table III, showing the number of slots and coil-sides per slot in symmetrical wave windings can now be drawn up and, wherever possible, the designer should adhere strictly to these conditions.

The following example will illustrate how K is determined. Let $p'=4$ and $C/S=3$. Then $A+B=p'=4$, and $x_1+x_2=C/S=3$. The possible values of x_1 and x_2 are 1 and 2. Taking $x_1=2$, then $A=\frac{1}{3}(4\times2+1)=3$; and taking $x_2=1$, $B=\frac{1}{3}(4\times1-1)=1$. We thus take $K=B=1$, and get for the possible numbers of slots $S'=p'n\pm K=4n\pm1$, as shown in Table III.

If $a=1$, as in the common wave winding, then $p'=p=4$ and $S'=S$. Thus the total number of slots in an 8-pole machine with a symmetrical wave winding and 6 coil-sides per slot is $S=4n\pm1$.

Similarly, if $a=2$, then $p=p'a=4\times2=8$; and $S=aS'=2S'=2(4n\pm1)=8n\pm2$. In this way, Table III. has been drawn up for machines with any number of poles up to 24 and any number of coil-sides per slot up to 16.

(ii.) *Number of Slots.*—To find what numbers of slots in a symmetrical winding are exactly divisible by N, we can re-write equation (11) for S' thus:

$$S'=p'n\pm K=p'n'\pm(p'n''\pm K),$$

where $n=n'\pm n''$. Let n' and n'' be chosen so that $n'=n'''N$ and $p'n''\pm K=kN$, where n''' and k are whole numbers. We can then write equation (11) in the form

$$S'=p'Nn'''\pm kN=p'Nn\pm kN,$$

where $S'/N=p'n\pm k$ is clearly a whole number (n''', being merely a number, can be replaced by n). In this way we get the values of S' which are divisible by N, and for the total number of slots we have

$$S=aS'=ap'Nn\pm akN. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

In this equation, then, $kN=p'n''\pm K$ is merely a value of S' divisible by N. For the sake of convenience, we shall always take kN as the lowest value of S' divisible by N.

Digitized by Google

Table III.—WAVE WINDINGS.

Pole-pairs. p'.	Slots S'.	Permissible coil-sides per slot. u.	No. of similar parts in winding a.	No. of pole-pairs in machine $p=p'a$	No. of slots in machine $S=S'a$	No. of slots, S, in machine when $N=3$.	$N=4$.	$N=6$.
1	n	Any even number	1	1	n	$3n$	$4n$	$6n$
			p	p	pn	$3pn$	$4pn$	$6pn$
2	$2n\pm1$	2, 6, 10, 14	1	2	$2n\pm1$	$6n\pm3$	...	...
			2	4	$4n\pm2$	$12n\pm6$	...	...
			3	6	$6n\pm3$	$18n\pm9$	...	...
			4	8	$8n\pm4$	$24n\pm12$	...	...
			5	10	$10n\pm5$	$30n\pm15$	...	...
			6	12	$12n\pm6$	$36n\pm18$	...	...
3	$3n\pm1$	2, 4, 8, 10, 14, 16	1	3	$3n\pm1$	...	$12n\pm4$	...
			2	6	$6n\pm2$	...	$24n\pm8$	...
			3	9	$9n\pm3$	...	$36n\pm12$	...
			4	12	$12n\pm4$	...	$48n\pm16$	...
4	$4n\pm1$	2, 6, 10. 14	1	4	$4n\pm1$	$12n\pm3$	...	...
			2	8	$8n\pm2$	$24n\pm6$	...	...
			3	12	$12n\pm3$	$36n\pm9$	...	...
5	$5n\pm1$	2, 8, 12	1	5	$5n\pm1$	$15n\pm6$	$20n\pm4$	$30n\pm6$
			2	10	$10n\pm2$	$30n\pm12$	$40n\pm8$	$60n\pm12$
	$5n\pm2$	4, 6, 14, 16	1	5	$5n\pm2$	$15n\pm3$	$20n\pm8$	$30n\pm12$
			2	10	$10n\pm4$	$30n\pm6$	$40n\pm16$	$60n\pm24$
6	$6n\pm1$	2, 10, 14	1	6	$6n\pm1$	...	...	...
			2	12	$12n\pm2$	...	...	...
7	$7n\pm1$	2, 12, 16	1	7	$7n\pm1$	$21n\pm6$	$28n\pm8$	$42n\pm6$
	$7n\pm2$	6, 8	1	7	$7n\pm2$	$21n\pm9$	$28n\pm12$	$42n\pm12$
	$7n\pm3$	4, 10	1	7	$7n\pm3$	$21n\pm3$	$28n\pm4$	$42n\pm18$
8	$8n\pm1$	2, 14	1	8	$8n\pm1$	$24n\pm9$	...	...
	$8n\pm3$	6, 10	1	8	$8n\pm3$	$24n\pm3$	...	...
9	$9n\pm1$	2, 16	1	9	$9n\pm1$	...	$36n\pm8$	...
	$9n\pm2$	8, 10	1	9	$9n\pm2$	...	$36n\pm16$	...
	$9n\pm4$	4, 14	1	9	$9n\pm4$	...	$36n\pm4$	...
10	$10n\pm1$	2	1	10	$10n\pm1$	$30n\pm9$	...	...
	$10n\pm3$	6, 14	1	10	$10n\pm3$	$30n\pm3$	...	...
11	$11n\pm1$	2	1	11	$11n\pm1$	$33n\pm12$	$44n\pm12$	$66n\pm12$
	$11n\pm2$	10, 12	1	11	$11n\pm2$	$33n\pm9$	$44n\pm20$	$66n\pm24$
	$11n\pm3$	8, 14	1	11	$11n\pm3$	$33n\pm3$	$44n\pm8$	$66n\pm30$
	$11n\pm4$	6, 16	1	11	$11n\pm4$	$33n\pm15$	$44n\pm4$	$66n\pm18$
	$11n\pm5$	4	1	11	$11n\pm5$	$33n\pm6$	$44n\pm16$	$66n\pm6$
12	$12n\pm1$	2	1	12	$12n\pm1$	...	...	...
	$12n\pm5$	10, 14	1	12	$12n\pm5$	...	...	...

Number of coils in winding: $C=uS/2$; commutator pitch: $y_c=(C\pm a)/p$; potential pitch: $y_p=C/a$; phase pitch: $y_{ph}=C/(aN)$; no idle coils permissible; n = any integer.

N.B.—$a=1$ denotes the common wave winding: *i.e.*, $y_c=(C\pm1)/p$.

To show how the values of S for $N=3$, 4 and 6 are obtained in Table III., we can work out an example. Let $p'=3$, $a=3$, and $N=4$. For $p'=3$ we see $S'=3n\pm1$, and the lowest value of this divisible by N is $kN=3\times1\pm1=4$. Hence the numbers of slots that can be used in a symmetrical four-phase wave winding with $p'=3$ and $a=3$ are

$$S=ap'Nn\pm akN=3\times3\times4n\pm3\times4=36n\pm12.$$

Attention may be drawn to the fact that, despite the restrictions on the number of poles, it is possible to obtain a symmetrical N-phase winding in most cases, though a modification in the design may be necessary. Thus, when a static balancer is to be used it is more important to have the N-phases symmetrical than to insist on making $N=3$ or $N=4$. Consequently with a four-pole wave winding we ought to make $N=3$; whilst with a six-pole winding we should make $N=4$. When it is important to obtain a symmetrical N-phase winding on a machine with a large number of poles, it is often essential to alter the number of poles; for example, with $p=6$, we can do nothing, but by making $p=5$ or 7, we can get symmetrical three-four- or 6-phase pressures.

Similarly, it is necessary to select the number of coil-sides per slot suitably to make the N-phases symmetrical.

In practice p, a and N are known, whilst an approximate idea of the number of coils or segments is obtained from the preliminary design of the machine. Table III. then shows the numbers of coil-sides per slot that are permissible, whence the value of S giving $C=\frac{1}{2}uS$ nearest to the approximate figure can be determined.

If a wave winding is closed, as it is when used with a commutator, the phases are obtained by means of tappings connected to slip-rings. When "polygon" loading is used, the phase-spread, $\sigma=\beta=2\pi/N$; but by doubling the number of tappings and loading them diametrally, the output is increased to the same extent as when the phase-spread of an open winding is halved. Diametral loading, however, calls for no special treatment, for the tappings are merely taken to correspond. Thus, for a three-phase diametral load we need to take the same tappings as for a six-phase polygon load.

When a wave winding is not used with a commutator, as in the case of alternators and induction motors, the phases should be given the narrow phase-spread. This is done by opening the winding for two N-phases and re-connecting the phases to form an N-phase winding.

The Paper concludes with a number of illustrative examples.

This Paper was written at the City and Guilds Engineering College, South Kensington, and the author has to acknowledge his indebtedness to many friends for valuable help and criticism.

Non-Corrosive Alloys.—The growing interest in special acid resisting alloys and the many uses found for them have stimulated both the search for efficient materials of this nature and the study of the causes underlying their inertness. The almost perfect insolubility of certain alloys in nitric and other acids seems to be conditioned upon a proper mixture of chromium, copper and nickel, together with smaller quantities of such added metals as tungsten or molybdenum. The University of Illinois Engineering Experiment Station has just completed a preliminary systematic study of such alloys under the direction of Dr. D. F. McFarland and Dr. O. E. Harder. Methods have been developed for making castings of alloys of chromium, copper and nickel, and 21 binary and 30 ternary alloys have been prepared, and physical and chemical tests have been made to determine their properties. More than 300 corrosion tests have been made to measure the effects of acids upon the metals. In general the results indicate that certain of the alloys of chromium, copper and nickel give promise of becoming of great commercial importance not only in the construction of laboratory apparatus, but in manufacturing and chemical processes in which the handling of acids is involved. Copies of Bulletin No. 93 containing the results of these tests may be obtained without charge from the Director of the Engineering Experiment Station, Urbana, Illinois.

Digitized by Google

THE RESISTANCE OF EARTH CONNECTIONS.*

BY L. BIRKS AND E. WEBB.

Summary.—Results of measurements are given of the resistance of earth connections and on the high-voltage electric power transmission lines erected for the supply of Christchurch and district from Lake Coleridge, New Zealand.

The present Paper aims primarily at the publication of data obtained during an investigation of earthing devices for use on the Canterbury Plains (New Zealand) in connection with the high-voltage electric-power transmission line recently erected by the Public Works Department of New Zealand for the supply of Christchurch and district from Lake Coleridge, a distance of 62 miles.

The Lake Coleridge power house is situated in the Rakaia River valley, 62 miles west of Christchurch, and from this point two 66,000-volt three-phase transmission lines are run to the city on independent pole lines. For the first 16 miles from the power house the lines are located about 3 chains apart, and pass along the terraces and low hills of the river valley, in many places over screes or fans of shingle detritus. In the next 14 miles the north line continues over low hills and rolling downs to Glentunnel, while the south stretches almost directly across the 32 miles of shingle beds which constitute the Canterbury Plains. At the city end the lines meet again at Bealey Road, 7 miles from the sub-station, and continue about 1 chain apart. For this distance the soil is largely of a sandy to peaty nature, the remains of a marsh formed by the sand hills of a former seashore and in the bed of an ancient river. It is thus evident that, although the major part of the line runs through dry shingle country, there is at the same time extensive variety. The shingle is, in the main, a hard, highly-crystalline bluish-grey sandstone, commonly known as greywacke. In size it ranges from sand to boulders 18 in. in diameter.

The line conductors consist of 7/0·135 bare aluminium wires, and are carried on Thomas No. 4,000 pin insulators, mounted on wooden (jarrah) cross-arms, and carried on ironbark poles standing 36 ft. out of the ground, and sunk 6 ft. into the ground. There are 864 poles in the northern line and 873 in the southern line. The standard pole spacing is 6 chains (396 ft.)—*i.e.*, about 13 poles to the mile. In order to obviate the burning of poles and cross-arms, it was decided to earth the whole of the high-tension insulator pins, and to earth each pole with an individual earth strip. In addition to this, the apparatus in telephone depots along the line required to be thoroughly earthed, while the stations at either end, and the numerous transformers in the distribution system, all required very efficient earths. The station lightning arresters in particular depend for their effectiveness on a low-resistance connection to ground.

The substance of the British Board of Trade specification in regulations concerning station earths and earths for tramways and general power purposes is that the resistance shall be less than 1 ohm between two plates of copper, cast iron or galvanised iron, packed in coke, and 60 ft. apart. Regulations under the Coal Mines Act (Great Britain), 1911, specify that "All conductors of an earthing system shall have a conductivity at all parts and at all joints at least equal to 50 per cent. of that of the largest conductor used solely to supply the apparatus a part of which it is desired to earth." In practice this would involve an earth resistance never greater than 10 to 15 ohms, and usually not more than 2 or 3 ohms.

It is now fairly common knowledge that the Board of Trade test is seldom obtained, and that values such as those quoted above are decidedly the exception rather than the rule.

Some tests were made locally on plate earths of the Christchurch City Council. These plates were ¼ in. copper, 2 ft. square, and were placed horizontally in a bed of coke 1 ft. thick above and below the plate, and at a depth of 6 ft. to 8 ft. These were tested against the city high-pressure water main, and (assuming the water main as of zero resistance to earth) these gave the following results: Beckenham transformer-house plate earth =51 ohms (loam and shingle); Sydenham transformer-house plate earth=17·2 ohms (clay); Montreal Street transformer-house plate earth=13 ohms (clay).

During the course of the present investigation plates were tried on the transmission line. Three copper plates 12 in. square were buried at a depth of 5 ft. 6 in. to 6 ft., and bedded in clay. In one case the country was loam to shingle, while the others were clay to sand. The plates were placed at intervals of 6 chains, and tests of pairs in series gave the following values: Resistance of plates immediately after placing No. 760 plate to No. 762 plate=260 ohms; No. 759 plate to No. 760 plate=200 ohms; No. 759 plate to No. 760 plate =180 after 4 gallons water had been poured over each; No. 760 plate to No. 762 plate=130 after 3 gallons of brine had been poured over No. 762 plate. Values by alternating-current bridge test.

* Abstract of Paper read before the Philosophical Institute of Canterbury, New Zealand.

The contrast of these values with those quoted is obvious, and these are from by no means in the worst districts. This chiefly indicates the unreliability of the earth connection by means of small copper plates. At the same time, since each earth plate in place costs from £1 to £1. 10s., the cost for such inadequate result precludes the adoption of the plate earth on any extended scale.

As it was apparently necessary to investigate in the actual country, some preliminary pipe earths were then tried on the transmission line at Bealey Corner, where the line passes into the heavy shingle of the old Waimakariri river-bed. Galvanised-iron pipes 1½ in. diameter were driven 4 ft. to 6 ft. deep beside line poles, 6 chains apart. In sand and clay the average individual resistance of seven pipes 5 ft. deep was 126 ohms by the direct-current bridge method. In heavy shingle the average individual resistance of four pipes 4 ft. deep was 1,800 ohms (direct-current bridge method). These pipes were driven into the ground with a 14 lb. hammer, and no brine or other electrolyte was added.

Further pipes were then driven in the neighbourhood of three other poles. The ground about the three poles selected was loam for a foot at the top, to clay and sand or clay and light shingle below. The uncertainty of the substratum was demonstrated by the fact that, though one pipe was easily driven in sand and clay, another, 6 ft. away, when driven a little more than 2 ft. refused to go farther on account of heavy shingle.

The pipes were drilled with two ⅜ in. holes at intervals of 1 ft. along the length of the pipe, and after starting with a crowbar were driven 5 ft. to 8 ft. deep with a hammer. They were then tested as driven, and results are tabulated below. Pipes A and B were then "salted" by filling with salt, pouring water in, and filling again with salt. They were then tested again, and at intervals subsequently. Pipes C were salted by pouring in at intervals hot saturated solutions of brine up to 20 gallons, testing between successive charges, and also subsequently. In pipes D cold saturated solutions (up to 9 gallons) of copper sulphate were used.

Table I.—*Test Pipes, Bealey Corner.*

(Average individual pipe-resistances to earth.)

Particulars of pipes, 6 chains apart.	Pipes as driven.	Immediately after salting.	Seven days after salting.	21 days after salting.	Three mnths. after salting.	Seven mnths. after salting.
	Ohms.	Ohms.	Ohms.	Ohms.	Ohms.	Ohms.
A. Three 2 in. pipes, 7 ft. deep	115	95	84	48	38	45
B. Three 1¼ in. pipes, 9 ft. deep	138	105	92	56	51	70
C. Two 1¼ in. pipes, 9 ft. deep	175	85	63	...	36	46
D. Two 1½ in. pipes, 7 ft. 6 in. deep (salted with copper sulphate)	78	68	...	...	...	94

These are all individual pipe-resistances obtained with a low-voltage direct-current bridge method.

The low-voltage direct-current Wheatstone bridge method has been most commonly used, owing to its ease of application and the portable nature of the apparatus. This test cannot give the true resistance under working conditions, when thousands of volts alternating current are concerned, but gives a proportional result, as indicated by the following observations: Some earths at Addington sub-station were tested by three different methods—(*a*) by direct-current bridge; (*b*) by voltmeter-ammeter direct-current, 110 volts; (*c*) by Wheatstone bridge, using surging alternate-current voltage and telephone receiver.

The results are tabulated below for three earths marked A, D and P.

Table II.—*Comparison of Methods of Testing.*

Earth-resistances (two in series).	(*a*) D.C. bridge.	(*b*) D.C. ammeter.	(*c*) A.C. bridge.
	Ohms.	Ohms.	Ohms.
A and P	31·3	23·6	22·8
D and P	37·3	31·2	28·8
A and D	15·3	13·0	12·8

Digitized by Google

Although the tests are not numerous, they are sufficient to indicate a large but fairly constant error in the ordinary low-pressure direct-current bridge test, and a fairly close approximation of the alternate-current bridge test to the positive voltameter determination.

Some measurements of earth resistances by direct and alternate-current voltmeter-ammeter method were made by Mr. Parry, chief electrical engineer, in Wellington. These were made on hemispheres 3 in. and 6 in. in diameter, placed in soil without addition of any salt.

These also gave an average of direct-current values greater than the corresponding alternate-current values by 16 per cent. The alternate-current ammeter used in these tests had a very close scale, and results are not entirely satisfactory.

In other experiments the direct-current bridge gave a resistance about 33 per cent. higher than the alternate-current bridge. There is a considerable range in the percentage difference, showing that the direct-current test probably gives a rather erratic result. Although results are not sufficiently numerous to warrant a definite statement, there is an indication that the difference unsalted is in the region of 30 to 40 per cent., while salted it is from 20 to 30 per cent.

It became evident at once that in the class of ground encountered earth resistances below 100 ohms were going to be very difficult and expensive in practice.

From the tests made it appears that once a pipe reaches a depth of 6 ft. to 7 ft., increase in depth has little effect on the final value. Any improvement produced by increased depth is so small as to be lost in the effect of other factors. It is common experience that in considering ground connections the character of the soil is the main factor concerned. However it is not the solids constituting the soil so much as the moisture and the salts in solution which command attention.

Considering the exceedingly high resistances of both approximately dry soil and approximately pure water, we must conclude that the conductivity—at least, in the immediate neighbourhood of the earth connection—is almost solely due to the salts, alkalies or acids in solution. The exceedingly large range of resistances is then explicable by electrolytes of variable specific conductivity, determined by the solutes or the degrees of concentration.

In the course of this investigation a few comparatively very low-resistance "earths" were obtained, ranging from 4 to 40 ohms. These invariably occurred either in marshy places or where there had been extensive accumulation of vegetable matter and a good depth of soil. It is probable that in these localities there is a liberal proportion of those decomposition products which may be included under "humus acids." Low-percentage solutions of acids have many times the conductivity of equivalent solutions of neutral salts or alkalies, and the existence of these in particular localities probably accounts for the comparatively low resistances encountered there.

Further valuable data were obtained from tests of artesian wells about Christchurch. Since these are from 70 ft. to several hundred feet deep, they might be expected to give resistances approaching zero. Four wells consisting of 2 in. pipes, 70 ft. to 80 ft. deep, at Addington, gave on the average a resistance of 6·2 ohms (alternate-current bridge and voltameter determinations). A 2 in. well, 80 ft. deep, at the city waterworks, Beckenham, had a resistance of 10 ohms (alternate-current bridge). The average of three 8 in. wells 80 ft. deep at the same place gave resistance of 8 ohms (alternate-current bridge).

Thus these well pipes have resistance of the same order as earth pipes 6 ft. deep in the same districts. It would, therefore, appear That depth and area of pipe in contact affect resistance only to a limited extent. The pure artesian water in the vicinity of the pipe is probably responsible for this effect.

On the majority of the pipe earths tested during the course of our investigations, with initial resistances ranging from 400 to 4,000 ohms, we found much larger percentage reduction of the initial resistance as the result of salting. This was clearly shown in some tests on over 100 pipes, each plotted point being the value from a group of three to eight 1 in. pipes, each 6 ft. to 7 ft. long. No two pipes were less than 6 ft. apart or more than 12 chains, and they were placed in groups of three to eight over the tract of country described, and therefore in all classes of soil. Salting was effected by pouring into each 4 gallons of saturated brine solution, and then filling the pipe with salt. Tests were repeated within an hour or so of salting. Initial resistances up to 250 ohms are in loam, sand or clay, and over 700 are in heavy shingle; others are in a mixture of earth and shingle. As the degree of penetration of the salt into the surrounding soil is a matter of considerable uncertainty, the percentage decreases in resistance are much more uniform than might be expected. Thus it appears that the reduction of resistance by salting is largely dependent on the magnitude of the initial resistance, and the salting is highly efficacious in reducing high resistances.

A further interesting feature of salting is the improvement of the "earth" with time. Apparently the salt continues to work into the surrounding soil for a considerable time after the initial salting. In time the salt must be dissolved by successive rains, and finally the "earth" must deteriorate. Apparently the brine continues to percolate into the surrounding soil, partly by soakage and partly by capillarity. Eventually the solution is weakened by the addition of rain and subsoil water until the resistance again increases.

From a cursory inspection of these values it is evident that—at least, in many cases—single-pipe earths, however well salted, will not give the value of resistance desired. The only loophole remaining is by way of placing a number of pipes in a group. The question immediately arises as to how close such pipes may be placed and still remain effective. A consideration of curves of the decrease in resistance with increase of distance indicates that the minimum useful distance between two pipes in good ground is about 6 ft. when the pipes are unsalted. After pipes have been salted the minimum distance must be increased.

In general, when pipes are salted, they must be placed at least 12 ft. apart to retain 90 per cent. of the efficiency of each pipe. The actual distance necessary in any particular case depends on the conductivity of the soil in which the pipes are placed, and the higher the conductivity the farther apart must the pipes be to retain their efficiency.

Groups of pipes were placed on the transmission line for the purpose of earthing depot telephones and apparatus. The following table gives particulars and results obtained with several pipes in parallel. No two pipes were placed less than 12 ft. apart.

Table III.—*Pipes in Parallel.*
(All alternating-current bridge.)

Locality.	No. of pipes.	Average resistance of each pipe.		Resistance of all pipes in parallel.		Class of soil.
		Unsalted.	Salted.	Immediately after salting.	Five mnths. after salting.	
		Ohms.	Ohms.	Ohms.	Ohms.	
Greendale ...	5	1,900	244	47	32	Very dry clay & shingle.
Charing Cross	4	840	141	44	57	Heavy shingle cemented with clay.
Aylesbury ...	7	2,000	440	80	78	Heavy shingle.
West Melton	4	910	305	55	80	Sand and clay to heavy shingle.
Bealey	4	534	150	34	61	Loam to heavy shingle.
Glenroy	4	180	94	26	...	Loam and clay, heavy boulder somewhat marsh
Highfield.....	4	556	126	31	...	Loam & sand for 4 ft. to shingle
Sandy knolls	5	2,334	417	90	...	Heavy running shingle.

It remains now to cite some actual methods employed, with the results attained. Pipe earths, as well as the plate earths before mentioned, were used by the Christchurch City Council (*see* diagram). These were placed in excavations 6 ft. to 7 ft. deep. The bottom of the pipe was packed with a mixture of rock salt (refuse salt from tanneries) and coke, while round the top was placed a drainpipe filled with rock salt and coke, and protected by a cover. Water was then poured in. The lead was 7/16 S.W.G. braided copper. These were tested against independent earths (either water or gas mains), with the result that resistances to earth varying from 4 to 76·5 ohms were recorded.

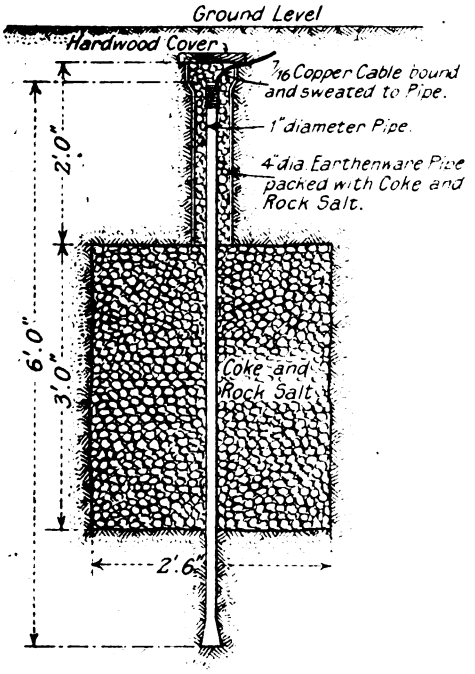
At the transformers, the pipe earths and plate earths were placed within a few feet of each other, and tests show in favour of the pipe earth. As might be expected, in good conducting soil there is very little difference between plate and pipe earths, but in high-resistance soil the salted pipe usually has a considerable advantage.

The practice pursued by the Public Works Department in the general transmission and distribution earths is to drive a 1 in. pipe, drilled with small holes every foot, to a depth of 6 ft. to 8 ft. in ground; then to pour 4 gallons of concentrated brine down the pipe and fill the pipe with rock salt, placing some rock salt round the top. The top of the pipe is stopped with a wooden plug, which can easily

Digitized by Google

be removed for replenishing the supply of salt inside the pipe. The conductor consists of 1 in. galvanised-iron strip, riveted round the pipe and bolted through. In attaching the lead it is essential to make a good connection mechanically. Also any combination of metals which would yield to electrolysis should be avoided, or otherwise the joint must be thoroughly covered with some waterproof material. On this account, as well as for economy in cost, the joint is not sweated.

The resistances recorded with this device ranged from 4 to 40 ohms, with the exception of one value of 100 ohms.



METHOD OF EARTHING EMPLOYED BY THE CHRISTCHURCH CITY COUNCIL (N.Z.).

A comparison of these two sets of values indicates that the bare pipe salted is more efficient than the pipe packed with coke and costing twice as much to place. The more elaborate earth, however, will probably tend to retain its efficiency longer.

Pipes are now being placed at each pole on the transmission line. Where there is nothing heavier than ordinary gravel, pipes can easily be started with a crowbar, and then driven to 6 ft. or 7 ft. with a hammer. The lower end of the pipe is flattened and closed, while the top is protected for driving by a loosely fitting cap turned from mild steel. In heavy shingle ground it is sometimes necessary to make an excavation in depth almost equal to the length of the pipe, and this very considerably increases the cost of placing. The lead from the pipe, as before, is 1 in. galvanised-iron strip, riveted round and bolted through by ½ in. bolt to the pipe, and riveted on to the earth strip running up the pole. Bolting and riveting were resorted to after it was found that the sweated joint broke away while driving.

For salting these pipes ordinary coarse salt is best for the initial charge, as it readily dissolves, while rock salt is better for filling and leaving about the pipe, on account of its taking a considerable time to dissolve. At present refuse rock salt from tanneries is being used, and found equal to ordinary salt for the purpose and much cheaper.

It still appears that in some districts single pipes will not provide a reasonably low-resistance earth connection. In such districts it will be necessary either to drive several pipes round each hole or to run a ground wire along that portion of the line and connect it with the single pipe at each pole.

With alternating current it appears that the ampere-hour capacity of a given earth is, in general, considerably higher than with direct-current. This is consequent on the excessive formation of films in the interspaces, consequent on electrolysis, these films forming to a very much lesser degree, and almost negligible, when the current is alternating. With a high frequency the inductance of the earth and lead is a proportionally large factor for consideration, and this must be reduced as far as possible by using shortest possible leads. This question will be the subject of further investigation as opportunity offers.

A SELF-RECORDING ELECTROMETER FOR ATMOSPHERIC ELECTRICITY.*

BY W. A. DOUGLAS RUDGE, M.A.

In the course of the writer's work on the local variations of the atmospheric potential gradient, the need was felt for a simple and inexpensive self-recording electrometer. A new arrangement has, therefore, been devised which has answered the purpose in view, and the apparatus may be useful in other directions.

It has been shown † that very considerable variations of the normal potential gradient are produced by clouds of dust raised by the wind, &c., and also by clouds of steam escaping under pressure from steam boilers.‡ These variations are very sudden and transitory, so that an instrument used for recording them must be fairly quick acting. The type of instrument adopted was a modified form of the quadrant electrometer, the record being photographed upon a piece of bromide paper attached to a revolving cylinder. One special use to which the electrometer was to have been applied was to find the relation between the potential gradient and the altitude of the place of observation, and for this purpose it was proposed to construct 10 or more instruments, so that a number of observations could have been carried out simultaneously. Some work of this kind has already been done in South Africa from which it appears that the potential gradient near to the ground diminishes with the height of the place of observation above sea level.§ The stations should be as far removed as possible from the disturbing influence of manufacturing operations, and of railways, and it was intended to have taken a set of observations in the neighbourhood of the Dead Sea, as in that district stations for the instruments might have been chosen with altitudes varying from 1,400 ft. below sea level to 3,000 ft. above, and in an open country. As a number of instruments were required it was necessary to keep the cost of construction low, and this has been achieved in the instrument to be described, so that the cost of material is less than 10s., and a moderate amount only of mechanical skill is required in the construction.

The complete apparatus consists of: (1) The electrometer, (2) the recording cylinder, (3) the illuminating arrangement, (4) the charging battery, (5) the collecting system.

1. *The Electrometer.*—This consists of four curved pieces of brass cut from a tube of 3 cm. diameter, and attached to a block of ebonite. The alternate pieces were connected together in the usual way. Each conductor subtended an angle at the centre of the mirror of about 60 deg., and the adjacent conductors were about 1 mm. apart. The "needle" was formed from a piece of silvered paper, 2·5 cm. by 1·5 cm., carrying a small mirror, or a piece of silvered thin "cover" glass could be used for both needle and mirror. A fine wire was attached to the needle to support a piece of wire gauze which was immersed in a small bottle containing paraffin oil, for damping the motion of the needle. The system was suspended by a fine phosphor bronze wire by means of which the needle could be charged. The whole was enclosed in a thin wooden case having a small window in front, and ebonite plugs to allow of connection being made to the quadrants.

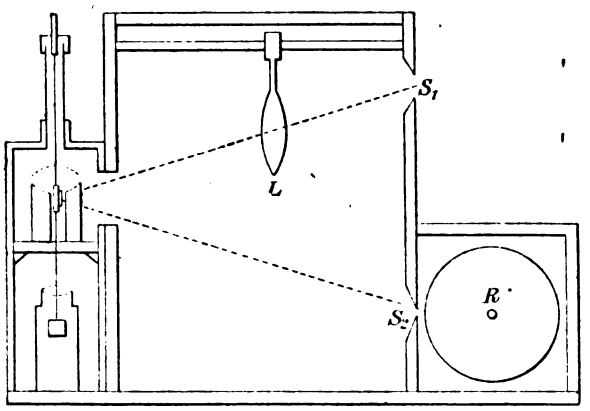


FIG. 1.

R = Reading drum. S_1 = Slit for admitting light. S_2 = Slit in clock case. L = Lens.

* Abstract of a Paper in the "Proceedings" of the Cambridge Philospohical Society.

† "Proc." Roy. Soc., A, Vol. XC.

‡ "Proc." Roy. Soc., A., Vol. XC.

§ "Trans." Roy. Soc. South Africa, Vol. VI., Part. 5.

Digitized by Google

2. *The Recording Cylinder.*—This is the most novel feature of the instrument, and is constructed from one of those small round clocks which may be bought from a shilling upwards. Two sizes of clock-case are common, of diameters 10 cm. and 6 cm., and both of these sizes have been used. A brass tube is substituted for the hour hand at the front of the clock, and a similar piece of brass tubing is attached to the arbour at the back of the clock, which is attached to the minute hand and used for setting the clock. These two tubes are in the same straight line and furnish a convenient axis about which the clock as a whole can rotate. If the tube

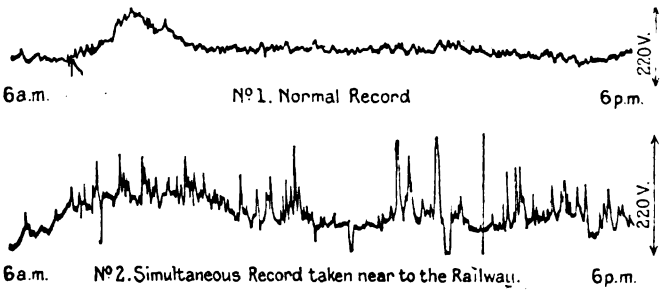


FIG. 2.—EXAMPLES OF RECORDS OBTAINED

attached to the hour hand is fixed, the clock-case will turn round once in *twelve* hours, whilst if the minute hand is fixed, the clock rotates once in *one* hour. Two scales of measurement are thus possible, and both have been employed. A light zinc tube was slipped over the clock-case to give a good support for the bromide paper which was wrapped round outside.

3. *Illuminating System.*—As the apparatus was used out of doors, daylight was used and found to be very suitable. The electrometer and recording cylinder were placed at the opposite ends of a light tight box measuring 20 cm. by 17 cm. by 14 cm. A hole was made in the top of one of the ends of the box, and covered over with a piece of silvered glass, upon which a fine vertical scratch—to serve as a slit—had been made. A lens, which could slide upon a rod inside the box, was employed to project the light upon the electrometer mirror, whence after reflection it was returned to the same end of the box as the slit, but at a lower level, and fell upon the horizontal slit in the case of the recording cylinder (Fig. 1). By this means a point of light impinged upon the bromide paper, and as the latter rotated, traced out the curve which appears after developing the paper in the usual manner.

4. *Charging Battery.*—In using the electrometer the opposite pair of quadrants were kept charged to a fixed potential by means of a battery of the small Leclanché cell used for "flash" lamps. These cells are sold in sets of three and a batch of eight, giving about 35 volts, is quite sufficient for atmospheric observations. The centre of the battery was earthed.

5. *The Collector.*—This consisted of a small plate of brass coated with a radioactive preparation. The plate was fixed in the centre of a very short piece of brass tubing and the open ends of the tubing covered over with wire gauze, so as to prevent loss of radium by rubbing, &c ; whilst allowing it to take up the potential of the air. The collecting plate was supported at the end of an insulated wire, and at such a height above the ground as would give a deflection suitable to the sensibility of the electrometer.

Up to the present time the apparatus has been used for the purpose of taking records of the variations in the potential gradient, due to the presence of clouds of dust raised by traffic on the roads, or to the variation caused by the steam escaping from passing trains. Two representative curves are given (Fig. 2).

No. 1. This is a twelve hour record, taken at a station on the Gog Magog Hill, about four miles from Cambridge, and so far from the railway and roadway that traffic had no disturbing influence.

No. 2 is a *simultaneous* record taken in Hills-road at a distance of less than a quarter of a mile from the railway, so that every passing train shows its influence in *increasing* the positive potential.

THE STANDARDISATION OF RESISTORS.

Summary.—A plea is made for the standardisation of ratings, arrangement and construction of starting and speed controlling resistors. Particulars are given of a number of cast and stamped-grid resistors and of wire-wound units.

Users and makers of electrical machinery would welcome any steps towards the standardisation of starting and speed controlling resistances or resistors. Not only is there little or no agreement at present as to the rating to be given for a particular service, but there are wide differences of opinion as to what is good practice in the construction and arrangement of resistors. By means of a representative committee it ought to be possible to settle these questions satisfactorily.

An important advantage of standardisation is that makers of resistors would not have to attend to the silly inquiries of those who attach more importance to low temperature rise than to common sense.

Recent practice in the United States is leading towards the entire elimination of "freak" boxes having a variety of grids connected in a variety of ways. Engineers in the States are said * to be placing their orders for future equipments to cover resistors in which standard boxes are used. These boxes are made up with only one size of grid, the grids being connected all in series, or two in parallel or three in parallel. This results in three standard boxes for each size of grid.

The various sizes of grids set out in Table I. are used by the General Electric Co., of Schenectady, in their standard boxes :

Table I.—*Grid Resistances and Capacities.*

Grid No.	Ohms per grid.	Amperes capacity.
1	0·01	140
2	0·02	100
3	0·03	85
4	0·04	70
6	0·06	60
8	0·08	50
12	0·12	35
18	0·18	30
22	0·22	22

* "General Electric Review," March, 1917, p. 203.

Since there are nine grids and three methods of grouping, it follows that 27 is the maximum number of standard boxes. In Table II. only 19 appear, because eight boxes are practically duplicates of those given.

Table II.—*Standard Boxes Made from the Grids in Table I.*

Amp. capacity.	Ohms per box.	Grid No.	Connections of grids.	Grids per box.
420	0·02	1	3 in parallel.	18
300	0·04	2	3 ,, ,,	18
280	0·045	1	2 ,, ,,	18
255	0·06	3	3 ,, ,,	18
200	0·09	2	2 ,, ,,	18
170	0·135	3	2 ,, ,,	18
140	0·18	1	Series.	18
120	0·27	6	2 in parallel.	18
100	0·36	2	Series.	18
85	0·54	3	,,	18
70	0·72	4	,,	18
70	0·84	12	2 in parallel.	28
60	1·08	6	Series.	18
60	1·26	18	2 in parallel.	28
50	1·44	8	Series.	18
44	2·64	22	2 in parallel.	18
35	3·36	12	Series.	28
30	5·04	18	,,	28
22	10·56	22	,,	48

When connecting these boxes in the equipment, one complete box is always used for a division of the resistor. If the necessary capacity cannot be obtained in one box, two complete boxes are put in. This eliminates any taps in the box, and in case one of the boxes is damaged it is only necessary to disconnect the two end terminals. In the article referred to above it is stated that the boxes described in Table II. are applicable to motors ranging from 5 H.P. to 200 H.P.

A somewhat similar method appears to be followed by

Digitized by Google

another well-known American firm, namely, the Electric Controller & Mfg. Co., of Cleveland. Six different sizes of grids are supplied, having the characteristics given in Table III. :—

Table III.—*Current Capacities and Resistances of Cast Grids.*

Grid No.	Continuous capacity at 250°C.	Resistance.	
		Ohms at 25°C.	Ohms at 250°C.
1	20 amps.	0·218	0·240
2	25 ,,	0·162	0·181
3	32 ,,	0·100	0·113
4	44 ,,	0·052	0·0594
5	60 ,,	0·029	0·0335
6	80 ,,	0·0163	0·0188

These grids also are connected all in series, or two in parallel or three in parallel. and the standard boxes are of three lengths.

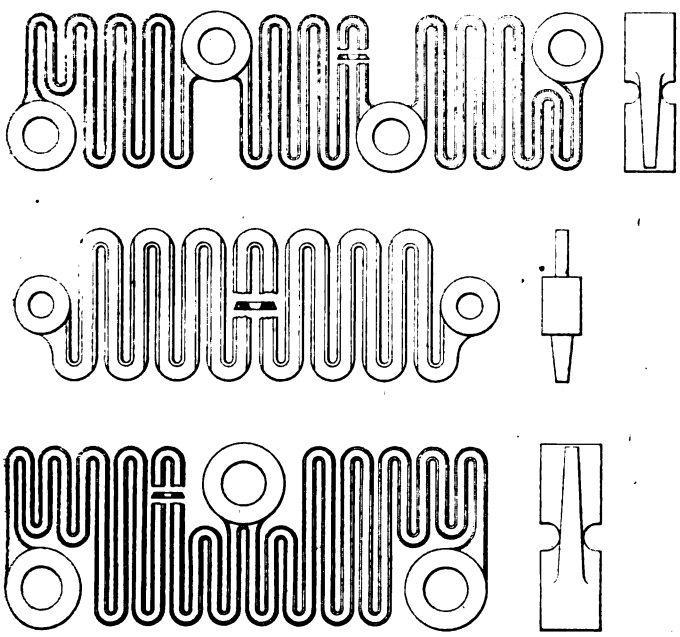


FIG. 1.—CAST-GRID RESISTORS (G.E.C. OF AMERICA)

With the exception of the No. 1 grid, all the grids have the same thickness of eye, and four No. 1 grids occupy the same space on the supporting rods as three grids of any other size. Particulars of the standard boxes are set out in Table IV. :—

Table IV.—*Standard Boxes made from the Grids in Table III.*

Continuous capacity at 250°C.	Resistance.		Grid No.	Connections of grids.	Grids per box.
	Ohms at 25°C.	Ohms at 250°C.			
20 amps.	5·232	5·760	1	Series.	24
25 ,,	2·916	3·258	2	,,	18
32 ,,	1·800	2·034	3	,,	18
40 ,,	1·308	1·440	1	2 in parallel.	24
44 ,,	0·936	1·069	5	Series.	18
50 ,,	0·729	0·815	2	2 in parallel.	18
60 ,,	0·522	0·603	7	Series.	18
64 ,,	0·450	0·508	3	2 in parallel.	18
75 ,,	0·324	0·362	2	3 ,, ,,	18
80 ,,	0·293	0·338	9	Series.	18
88 ,,	0·234	0·267	5	2 in parallel.	18
96 ,,	0·200	0·226	3	3 ,, ,,	18
120 ,,	0·130	0·151	7	2 ,, ,,	18
132 ,,	0·104	0·119	5	3 ,, ,,	18
160 ,,	0·073	0·085	9	2 ,, ,,	18
180 ,,	0·058	0·067	7	3 ,, ,,	18
240 ,,	0·033	0·038	9	3 ,, ,,	18

The other standard boxes made by the Electric Controller Co. contain twice and 2⅔ times as many grids as the above box, and the resistances are proportionally increased.

It is highly satisfactory to note that clamped terminals are being used. Such terminals are strong mechanically and good electrically. The sweated thimble is neither the one nor the other.

In the case of the grids made by the General Electric Co. the grid number appears to bear a direct relation to the resistance of the grid, thus a No. 4 grid has a resistance of 0·04 ohm, and a No. 18 grid has a resistance of 0·18 ohm.

The Controller Co. uses the letters A, B and C to indicate the arrangement of the grids. As an example, an A 1-48 box includes 48 No. 1 grids, all in series ; a B 5-18 box consists of 18 No. 5 grids, two in parallel and the pairs in series. It is unfortunate that in this case the grid number does not give a direct indication as to the resistance of the grid, otherwise it would be difficult to find a better designation.

We are in favour of a three-part section name. The Roman numerals I., II. or III. to indicate the arrangement of the grids and to form the first part of the name of any section. The second part of the section name indicating the resistance of the grids used, and in order to avoid the use of decimals the plan adopted by the General Electric Co. is recommended. The third part of the section name—separated from the second part by a dash—is a number designating the number of grids in the box. According to this plan a III. 2—48 box includes 48 grids,

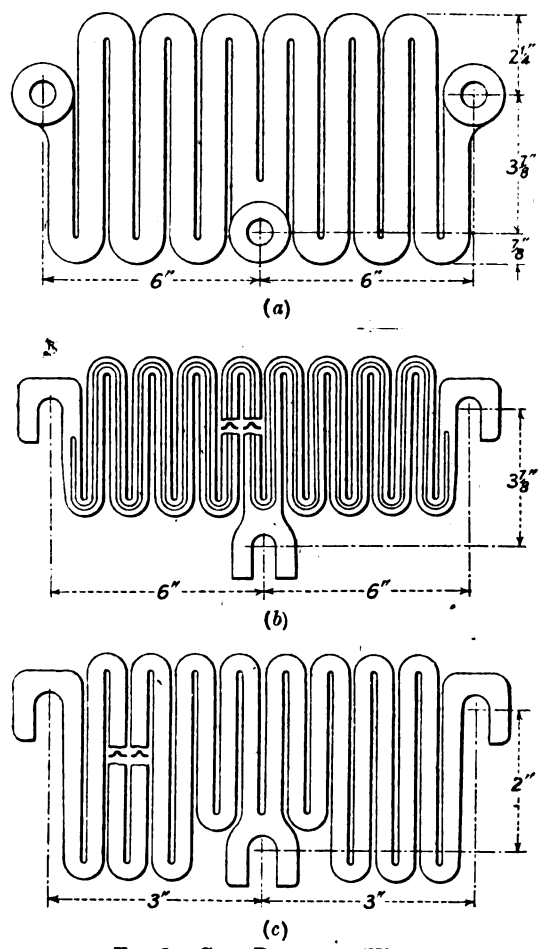


FIG. 2.—GRID RESISTORS (WEST).
(*a*) CAST GRID ; (*b*) STAMPED GRID TYPE 1; (*c*) STAMPED GRID TYPE 2.

each having a resistance of 0·02 ohm, and arranged three in parallel, the sets of three being connected in series. This use of the Roman numeral is a good one, since it indicates pictorially the number of grids connected in parallel. It may be thought by some that this method discloses too much, but we have little patience with those who are of the opinion that the ohmic value and arrangement of a resistor should not be disclosed.

Standardisation of resistors should include cast-grids, stamped grids and wire-wound units, and the same boxes should be used for grids and wire-wound units. This greatly simplifies manufacturing processes, and at the same time allows a workmanlike job to be made of the mounting of the boxes.

American engineers appear to use cast-grids for currents of too low a value to secure what home engineers mean by a mechanically robust grid. It is good practice to restrict the use of such grids to currents in excess of 80 amperes continuous rating with a temperature rise of 200°C. For smaller

Digitized by Google

Table V.—*Ratings of Cast Grids.*

Resistance cold, ohm.	Weight, lb.	Watt secs. $\times 10^3$.	Carrying capacity, amperes.																
			200°F.	200°C. rise.									300°C. rise.						
			Cont.	Cont.	5 min.	4 min.	3 min.	2 min.	1½ min.	1 min.	¾ min.	½ min.	5 min.	4 min.	3 min.	2 min.	1½ min.	1 min.	¾ min.	½ min.
0·01	6·9	470	115	160	325	362	420	517	585	730	860	1,030	395	440	510	626	710	885	1,040	1,250
0·02	5·9	400	88	120	214	240	276	338	388	478	553	675	260	290	336	410	472	580	670	820
0·03	3·9	265	81	92	142	158	182	222	258	316	364	450	172	192	221	271	314	384	442	545
0·04	4·8	330	70	80	137	152	177	216	247	305	350	433	166	185	215	262	300	370	425	525

Table VI.—*Particulars and Ratings of Stamped Grids.*

Resistance cold, ohm.	Thickness, S.W.G.	Watt secs. $\times 10^3$.	Current carrying capacity, amperes.																
			200°F. rise.	200°C. rise.									300°C. rise.						
			Cont.	Cont.	5 min.	4 min.	3 min.	2 min.	1½ min.	1 min.	¾ min.	½ min.	5 min.	4 min.	3 min.	2 min.	1½ min.	1 min.	¾ min.	½ min.
0·043*	16	542	37	51	62	68	74	87	97	120	138	172	75	82	90	106	118	145	167	208
0·058	18	412	32	44	51	54	58	63	72	88	103	126	62	66	70	77	88	108	125	153
0·077	20	305	28	38	41	44	49	53	58	67	77	95	50	54	59	64	71	81	93	115
0·102	22	235	22	30	33	36	38	40	45	50	58	71	40	43	46	49	55	61	70	86
0·125	24	166	21	29	31	33	36	38	41	44	50	55	37	40	43	46	50	53	61	70
0·192	24	166	17	24	26	27	28	30	32	34	40	45	32	33	35	37½	40	43	50	57
0·112†	20	99	12	17	20	22	24	26	30	34	39	49	23	25	27	31	34	39	45	55
0·14	22	75	11	15	17	18	19	20	23	26	30	35	20	21½	23	25	28	31	35	43
0·185	24	59	9	12	16	17	18	19	20	22	25¼	30	17½	18¾	20	22	24	27	30½	35
0·22	26	37·6	8	11	14	15	16	17	17	19	21	26	16	17¼	18¼	20¼	21	23	26	32
0·33	26	37·6	7	9	12	13	13	14	14	15	17	21	12¾	13½	14½	16	17	18¾	21½	26

* Type 1, Fig. 2. † Type 2, Fig. 2.

Table VII.—*Particulars and Ratings of Wire-wound Resistance Units (Eureka).*

S.W. gauge.	Turns per inch.	Weight of wire, lb.	Ohms.	Carrying capacity 200°C.					Carrying capacity 300°C.			
				Cont.	5 min.	2 min.	1 min.	½ min.	5 min.	2 min.	1 min.	½ min.
36	37	0·0135	380	0·4	...	...	...	...	...	...	...	...
34	40	0·022	280	0·7	...	...	...	...	...	...	...	...
32	40	0·029	203	0·82	1·1	1·43	1·8	2·1	1·19	1·63	2·1	2·45
30	36	0·039	155	0·93	1·25	1·64	2·1	2·4	1·48	1·92	2·45	2·8
30	26	0·057	108	1·12	1·45	1·95	2·5	2·9	1·7	2·3	2·94	3·4
28	33	0·053	84	1·27	1·65	2·22	2·8	3·0	1·95	2·6	3·3	2·9
26	32	0·068	59	1·5	1·96	2·68	3·4	3·9	2·3	3·14	4·0	4·55
26	24	0·052	44	1·75	2·26	3·1	3·9	4·5	2·66	3·65	4·6	5·3
24	24	0·074	29·6	2·2	2·75	3·75	4·7	5·5	3·34	4·4	5·5	6·5
24	18	0·055	22	2·5	3·2	4·35	5·5	6·4	3·77	5·1	6·5	7·5
22	20	0·10	15·3	3·0	3·84	5·2	6·6	7·7	4·5	6·1	7·7	9·0
22	15	0·067	11·5	3·45	4·43	6·5	7·6	8·9	5·2	7·6	8·9	10·4
22	10	0·05	7·7	4·25	5·4	7·3	9·2	10·8	6·3	8·5	10·8	12·7
20	15	0·128	6·9	4·4	5·7	7·7	9·8	11·4	6·7	9·0	11·5	13·4
20	12	0·10	5·6	4·9	6·4	8·6	11·0	12·7	7·5	10·0	13·0	14·9
19	12	0·128	4·6	5·4	7·0	9·6	12·0	14·0	8·2	10·8	14·1	16·4
19	10	0·107	3·9	5·9	7·6	10·6	13·0	15·2	8·9	12·4	15·2	17·8
18	12	0·182	3·15	6·6	8·5	11·5	14·5	17·0	10·4	13·3	17·0	20·0
18	10	0·15	2·6	7·2	9·3	12·6	16·0	18·5	11·2	14·8	19·0	22·0
17	10	0·265	2·03	8·2	10·5	14·3	18·0	21·0	12·4	16·8	21·0	25·0
16	12	0·32	1·76	8·8	11·3	15·3	19·3	22·6	13·3	18·0	22·8	26·5
16	10	0·265	1·48	9·5	12·4	16·8	21·0	24·7	14·6	19·8	25·0	29·0
16	8	0·21	1·17	10·7	14·0	18·8	24·0	27·7	16·5	22·0	27·0	33·0
14	9	0·375	0·86	12·5	16·2	22·0	28·0	32·5	19·0	26·0	33·0	39·0
14	7	0·29	0·67	14·2	18·4	25·0	31·0	37·0	22·0	29·0	37·0	44·0
14	6	0·25	0·57	15·5	20·0	27·0	34·0	40·0	24·0	32·0	40·0	47·0

currents stamped grids should be used in order to secure the mechanical strength demanded by the rough treatment which they receive during manufacture and in service. For still smaller currents a continuously-supported wire or strip is imperative, and the support itself should possess considerable mechanical strength.

Typical cast-grids are illustrated in Fig. 1 (*a*) to (*d*). These grids are said to be made of a special mixture of cast iron. It were better to eliminate such "special mixtures," and with this object in view we would say that it is the practice of one of the largest users of cast-grids in the country to use the ordinary cast iron of the general iron foundry for the manufacture of grids.

The ratings of cast-grids, by West, built up in frames and exposed to free circulation of air are set out in Table V.

The periods of service given in the above table are the times allowable in circuit out of every 15 minutes. In each case the temperature coefficient is 0·07 per cent. per degree centigrade.

For stamped grids "stalloy" has been largely used. Of such grids, that used by West, depicted in Fig. 2, makes a good mechanical job. The ratings of these grids are given in Table VI. With the exception of the 0·192 ohm and 0·33 ohm grids, all the grids are of stalloy.

The carrying capacity is calculated for grids built up in frames and exposed to free circulation of air, the period of service given being the time allowable in circuit out of every 15 minutes. The standard spacing is ¼ in. for Type 1 and $\frac{5}{16}$ in. for Type 2.

Continuously supported wire-wound units may be wound upon split iron or steel tubing insulated with impregnated asbestos. A typical set of windings for a range of such units is appended (Table VII.).

It would greatly simplify the work of electrical engineers and of large users of electrical machinery if the makers of resistors would furnish the thermal characteristics of their resistors. By so doing the user would be in a position to determine the rating for himself.

Digitized by Google

THE PROTECTION OF TELEPHONE CIRCUITS USED IN ELECTRIC POWER DISTRIBUTION.*

BY E. K. SHELTON.

The lack of system or standardisation in the construction of telephone circuits used in power distribution makes the problem of protection a difficult one. The protection in many cases consists entirely or in part of home-made devices designed by the operating engineers, which are more or less efficient, according to conditions.

The main sources of trouble to which such telephone circuits are exposed can be briefly stated as follows :—

1. Electrostatic and electromagnetic induction from the power circuit.
2. Crosses with the power circuit.
3. Lightning disturbances.

Induction is likely to be the most troublesome on account of its being continuous, but lightning and crosses, although infrequent and of short duration, are likely to cause the most damage and danger.

Electromagnetic and electrostatic induction cause noise in the telephone instruments and high voltage on the telephone lines and instruments, thus making communication difficult and dangerous. Transient currents and voltages caused by the operation of switches, lightning discharges to, or in the neighbourhood of the transmission line, short circuits on the transmission line, and arcing grounds affect the telephone line, due to the sensitiveness of the telephone instruments and the cumulative effect of the long paralleling.

Induction between lines produces a voltage between the wires of the telephone circuit, and raises the potential of the telephone line above earth.

Voltage between the telephone wires results in a circulating current through the line, which produces noise in the instruments. This is an electromagnetic action caused by the fact that the wires of the transmission line cannot be spaced symmetrically with respect to both wires of the telephone line. The effect is that of a residual loop in the transmission line, which may be exaggerated by abnormal conditions. The remedy is careful transposition of the telephone line, so that such induced voltages are broken into opposed sections and neutralised. Transposition of the transmission line also tends to reduce this effect.

If unequal voltages are induced on the two sides of the telephone line, a circulating current will also result. This may be caused by an electrostatic induction due to the position of the telephone line with reference to the transmission wires and earth. It may also be caused by any circuit composed of the transmission line and earth return, such as a ground of one wire, triple or three multiple harmonic charging currents in grounded star systems, single-phase grounded return systems, &c. Transposition of the telephone line or the transmission line, or both, will not eliminate this trouble, but transposition of the transmission line tends to reduce it.

In general, the effect of higher harmonics in the transmission line is greater than that of the fundamental frequency, since both the telephone instruments and the ear are more sensitive to these higher frequencies than to the fundamental frequencies, although the magnitude of the harmonics is less.

One method of relieving this strain is to run a grounded shielding wire parallel and as close to the telephone line as possible. This wire should be grounded at every tower. The method which has given best results in practice consists in the use of so-called "drainage" or "bleeding" coils, connected between the telephone lines with the neutral point grounded. These coils present a path of low impedance to currents which pass equally from each of the two telephone lines to earth, such as charging current produced by the relation of the telephone line to the transmission line, and which, passing from the two ends of the coil in opposite directions to the centre, neutralise each other's magnetic effect. On the other hand such coils present a relatively high impedance to the high frequency alternating telephone currents.

The number of these coils must be kept low, since they take a comparatively high exciting current from the low frequency ringing generator, and under certain conditions may also affect telephone transmission. The installation of one drainage coil at each end of the line should usually be sufficient to obtain good results. If necessary a third may be installed at the centre of the line.

For lightning disturbances only, uncomplicated by any of the other kinds of disturbances, a vacuum gap (the vacuum tube arrester) gives the best and most reliable discharge path to ground. The air gap is preferred to the vacuum gap in order to avoid the continual grounding of the telephone lines which would occur through the low breakdown path of the vacuum arrester as a result of the induced potential to ground, which may be quite high. The vacuum gap is put across the telephone lines where the induced potentials can be controlled by careful transposition.

* Abstract of an article in the "General Electric Review."

Where there is any possibility of induction troubles the telephone line insulating transformer is of prime importance. This provides an insulation barrier of 25,000 volts test between the telephone instruments and the lines.

The recommendations for the classification and protection of telephone lines may be summarised as follows :—

CLASSIFICATION OF TELEPHONE CIRCUITS FROM THE STANDPOINT OF PROTECTION.

As the position of the telephone circuit with respect to the transmission circuit determines the likelihood of troubles due to crosses or induction, the telephone circuits have been classified with this point in view.

Class 1.—Telephone circuits which do not cross or parallel power lines.

Class 2.—Telephone circuits which cross but do not parallel power lines.

Class 3.—Telephone circuits which parallel power lines but are not on the same towers or poles and do not cross power lines.

Class 4.—Telephone circuits which are on the towers or poles with the power lines.

This classification covers every possible case from a telephone line far removed from the power circuit to one mounted on the transmission towers themselves. Classes 3 and 4 are the most common. The sources of trouble vary from lightning only in Class 1 to lightning crosses and induction in Class 4.

SPECIFIC RECOMMENDATIONS FOR PROTECTION.

Specific recommendations for the protection of the telephone circuit according to the classification of the circuit into which it falls are as follows :—

Class 1.—Telephone circuits which do not parallel or cross power lines

Disturbances : Lightning.

Recommendations : Vacuum tube lightning arresters from each line to ground at all telephone stations.

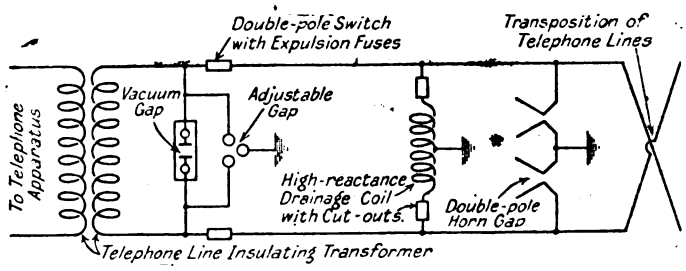


DIAGRAM OF CONNECTIONS FOR PROTECTIVE APPARATUS RECOMMENDED FOR TELEPHONE LINES, CLASSES 3 AND 4.

Class 2.—Telephone circuits which cross but do not parallel power lines.

Disturbances : These circuits are subject to lightning disturbances and to contact with the high voltage power lines through broken wires, &c. They are not subject to any extent to electromagnetic or electrostatic induction.

Recommendations : (1) Combined double-pole fused switch and lightning arrester in series with the main telephone line on both sides of crossing at nearest telephone stations. (2) Lightning arresters at all other stations.

Class 3.—Telephone circuits which parallel power lines but are not on the same towers or poles and do not cross power lines.

Disturbances : These circuits are subject to lightning disturbances and electro-magnetic and electrostatic induction. They are not subject to contact with the power lines.

Recommendations : (1) Insulating transformers at all telephone stations. (2) Combined double-pole fused switch and lightning arrester at all telephone stations on the line side of the insulating transformer. (3) Drainage coils preferably one at each end of line.

Diagram of connections : A diagram of connections for the apparatus used on this class of telephone circuits is shown in the diagram. The double-pole horn gap shown on the diagram is not used on this class of circuit but on circuits coming under Class 4.

Class 4.—Telephone circuits which are carried on the towers or poles with the power lines.

Disturbances : These circuits are subject to lightning disturbances, electrostatic and electromagnetic induction, and to crosses with the power lines.

Recommendations : (1) Insulating transformers at all telephone stations. (2) Combined double-pole fused switch and lightning arrester at all telephone stations on the line side of the insulating transformer. (3) Double-pole horn gap across line at each station on line side of all other apparatus for the protection of insulators on telephone circuit in case of crosses with the power lines after series fuses are blown. (4) Drainage coils installed with fuses at each end of line : possibly an additional coil at the middle if the voltage to ground is not held to a safe value by two coils.

Diagram of connections : A diagram of the connections for the apparatus used on this class of telephone circuits is shown in the diagram.

Digitized by Google

The Electrician.

FRIDAY, JUNE 1st, 1917.

CHANGE OF ADDRESS.

The Editorial, Publishing and Advertisement Offices of

"THE ELECTRICIAN"

are now at

8, BOUVERIE STREET,
LONDON, E.C.4.

Telegrams: BENBROTRIC, FLEET, LONDON.
Telephone: 9854 CITY, 4 lines.

THE WASTING ASSET.

What is known as the "wasting asset" is, unfortunately, an important feature, and one which often leads to financial instability, in most industrial concerns. Many assets, in their very nature, are of a wasting character. Land is an exception in this respect, but for manufacturing operations the amount of land that is involved is comparatively small from the point of view of the proportion of capital. Most of the expenditure in such cases is on machinery of one kind or another and on buildings; and the depreciation of machinery, generally speaking, is at a somewhat high rate.

Not only does the value of the assets come into the balance-sheet, but such questions as depreciation also have a distinct bearing on the cost of production. This is sometimes not realised to the extent that is desirable. We may go further and say that interest on capital is sometimes forgotten, with the result that very loose statements are made in regard to the cost of production. Take, for example, the cost of water power. Statements are occasionally made that the cost of some particular water power is extraordinarily low, but there is generally a failure to state whether such prices include adequate provision for depreciation and interest on capital. It is reasonable to take some such figure as 5 per cent for interest in such cases, as it is practically impossible for private enterprise to obtain capital on lower terms, and this charge should form part of the cost. In Government and municipal enterprises a lower figure is, no doubt, permissible.

From the point of view of providing for capital charges, municipal undertakings are, no doubt, carried on upon a basis which is to some extent more satisfactory than is often the case with private enterprise, for the simple reason that capital must be repaid in a certain defined time. On the other hand, there is a very distinct weakness, due to the assumption so often made that the time for repayment is satisfactory under all conditions, and is a fair measure of depreciation. More than one municipality has got into difficulties on this account.

The subject has been brought to our notice once more by a new edition of a book by Mr. P. D. LEAKE on "Depreciation and Wasting Assets." This is a question which engineers have recently had before them somewhat prominently. For example, Messrs. F. GILL and W. W. COOK read a Paper a few months ago before the Institution of Electrical Engineers upon "Principles Involved in Computing the Depreciation of Plant," and they discussed at considerable length the relative merits of various systems for dealing with depreciation. First of all there is the difficulty of deciding on the extent of depreciation, and, secondly, there is the question of bookkeeping in order that proper account shall be taken of all necessary items. In order to determine the amount of depreciation various laws have been suggested. There are, for instance, the straight line method, the annuity method and the sinking fund method, all of which enable us to arrive at certain figures, but there is no guarantee that any one of them gives the correct result. We are glad to see that Mr. LEAKE realises that such methods can only be used to give an estimate owing to the fact that the useful life cannot be determined with certainty, nor is the remainder value a very definite figure. He, therefore, contends that the estimates should be revised from time to time where necessary. We would go further, and say that a thorough valuation from time to time is the only safe means of arriving at depreciation, for some of the factors are so uncertain that no other method can be considered reasonable. It may, of course, be argued that obsolescence is a factor distinct from depreciation, but it is safer to consider depreciation in its broadest aspect and to let it embrace obsolescence, the extent of which can never be predicted. Further, the needs of an undertaking which expands more rapidly than was anticipated may have a marked effect on the depreciation that must be met.

In his preface Mr. LEAKE calls attention to the importance of depreciation in discussing such a question as the fair share of capital, and that of labour, in the annual profits of industry. This question requires more careful consideration as time goes on because the tendency is to increase the capital expenditure per man employed. According to a recent discussion of this subject by the President of the Engineering Section of the British Association the capital per individual employed is about £200 in engineering works, and the dividends thereon average 4 per cent. The conclusion is reached that the annual earnings of the workman are equal to the annual earnings of £1,750 of capital. But if such figures are to be of value they must take full account of depreciation.

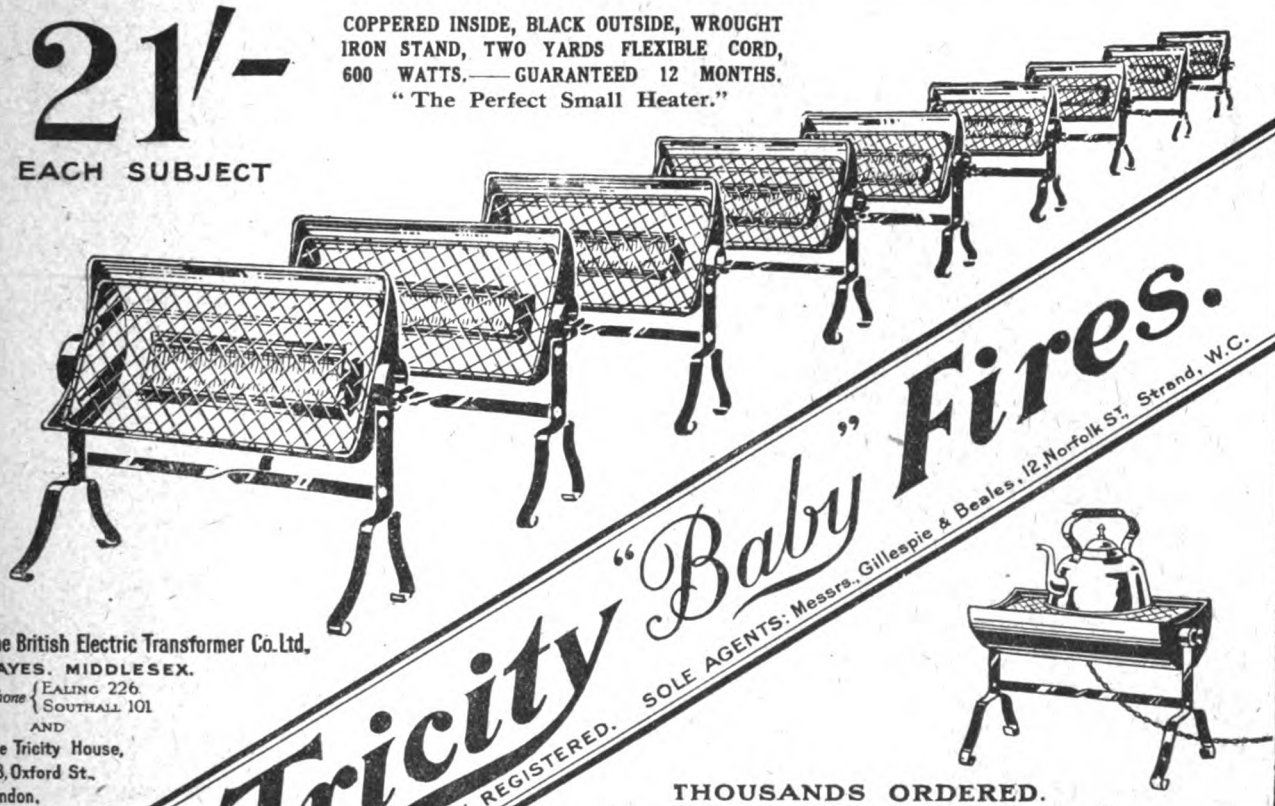
In order to ensure that depreciation is dealt with on proper lines Mr. LEAKE proposes that companies should be forced to keep a statutory register of plant in which the depreciation of all items would be entered. The French law requires not less than 5 per cent. of the surplus balance to be put to reserve, and although this may be far from sufficient it is at least a move in the right direction. British companies are not compelled to do anything to meet depreciation. We think there is a good deal to be said in favour of such a statutory register, as it would show at a glance how the assets stand. It is much more difficult, however, to arrive at a means of ensuring that the depreciation allowed is what it should be. Leaving that difficulty on one side, there is no question that the splitting up of plant into items is a proper course to follow; the old method of adding the old and the new capital expenditure together and depreciating the whole at, say, 10 per cent., is a misleading process.

In considering this important subject we should like to see greater co-operation between the accountant and the engineer. In some concerns the accountant has had things far too much his own way, with the result that the depreciation that has been allowed by no means meets the case, and the apparent financial result is by no means sound. It is not the fault of the accountant that he is ignorant of the value of machinery at special time of its existence; it could not be otherwise. But the engineer, if he is competent, knows very fairly the value of his plant. Therefore, on him should devolve the determination of the depreciation to be allowed.

Digitized by Google

21/-
EACH SUBJECT

COPPERED INSIDE, BLACK OUTSIDE, WROUGHT IRON STAND, TWO YARDS FLEXIBLE CORD, 600 WATTS.—GUARANTEED 12 MONTHS.
"The Perfect Small Heater."



Tricity "Baby" Fires.

TRADE MARK REGISTERED. SOLE AGENTS: Messrs., Gillespie & Beales, 12, Norfolk St., Strand, W.C.

The British Electric Transformer Co. Ltd.
HAYES. MIDDLESEX.
'Phone { EALING 226 / SOUTHALL 101
AND
The Tricity House,
48, Oxford St.,
London,
W.

THOUSANDS ORDERED.
These Times:—"First come, first served."
ORDER YOUR SHOWROOM SAMPLES NOW

SIMPLEX
WIRES AND CABLES

RUBBER
CAMBRIC
PAPER

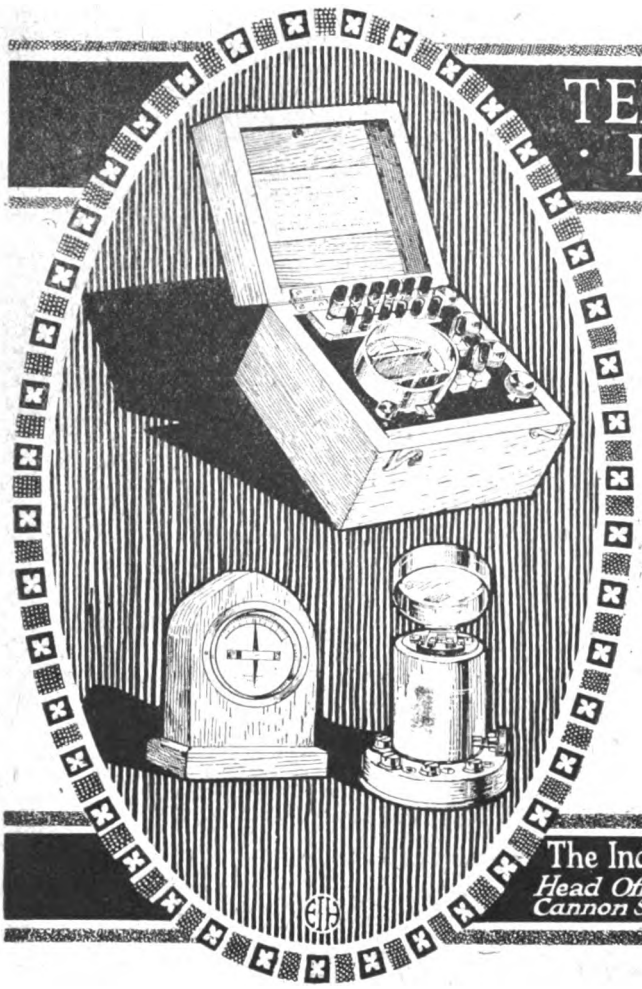
SIMPLEX WIRE & CABLE Co

MANUFACTURERS

201 DEVONSHIRE ST. BOSTON
U. S. A.

1636

Digitized by Google



TELEGRAPH and TESTING INSTRUMENTS

EVERY ENGINEER who is interested in telegraphy should obtain a copy of the Silvertown Catalogue No. 33—a fine 96-page book which describes the wide range of telegraphic apparatus made by the Silvertown Company, to whose enterprise Raymond Barker's Multi-Tone Vibrating Transmitter, Appleyard's Conductometer, Rymer-Jones' Testing Keys, and many other noteworthy inventions owe their introduction.

SILVERTOWN

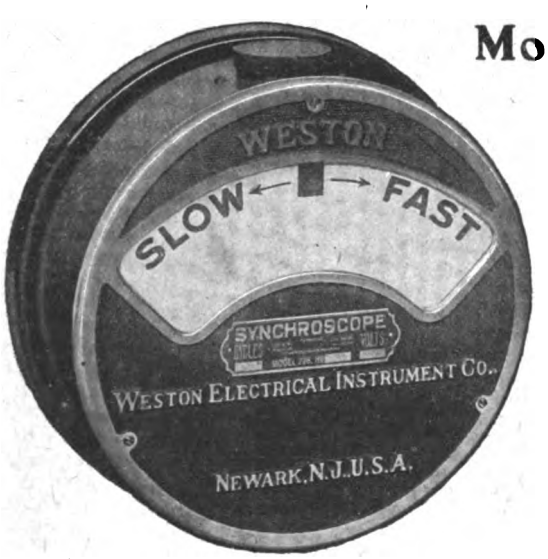
Telegraph and Testing Instruments are the outcome of 50 years' experience, and conform to the highest standards of design and workmanship. These instruments, including Wheatstone Bridges and the well-known Silvertown Portable Testing Sets are used by all Government Departments, Colonial Administrations, the leading Cable Companies, and many Foreign Governments.

A copy of this Catalogue will be sent on application.

The India Rubber, Gutta Percha & Telegraph Works Co Ltd
Head Office, 106 Cannon St, London E.C. (THE SILVERTOWN Co) *Works Silvertown, E.*

The Weston Synchroscope.

Model 226.



For full particulars write for Cat. 16.

The indications of this Synchroscope are infallible.

A glance at it shows immediately to what degree the incoming machine is fast or slow.

The movement of the pointer is smooth and certain and inspires confidence.

The superior design and construction of the instrument ensures a very long life and permanent accuracy throughout its life.

It indicates exact synchronism within one degree of true phase coincidence throughout a wide range of frequency and voltage.

It is impossible to make an error in synchronising with it.

We invite the most Minute and Critical Examination of this Instrument, both Electrically and Mechanically, in comparison with any other Synchroscope at present Manufactured, and we are confident that a Comparative Test of the Instrument will easily Demonstrate the Superiority of the Weston Synchroscope.

Weston Electrical Instrument Co.,

AUDREY HOUSE, ELY PLACE, HOLBORN, LONDON, E.C. 1.

Telephone: 2029 Holborn. Inland Telegrams: "Pivoted Smith London." Telegraphic and Cable Address: "Pivoted London."

Digitized by Google

REVIEWS.

Alternating Currents in Theory and Practice. By W. H. N. JAMES. (Cambridge: University Press.) Pp. vii.+353. 10s. 6d. net.

Most elementary books on alternating currents fall into one or other of two groups—namely, those which presuppose mathematical knowledge on the part of the reader and those which do not. The invariable rule is for authors of such books to adopt an apologetic tone craving the indulgence of the reader, in the one case for doing what they ought to do, and in the other for doing what they ought not to do.

With perhaps one exception, in no branch of engineering do students present themselves so ill-prepared as in electrical engineering, and more particularly in alternating currents. The inevitable result of this lack of preparation is that students waste not only their own time and that of their instructors, but also that of students who have had the grit properly to prepare themselves before joining the class. The fact that many students fight shy of mathematics is due, in some cases, to faulty tuition; but now that the teaching of engineering mathematics has been made "practical," there is less excuse for a student's ignorance than there was formerly.

To become an indifferent fitter a student has to spend from five to seven years at the bench. Nobody knows this better than the student himself. Why, we ask, should he complain when he is told that in order to obtain an insight into engineering "theory" it is necessary to devote two or three years of his spare time to the study of mathematics?

The absence of what we have called grit is a sure sign of decadence, and those who encourage technical students to avoid the use of mathematics are unwittingly hastening the decadence.

The book under review is one of the volumes in the Cambridge Technical Series, and the name of the author will be familiar to the many elementary students whose good fortune it has been to read a useful little book entitled "Electric Light and Power." The present volume contains an account of the fundamental principles of the alternating-current circuit, as well as a fair amount of matter on machines and apparatus, and, although there is little that is novel, the arrangement of the book is good and the reasoning is clear to the well-grounded beginner.

Lack of novelty is neither a detriment nor is it uncommon. Of the scores of books on alternating currents that have been published during the past 10 or 15 years, as far as we are aware there has been but one really novel book. Those who are employed by local education authorities, and who have to submit to the degradation of 30 or more hours of teaching per week, have neither the time nor the spirit to adopt novel methods, the more so since original thought counts for little with those who mark examination papers at a few pence each.

Of the 11 chapters into which Mr. James's book is divided, the first five deal with fundamental principles. The preliminary considerations set out in Chapter I. are followed by chapters dealing with inductance and with the flow of single-phase alternating currents in circuits possessing resistance, inductance and capacity. In the latter chapter we think it would have been an advantage to consider what happens in a circuit having R, L and C when the impressed wave is not sinusoidal; also to plot curves for two examples, one series and the other parallel, in order to study resonance. Power in alternating-current circuits is considered in Chapter IV., and multi-phase currents in Chapter V. The latter, though brief, is very well written.

The remainder of the book deals with apparatus and machinery. It is seldom one finds so much information on what some call the "engineering side" in an elementary book, and we agree with the author that those who have worked through the book will be able to proceed at once to a specialised study of the particular machine or appliance in which they are interested.

Having spoken well of the book, we feel to be on sufficiently good terms with the author to venture to criticise some of his diagrams. Most of the diagrams could not very well be better, and for this reason those which are badly drawn stand out prominently. It is very important that all the diagrams should be well drawn in a book intended for elementary students, otherwise how can young students be taught the art of draughtsmanship?

Depreciation and Wasting Assets and their Treatment in Computing Annual Profit and Loss. By P. D. LEAKE. (London: Messrs. Sir Isaac Pitman & Sons, Ltd.) Pp. xxiv.+233. 2nd edition. 10s. 6d. net.

This volume includes a careful survey of depreciation and present methods of meeting this serious charge on industrial concerns. We agree with the author that present methods leave much to be desired. The suggestion is made that limited companies should be required to keep a statutory register of their assets, showing the depreciation that is allowed each year on the separate items into which the assets would be divided. This would eliminate the slip-shod way in which the question is handled at the present time, as it would give a complete record of capital expenditure from year to year and the extent to which the assets are written off from time to time, not merely collectively but individually. The weak point about such a scheme is that there would be no statutory control of estimates of life of plant, nor could there be such control. This part of the record would depend upon the good faith of the officials, though doubtless some rough standard would arise in time.

Since the appearance of the first edition of this work, three chapters have been added. The first of these deals with the "then value" of plant as discussed in the case of the National Telephone Co. *v.* the Postmaster-General. Readers will here find set out in convenient form the arguments which were used on the occasion of that historic arbitration. The second chapter deals with the proposals of the London County Council on London electricity supply. The greater part of this criticism appeared in the columns of THE ELECTRICIAN in 1915, but we find no reference to THE ELECTRICIAN in reproducing the article. The third chapter deals with depreciation and controlled establishments under the Munitions of War Act, 1915, and calls attention to the fact that at length a Government Department has shown readiness to allow depreciation on a commercial basis as distinct from the value that is placed upon it by the Inland Revenue Department.

We need not here refer at any great length to the volume, as we deal with some of the points the author raises in our Leading Article this week. Suffice it to say that the subject is one of great importance, and we recommend manufacturers to have Mr. LEAKE's book before them, and to inquire whether they are meeting the effect of depreciation on sound lines in the works under their control.

Annuaire pour l'An 1917. (Paris: Gauthier-Villars et Cie.) Pp. vii'+452+appendixes. 2 francs.

The effect of the war on this well-known publication seems to be that the price is slightly increased, while the bulk of the body of the work is somewhat decreased, this decrease being more than counterbalanced by the length of some rather voluminous appendices. The contents are mainly of interest to astronomers and mariners, and in the present issue a very considerable section relating to physical and chemical data has been temporarily suppressed and replaced, seemingly, by others which refer to astronomy, spectroscopy, metrology (which is made to include such mundane affairs as the measurement of the tonnage of ships) and meteorology. A new editorial hand appears to some extent to have remodelled the general design of the publication, but a note in the preface leads us to think that this is due to some transient cause, and is merely a temporary expedient. One of the appendixes by M. J. Renaud, dealing with the question of the alteration of legal time in the summer of 1916, is of much general interest, and discusses the matter both from the scientific, legal and commercial points of view, adding a few notes with regard to general experience and procedure in the other countries of Europe.

Digitized by Google

ELECTRICITY SUPPLY IN RUSSIA.

BY P. GUREWITSCH.

In THE ELECTRICIAN I have already dealt with the position of the Russian electro-technical industry, Russia's requirements and import of electro-technical goods,* and the financial results of the important Russian electrical enterprises,† as well as the question of water power in Russia.‡ As a conclusion and supplement to these articles, electricity supply in Russia before the outbreak of war and the lines of its future development after the war will be dealt with in what follows.

According to statements of the Russian Ministry of Finance the total units delivered by all Russian central stations and isolated plants during the year immediately preceding the war—namely, in 1913—amounted to about 2,000,000,000. In comparison with other countries this output is, however, very small. For instance, in Germany, in the same year, 2,800,000,000 kw.-hours were sold by the stations for public supply alone, while the isolated plants delivered about 10,000,000,000 units, so that the total kilowatt-hours supplied in 1913 in Germany were equal to about 12,000,000,000 units. In the U.S.A., the output of all municipal and private stations for public supply was 11,533,000,000 in 1912. When we add to these 6,952,000,000 units, delivered by the works for electric railways, we arrive at a total output for all the American stations amounting to 17,585,000,000 kw.-hours.

Hence, we see that the number of units delivered by the central stations and isolated plants in Germany was 6½ times greater than in Russia, while the American stations (not including isolated plants) delivered about eight times more kilowatt-hours than all the Russian stations and isolated plants together. Two of the greatest American stations (those of the Commonwealth Edison Co., in Chicago, and of the Niagara Falls Power Co.) alone generated in 1914 more units than all the Russian central stations and isolated plants supplied in 1913. The output of the first-named station was 1,114,000,000 units and of the last-named 906,000,000, which make a total of 2,020,000,000.

However, if the electricity supply in Russia has so far developed comparatively slowly it is now increasing at a rapid rate. Especially the electricity supply in the four Russian towns, Petrograd, Moscow, Baku and Lodz, which possess the largest electricity works in Russia, is increasing rapidly. This is clearly shown by Table I.:—

Table I.

—	Lighting.	Power.	Tramway.	Total.
Units delivered by *all* Russian stations in 1905	49,700,000	25,581,000	19,726,000	95,007,000
Units delivered by the stations in Petrograd, Moscow, Baku, and Lodz in 1913	82,057,000	207,083,000	89,695,000	378,836,000

The units delivered in these four towns in 1913 were as follows:—

—	Lighting.	Power.	Tramway.	Total.
Petrograd	48,644,000	41,490,000	34,872,000	125,006,000
Moscow	26,830,000	52,324,000	53,585,000	132,740,000
Baku	2,920,000	79,860,000	...	82,780,000
Lodz	3,663,000	33,409,000	1,238,000	38,310,000
Total	82,057,000	207,083,000	89,695,000	378,836,000

While in the eight years 1905-1913, as will be shown later, the energy delivered by all Russian stations and isolated plants increased four times, in Germany the units sold rose during the same period only 3·4 times. In the years 1905 and 1913 the electric energy delivered in Russia was as shown in Table II.:—

Table II.

Units delivered.	1905.	1913	Per cent. increase.
By central stations—			
For lighting	52,400,000	175,560,000	238
For power, tramways, &c.	47,900,000	444,800,000	829
By isolated plants—			
For lighting	169,800,000	209,400,000	23
For power, &c.	212,400,000	1,045,000,000	393
Total	482,200,000	1,874,700,000	289

* *See* THE ELECTRICIAN, April 30, 1915, and May 7, 1915.
† *See* THE ELECTRICIAN, October 8, 1915, p. 29.
‡ *See* THE ELECTRICIAN, January 7, 1916.

As we see from this table, the energy delivered by the central stations for power and tramways shows the greatest tendency to rise. The units delivered for tramways alone increased from 19,700,000 in 1905 to 205,200,000 in 1913, which is an increase of 941 per cent. Further, we see that the energy delivered by the Russian isolated plants was only double the energy delivered by the Russian central stations. Hence, the future prospects of the central station in Russia are more favourable than in Germany, where the supply of isolated plants is 3·5 times greater than that of the central stations.

In the statistics of the above table the figures for eight provinces of Russian Poland could not be included on account of the war. In the year 1905 37,000,000 units were there delivered. Assuming that in these eight provinces also, as in all the other provinces of Russia, the energy delivered increased fourfold, the units delivered in Russian Poland must have reached in 1913 a total of 148,000,000. Therefore, the total energy, delivered in 1913 in Russia, was about 2,000,000,000 kw.-hours, of which 20·5 per cent. were delivered for lighting and 79·5 per cent. for power and tramways. However, in 1905 46 per cent. of the total energy was delivered for lighting, and only 54 per cent. for power and tramways, showing that in the Russian electrical stations and private plants the supply of power is gradually becoming more important than energy for lighting. The same tendency can be observed also in other countries. Thus, in the U.S.A., from 1902 to 1912 the connected kilowatts for power increased by 842 per cent., while the connected kilowatts for lighting increased during the same decade by only 270 per cent.

The energy for lighting, power, and traction delivered in the four Russian towns having the largest stations was as follows:—

—	Petrograd.	Moscow.	Baku.	Lodz.
Population	2,000,000	1,500,000	300,000	500,000
Power stations, No.	4	2	2	2
Installed capacity	64,280	58,100	32,000	16,350 kw.
Total peak load	42,826	48,130	20,682	11,000 kw.
Kw.-hours sold	125,000,000	132,740,000	82,780,000	38,310,000
Kw.-hours sold per cap.	62·5	87	276	76·5
Comprising—				
Lighting	39	19	3·5	9·6 p.c.
Power	33	40	96·5	87·3 p.c.
Traction	28	41	...	3·1 p.c.

These figures are given generally for 1913. For some of the stations the statistics are published only for that year, and consequently these statistics must be used. If we compare this table with the one published in THE ELECTRICIAN in 1913 (p. 399) in regard to the supply of electricity in London, Berlin and Chicago in 1911-1912, we see that Petrograd, like London, consumed the greatest part of the energy for lighting purposes. On the other hand, Moscow, like Chicago, consumed only one-fifth of the energy for lighting, and was in this respect in a more favourable position than Berlin, where one-fourth of the total energy was consumed for lighting. Two-fifths of the total energy in Moscow was consumed for power, while in London for this purpose only 27 per cent., and in Chicago, 19 per cent., were so consumed.

The centre of the Russian-Polish textile industry, Lodz, and the centre of the Russian naphtha industry, Baku, occupy a special position in regard to consumption of electrical energy for power, on account of the great use of electric motors in these two towns. 87·3 per cent. of the total energy was consumed for power in Lodz, and actually up to 96·5 per cent. in Baku. In the consumption of electrical energy Baku, with 276 kw.-hours per capita, holds the first place among all Russian towns.

With the exception of the stations of Baku and Lodz, which possess a high load factor of 61·4 and 32·7 per cent. respectively, the other Russian stations are pure lighting stations, with low load factors, which in 1913 were as follows: For the three Petrograd stations, 28·6, 29 and 31·1 per cent.; for the lighting station of Moscow, 24·8 (1912) per cent.; for Kharkoff, 30 per cent.; for Riga, 20·8; and for Odessa, 11·4 per cent. even.

The use of electrical power in Russia is generally very small on account of the high prices of electric motors, this being the result of the high duties. The high tariffs for electrical energy also check in a great measure the general use of electric motors. While in Germany the normal tariff for power is only 16 pfennig (2d.), and in Switzerland 16 centimes (1½d.) only, the normal Russian tariffs for power are about 16 kopeks (4d.) per unit—that is, more than 100 per cent. dearer. In some towns the power tariff amounts even to 18-20 kopeks (i.e., 4½d.-5d.) per kilowatt-hour. In this way the fact is explained that in Petrograd the number of the electric motors connected was in

Digitized by Google

1913 only 6,851, in Moscow (in 1912) 6,976, in Warsaw (in 1913) 3,103, and in Lodz 2,404 (in 1912), while the number of electric motors connected to the Berliner Electricitätswerke was about 45,000 in 1913-14.

The small use of electric motors and the high tariffs for electrical energy are, moreover, a great danger to the whole future development of the Russian industry after the war. On account of high taxes, freight, wages, prices of raw materials, &c., all countries will be forced more than ever to produce cheaply and economically; otherwise, the home industries will not be able to compete with countries like the U.S.A., Japan, &c., which have suffered very little through the war, or have even profited by it. The productive capacity of an industry depends, however, principally on the great application of mechanical power, and the great productive capacity of the American industry is to be explained for the greater part by the fact that wherever possible efforts have been made to replace manual labour by mechanical power.

By rational generation and distribution of electrical energy electric motors in most cases become the most advantageous and convenient form of power, and only by the electrification of a factory can its capacity be raised without radical alterations. In countries with few coal deposits, and these not centrally placed, in which category Russia is to be found, the electric motor is, as we may learn from Sweden, Norway, Northern Italy, Switzerland, &c., the only rational form of power.

Among the technical and industrial problems, the resolution of which has been made indispensable in Russia through the war, the adequate supply of electricity will certainly take a very important place. However, if we turn to the present state of affairs we see that electricity supply in Russia has hitherto been on a very irrational basis, being uneconomical and expensive. In Germany the decade 1900-1910 was characterised by the development of electricity supply by means of long distance transmission, and in the last few years further progress has been noticeable there by the erection of large stations. Electricity supply in Russia, on the other hand, has not yet stepped out of the stage of uneconomical local stations. The exploitation of large hydro-electric works or of the potential energy accumulated by nature in the form of pit coal, brown coal, and peat, in large stations, built on the spot, with long-distance transmission, has hitherto been, with a few exceptions, quite unknown in Russia. Moreover, the existing Russian steam stations, which work with expensive Donetz or English coal, correspond in no wise with the modern technical demands and are, with few exceptions, not up to date.

Electricity supply has lately made such progress that machines, which some 10 to 15 years ago were the leading product of their time, are now little suited for generating cheap electrical energy. The most important Russian electrical plants were built about 14 to 20 years ago, and have been only partially modernised since. According to Russian statistics, in 47 Russian steam stations in 1913, with a total capacity of 228,000 kw., there were 70 steam turbines, as against 137 old type steam engines, and of these there were 25 still working in 1913 in Petrograd. Of the larger Russian stations only the following were provided with turbo-alternators: The station of the Company for Electric Lighting in Moscow, started in 1886 (1912: 10 turbo-alternators, Siemens & Schuckert, with a total capacity of 35,000 kw.); the municipal tramway station of Moscow (1913: Six turbo-alternators, Brown & Boveri, with a total capacity of 23,100 kw.); the municipal tramway station of Petrograd (1913: Three turbo-alternators, with a total capacity of 7,500 kw.); the station of the Company for Electric Lighting in Lodz, started in 1886 (1912: Six alternators with a total capacity of 15,000 kw.); the station of the Electric Company of Odessa (Ltd.), in Odessa (1913: Three turbo-alternators, A.E.G., with a total capacity of 7,500 kw.). All the other stations were worked either with steam engines, or, like the three stations of Petrograd and the station of Baku, were partially provided with modern turbines and partially with old type steam engines; but even where steam turbines were employed, the sets had a capacity of only 2,500 kw. to 3,500 kw.

But even if the Russian stations were modernised, as, for instance, it is intended in the case of Petrograd at a cost of 15 million roubles (=£1,500,000), it would be of little service, for the entire present Russian supply is based on the wrong principle of local works, which can never supply cheap energy, the more so as they are all working with expensive coal, having heavy freight charges. If, therefore, money were spent upon modernising the existing Russian stations the result would still be incomplete; for within a few years Russian electricity supply will have to adopt a system of inter-connected stations, working with cheap, if even inferior, fuel, or water power, as only on this basis is cheap electric power possible. In the present state of Russian electricity supply there is, however, no tendency towards concentration. In 1913 there were only 12 stations with a capacity of more than 5,000 kw., as is to be seen from the following table:—

Table III.

Country.	I. Year.	II. Total No. of stations.	III. No. of stations with capacity greater than 5,000 kw.	IV. Ratio of III. : II. in per cent.	V. Capacity of all stations in kw.	VI. Capacity of stations greater than 5,000 kw.	VII. Ratio VI. : V. in per cent.
U.S.A. .	1912	5,221	161	3·1%	5,135,000	3,610,000	70%
Germany	1913	4,040	103	2·0%	2,100,000	1,560,000	74%
Russia .	1913	about 220	12	about 5·5%	...	199,000	...

Among the 220 stations there are in Russia 90 municipal works. As regards the total capacity of these 220 stations, there are unfortunately no precise statistics. More exact particulars are given in the Russian statistics for only 74 central stations. Of these works 43 were steam stations with a total capcity of 228,562 kw., while the total capacity of the 74 stations was about 248,000 kw. Among these were almost all the most important Russian stations, so that the total capacity of the other 145 stations with an estimated average capacity of about 600 kw. each comes to about 85,000 kw. The aggregate capacity of all the Russian central stations can scarcely exceed 325,000 kw. to 350,000 kw. The 12 stations with a capacity of more than 5,000 kw. in 1913 were the following: The lighting station of Moscow, with 35,000 kw.; the tramway station of Moscow, with 23,100 kw.; the station of the Company for Electric Lighting of 1886 in Petrograd, with 25,000 kw.; the station of the Belgian Company in Petrograd, with 18,460 kw.; the station of the Company for Electric Plants in Petrograd, with 12,320 kw.; the Municipal tramway station of Petrograd, with 7,500 kw., to which should be added Baku, with 29,000 kw.; Varsovie, with 11,590 kw.; Lodz, with 15,000 kw.; Kiew, with 7,500 kw.; Odessa, with 7,500 kw.; and Riga, with 7,060 kw.

As compared with the parochial character of Russian electricity supply stations, we have in Germany such undertakings as the Gröba works (in Saxony), supplying 814 places with cheap energy; the Amperewerks of Munich, supplying about 348 places; and the station Kretschau, supplying 249 places; further, 19 stations supply with energy 100 to 200 places each, 52 stations 50 to 99 places each, and 133 stations 10 to 49 places.

The necessary conditions for building large stations for transmission certainly exist also in Russia. Besides large water powers, which were mentioned in a previous article, there still exist in Russia immense moors, which could supply cheap fuel for large stations.

The surface in Russia covered with peat moors is in comparison with other countries, as follows*:—

European Russia	38,000,000 ha., or 7·0 per cent. of the total surface.
Germany	2,837,000 ha., or 5·2 per cent.
Sweden	5,198,000 ha., or 12·6 per cent.
Finland	7,400,000 ha., or 20 per cent.
Ireland	475,000 ha., or 5·8 per cent.

The exploitation of these moors for generating cheap electrical energy, as is carried out in a great measure at Wiesmoor, near Aurich (Germany), ought to be of still greater importance in Russia, since just those provinces in which there are many moors are very far from the deposits of other fuel, such as coal or naphtha, which latter is very much employed as fuel for steam boilers. Since the moors are found only in flat country, there is in their vicinity no important water power, which could be used for electricity supply. On the other hand the moors are situated close to those provinces where important industries are already carried on; for instance, in the provinces of Vladimir and Moscow, with their highly-developed textile industry.

The importance of the peat moors for the future electricity supply of Russia is to be seen clearly from the fact that they can supply about 96 milliards of tons of peat. Even if, in calorific value, a ton of peat is only equal to half a ton of Donetz coal, nevertheless the heat value of the existing peat reserves is equivalent to 48 milliards of tons of coal. The total coal reserves of European Russia were valued before the war at only 75 milliards of tons, of which 56 milliards belong to the Donetz basin, and these relatively small coal reserves must in the first instance be reserved for the Russian metallurgical industry, which will increase immensely after the war.

In conclusion, reference may be made to the financial condition of

* 1 Hektar = 10,000 sq. meters.

Digitized by Google

the Russian electrical undertakings. According to the statistics of the Russian Ministry of Finance, the capital invested in Russian private enterprises for electricity supply in 1905 and 1912 was as given in Table IV. :—

Table IV.

—	1905.	1912.
Number of companies	9	21
Capital	29,900,000 roubles (£2,990,000)	84,890,000 roubles (£8,489,000)
Debentures	9,100,000 roubles (£910,000)	15,700,000 roubles (£1,570,000)
Capital and debentures	39,000,000 roubles (£3,900,000)	100,590,000 roubles (£10,059,000)
Profits in per cent. of the capital	7·79 per cent.	14·43 per cent.
Dividends	3·78 per cent.	7·66 per cent.

In the seven years from 1905 to 1912 the capital of the Russian private companies for electricity supply increased threefold, and the dividends more than doubled, whereby these dividends exceeded 7·5 per cent. This dividend, however, should not be regarded as a high one, for in Germany the average dividend of 189 electrical companies was in the five years 1907-8—1911-12, 8·13 per cent.

Among the Russian enterprises for electricity supply the above-mentioned "Company for Electric Lighting of 1886" took a predominant position before the war. This company was founded in 1885 by Mr. Carl Siemens, with a capital of 1,000,000 roubles, and up to 1914 this capital gradually rose to 50,000,000 roubles. About 73 per cent. of the total share capital of 84,890,000 roubles, which was invested in 1912 in the Russian electric lighting companies, belonged to the "Company of 1886" and to the enterprises which were controlled by it. These enterprises, in which the German "Elektrische Licht und Kraft-Anlagen Akt. Ges."* and the "Bank für Elektrische Unternehmungen," of Zurich, are greatly interested, are known in Russia as the "Light and Power" group, and had in 1912 a total capital of 66,250,000 roubles, shown in Table V. :—

Table V.

—	Established.	Capital.
Company for Electric Lighting of 1886	1886	40,000,000 roubles (£4,000,000)
"Imatra" société Anonyme pour la production et la distribution de l'énergie électrique (capital Fr.30,1 0,000, of which 70 per cent. is paid up)	1913	11,250,000 roubles (£1,125,000)
Electric Power Company of Baku	1899	9,000,000 roubles (£900 000)
Company for Power Transmission (Ielectro-peredatcha)	1913	6,000,000 roubles (£600,000)
Total	...	66,250,000 roubles (£6,625,000)

In 1914 the "Company of 1886" issued further shares to the extent of 10,000,000 roubles, so that the capital of this group has now risen to 76,250,000 roubles.

The second important group of Russian electric lighting companies is formed by a number of companies with a total capital of 20,080,000 roubles, in close relation with the A.E.G. To this group belong, among others, the following companies: "Société d'Electricité d'Odessa (established 1910, capital 3,000,000 roubles); the "Electric Company of Kiev" (established 1902, capital 6,000,000 roubles); the "Central Electric Co." (established 1897, capital 3,260,000 roubles), &c.

As was mentioned above, only about 90 to 100 Russian stations are municipal, but most of these municipal works (excluding the tramway works) are unimportant, and of little capacity. Of the more important municipal stations, we may mention the tramway stations of Moscow (23,100 kw.), Petrograd (7,500 kw.), Warsaw (4,000 kw.), and the lighting stations of Riga (7,060 kw.), Vilna (1,025 kw.), Vladivostok (1,350 kw.), Kharkow (2,500 kw.), Jaroslawl (1,240 kw.), &c. But during the war a strong tendency has been developing in Russia for the transfer of private stations into the hands of the municipalities. At the head of this movement stood the municipalities of Moscow and Kiev, and it benefited by the fact that most of the Russian private stations were entirely in the hands of German companies or, as is the case with the "Company of 1886," working for the greater part with German capital.

* This company is closely connected with Siemens-Schuckert and the "Deutsche Bank."

The Russian Government also has lately taken the point of view that the accumulation of large private capital in the electric lighting enterprises must be stopped as much as possible, and that electricity supply by the municipalities ought to be fostered by every means. According to the project of the Russian Ministry of Commerce and Industry, which, however, has not yet become law, certain restrictions in the granting of concessions for the erection of electric stations ought to be made. The manager and not less than three-fourths of the administrative members must be Russian subjects. Moreover, the companies have to be formed in accordance with Russian law. When granting concessions, the tariffs for electrical energy must be fixed and special advantages for particular consumers are forbidden. Concessions may not exceed a period of 80 years, and must be put in operation within five years after having been granted. The re-purchase by the Government can be effected after a period of 30 years.

But by thus increasing the difficulties of private companies and by granting facilities to municipal stations, which generally supply electrical energy much more cheaply than the Russian private stations, a rational electricity supply cannot be obtained. The root of all evil in this case is the parochial character of the electricity works, and from this disadvantage the municipal works will never be free. The erection of small, or at most, medium size, works, is the result, and each town or community is influenced only by its local interests. Moreover, the political boundary of a town is at the same time the limit of the area of the undertaking. Therefore, the local municipal stations are as uneconomical as the private ones. A rational and economical electricity supply can only be reached by State interference and the erection of large Government stations, working with cheap fuel or water-power. With a view to increasing the utility factor and diminishing the working costs the several stations should be connected by a high-tension network, while the sale of the energy produced by the State stations could be left in the hands of the existing company and municipal stations.

But although this solution is theoretically the only rational one, there are nevertheless great difficulties in the way of its realisation. The State purchase of the existing electricity works would not create any difficulties to the Government, as the total capital of the private Russian undertakings in 1912 did not exceed 100,000,000 roubles (£10,000,000).

On the other hand, great difficulties would arise in the realisation of this plan on account of the small development of Russian industries, the low density of the population, and the immense distances between the larger Russian towns.

As the consumption of energy in Russia in the eight years 1905-1913 rose fourfold and reached 2,000,000,000 kw.-hours, the consumption up to 1926, even at the former rate of development will be six times greater than in 1913, and will reach 12,000,000,000 units. If, therefore, in Russia in the next decade—*i.e.*, till 1926—no plan is worked out for the rational and uniform electrification of the whole empire, then the reorganisation of the Russian electricity supply will have to battle with the same difficulties which are now checking the rational concentration of electricity supply in the West of Europe.

CORRESPONDENCE.

THE CHOICE OF VOLTAGE FOR RAILWAY ELECTRIFICATION ON THE DIRECT-CURRENT SYSTEM.

TO THE EDITORS OF THE ELECTRICIAN.

Assuming Mr. Lydall wishes to put the case for the electrification of main lines as strongly as possible, there seems to me to be an inherent weakness in his proposal to use field control for increasing the speed of the driving motors. However economical and convenient this method may be, it seems unsound in principle to reduce one of the torque-producing factors in the motors by weakening the field at speeds where the train resistance is highest. Consequently with field control it is not possible to use the material of the motor to the best advantage when the load is greatest.

What is really needed for main line work is a family of speed-tractive effort curves similar to that shown by Mr. Lydall, but produced by voltage control. As an example of curves obtained in this way, the locomotives on the Loetschberg railway may be mentioned, where single-phase commutator motors are used and the voltage is varied by means of transformer taps.

Digitized by Google

Voltage control would also be more economical than resistance control in the shunting yard, where starting losses are so important.

In making these comments I trust I shall not be thought presumptuous for referring to a type of motor condemned by so many before reaching its full maturity.

London, May 28. S. P. SMITH.

ITALIAN WIRELESS TELEGRAPH INVENTIONS.

TO THE EDITORS OF THE ELECTRICIAN.

In the number of your journal for April 13th, under the above title in the column devoted to "Legal Intelligence," M. Gerard, advocate, publishes the résumé of a case which was decided in Italy two years ago. The purpose of the publication was to support M. Artom's pretensions to be the inventor of the triangular directive aerial and of the radiogoniometer.

As it is not the moment to indulge in personal competitions, I reserve to myself the right to enter into the merits of the question when the war is over. For the moment I will limit myself to the following remarks :—

1. M. Gerard is one of M. Artom's numerous lawyers.

2. M. Gerard's note contains nothing more than what M. Artom himself had already stated in his letters published in your journal in the autumn of 1915.

3. M. Artom and M. Gerard's letters and notes might lead the reader to conclude that the Courts had examined and decided the question who was the inventor of the triangular aerial and of the radiogoniometer. This is not so. I quote from the judgment of the Court of Appeal : "It is not decided here whether the inventions, the subject of the Italian patents No. 88,765 and No. 88,766, were made by the scientists Brown and Blondel, or by M. Artom, or by MM. Bellini and Tosi, whose research was the subject of the cases which were heard in the years 1911-12, and which were terminated by the transaction. The sole purpose of to-day's inquiry is to ascertain which of the two parties did not fulfil the obligations assumed with the 'transaction.'"

4. M. Artom exploits the obscurity of a Notarial Act in order to prove that it was my intention to recognise his rights to the invention of the radiogoniometer. I explicitly declare that this was not my intention. The Tribunal has interpreted the aforesaid act according to my views, the Court of Appeal according to M. Artom's pretensions. Legal subtilties cannot render M. Artom the inventor of an apparatus which even now he has not understood, as clearly appears from all his publications, and in particular from the last one of the "Rendiconti" of the "Reale Accademia dei Lincei," 1917, p. 50, abstracted in "L'Elettrotecnica," 1917, p. 237.

5. M. Artom has always refused to accept a loyal inquiry into the question, such as Capt. Tosi and myself have often proposed during these last 10 years.

6. My opinion is that neither M. Artom, nor myself, nor Capt. Tosi have any claims to the invention of the triangular aerial.

7. The patents of the radiogoniometer in the countries in which the patentees must declare or swear that they are the real and sole inventors are in the names of Bellini and Tosi.

8. M. Artom himself has recognised that I was the inventor of the radiogoniometer in a letter written to me on March 4, 1907. The translation of the phrase relative to the question is as follows : "I thank you for your letters of February 27th and March 1st. I very much approve the apparatus proposed and imagined by you for the determination of the azimuth, and I hope that you will also succeed in overcoming the difficulties of construction with which you will meet. Altogether, it would be convenient to cover the thing immediately by a patent."

Enghien-les-Bains, May 26. E. BELLINI.

"THE THEORY OF ARMATURE WINDINGS."

TO THE EDITORS OF THE ELECTRICIAN.

I am much obliged to you for sending me a proof of the abstract of the above Paper, which you are about to publish. In this connection I should like to say that the Institution of Electrical Engineers have kindly permitted me to reproduce Tables II. and III. separately, in the form of a separate sheet, so as to be in a handier form for use in the design office. I have already sent these sheets to many of my fellow designers, and shall be pleased to send them to others who would like to have them if they will kindly drop me a line.

London, May 24. S. P. SMITH.

CHARGING APPARATUS FOR ELECTRIC OMNIBUSES.

That the electrically propelled vehicle has come to stay is evidenced by the remarkable number of such vehicles in use, especially since the beginning of the war. The progress of the electric vehicle has been mainly due to the fact that when the war started the best horse and petrol vehicles of all kinds were commandeered by the Military Authorities. Further, the increased cost and more or less limited supply of petrol has helped to give an impetus to the electrical method of transportation by providing an opportunity which has been promptly seized by the manufacturers of electric vehicles, with the result that orders have been received beyond their capacity for early and prompt delivery. The electrical vehicle to-day occupies a strong position owing to its reliability and economy due to well constructed motors, chassis and thoroughly reliable and durable batteries. Although such rapid progress has been made we have not as fully appreciated the many advantages of this type of vehicle as has been the case in the United States of America, where it is estimated that there are about 40,000 electrical vehicles in use. A short time ago the number of electric vehicles estimated to be in use in the United Kingdom amounted to 150, but at the end of 1915 this number had increased to something over 660.

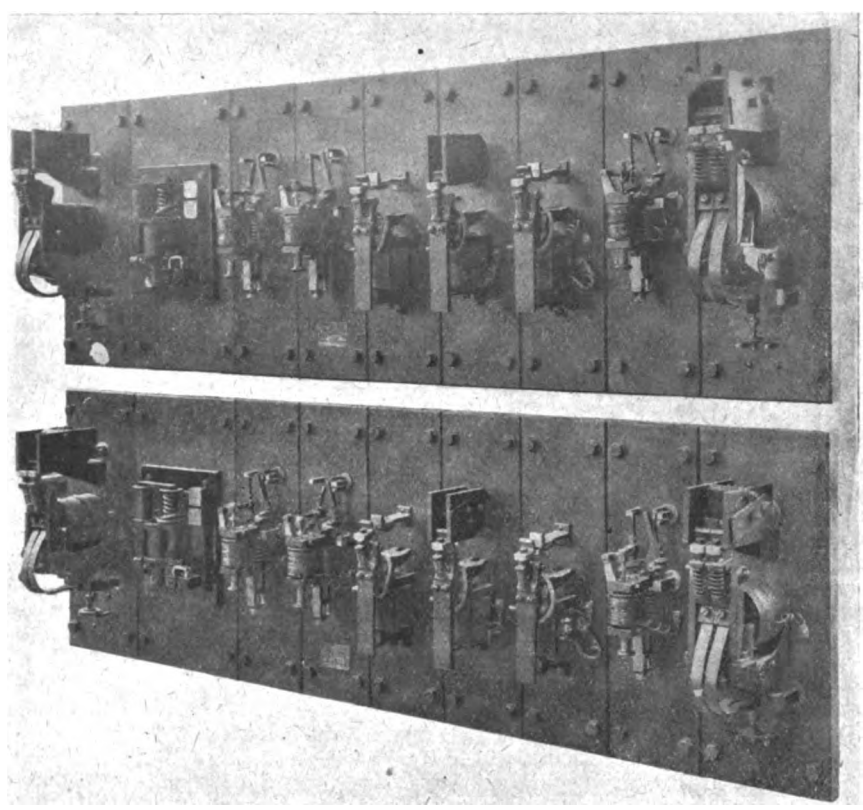


FIG. 1.—VIEW OF CONTACTOR PANEL FOR CHARGING ELECTRIC OMNIBUSES AT YORK.

Many municipal authorities are beginning to appreciate the advantages of electrically propelled vehicles, especially as they provide a means for boosting up their load at times of low peak.

Digitized by Google

While the conditions outlined above are more or less satisfactory full advantage cannot be taken of electric vehicles until the charging arrangements in connection with any station are designed to give the widest scope for charging the vehicles, and thus further increase their useful range. It is with this idea in view that the B.T.-H. Co have recently built, for the City of York, in connection with the running of their electric 'buses, motor booster sets with a specially reliable and fool-proof control gear for charging the accumulators used in this service.

The charging switchgear, which is as is simple as possible, and capable of operation by unskilled persons, consists of an automatic starter and battery switch, having no-volt and overload features, the whole of the switchgear being installed in shelters placed at the outlying terminus, to which these 'buses run, so that the cells can be charged when necessary at the end of the journey.

The operation of this gear, which is controlled from outside the building, and the functions performed by the switchgear, are as follows:—On closing a small snap switch, the motor booster set is started up, but before this can be done, a field rheostat controlling the generator field, must be brought back into the weak field position; this rheostat is interlocked with the other gear, so that it is impossible to start up the set except under these conditions. The closing of the switch puts into operation the control gear of the motor, which consists of special series contactor switches, for which the B.T.-H. hold the patents. These switches remain open when any current exceeding that for which they are set, is thrown on the motor, but when this current dies down, due to the motor speeding up, they will close in the correct sequence, bringing the motor up to full speed. When the set is up to speed, the generator volts may be raised by means of the field rheostat, until a point is reached at which the voltage is just above the voltage of the battery being charged, when the automatic battery switch closes the circuit to the accumulators, the charging current being further regulated by raising the generator volts by means of the field rheostat.

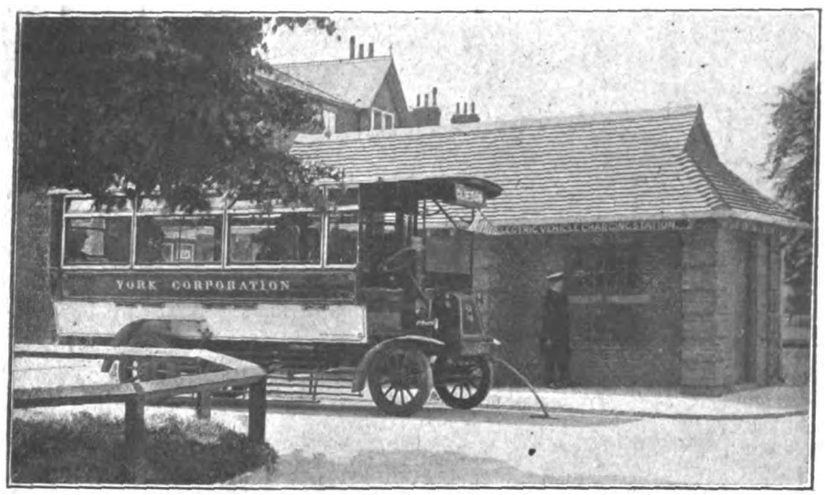


FIG. 2.—VIEW OF ELECTRIC OMNIBUS ON CHARGE AT YORK.

The automatic battery switch is arranged to open in the case of reverse currents, due to the booster set shutting down from any cause whatever.

Overload relays are also included, giving efficient protection against an earth on either pole of the generator circuit, and against overload on the motor circuit itself. When any relay trips it disconnects the faulty circuit, and at the same time shuts down the motor booster set. If such should occur during the charging of the cells, these relays can be electrically re-set by re-closing the small snap switch used for starting. A similar snap switch is provided for disconnecting the starting gear when the charging of the cells has been completed.

The whole of the control operations outlined above are made out side the shelter in which the switchgear is enclosed, the control panel consisting of a small junction box, conveniently placed, containing the stopping and starting switches, field rheostat handwheel, and necessary terminals for connecting up the charging plugs and cables from the vehicle to the charging switchgear, these plugs and receptacles being designed to comply with the requirements of the Electrical Vehicles Committee.

Fig. 1 shows the control gear and Fig. 2 is a view of one of the omnibuses.

WOMEN IN INDUSTRY.

A discussion on "Women in Industry" took place at a meeting of the Circle of Scientific, Technical and Trade Journalists on May 24, Mr. L. Gaster being in the Chair.

In the course of a few introductory remarks Mr. Gaster said that while all must share in the admiration of the work done by women since the outbreak of war, it was necessary to consider how far such efforts, made in an emergency, could be permanently continued without prejudice to health. It was desirable to know in what fields women had shown themselves specially apt and for what classes of work they were clearly unsuited. Mr. Baillie, the Chief Technical Adjudicator of the D.A. Section, Ministry of Munitions, had kindly consented to give them the benefit of his experience in regard to munition work, and they would also have the opportunity of hearing the views of others connected with special fields of labour. One important question for consideration was how far well educated people could take up higher positions in industry. Owing to the demands of the army very few young men were now being trained for chemistry, engineering and professional pursuits, and it might be that women could step in and fill the gap to some extent. In conclusion, Mr. Gaster said that scientific and technical journalists should endeavour to elicit the actual facts on these matters and then to pass on the information thus acquired to the manufacturers and others interested.

Mr. G. H. BAILLIE, referring to the employment of women in munition works, said that there had been three great steps taken early in the war—the agreement with the trade unions as to dilution with female labour, the distribution of the labour available, and the appointment of dilution officers to meet manufacturers and give advice on the subject. In some cases there had been a prejudice to overcome regarding the employment of women. It was easier to get consent for dilution with men and boys than for dilution with women.

The variety of work being done by women to-day had been strikingly shown at the Exhibition at the Royal Colonial Institute. All this involved much re-organisation of work and he welcomed the opportunity of discussing the matter with technical journalists in order that the nature of this re-organisation might be more generally known.

The results obtained were due to the policy of re-distributing the work in each process so as to make the fullest use of the few skilled men available, and enable women to be trained for some specific detail. Thus in connection with drilling, there were the separate processes of grinding the drills, setting the work and undertaking the actual drilling. By specialising on these distinct elements it was possible to make use of unskilled labour which, however, could be trained in a very short time to do the one particular thing exceedingly well. The general adaptability and versatile skill of the craftsman naturally involved a much longer period of training. This specialisation was not really a new thing. It had already come about in engineering in the division of work among fitters, millers, planers, &c., and was now only being carried to its logical conclusion. A notable instance of such methods was the Ford car. Speaking generally it was now possible to do, after a few months' training, what previously required years of training to accomplish.

An important feature, also, was the careful organisation of the training itself. No time was wasted and the process of instruction was carefully thought out; whereas in the old form of apprentice training it was common knowledge that the boy was expected to pick up knowledge rather than be instructed, and a great deal of his time was spent in work which taught him very little.

As regards the nature of the work, they had found out that there were some jobs, those requiring manual dexterity and delicacy of touch, particularly, which women could do better than men, some even that only women could do. On the other hand, there were naturally others that required strength and special forms of endurance which could only be done by men. They had found that a well educated woman picked up the work with greater ease than a boy, and was helped by her keen interest in what went on. The advantages of this specialisation and organisation of detail were so great that he did not believe either workers or manufacturers would be content to return to the old methods after the war.

Digitized by Google

The Chairman mentioned that letters had been received from the Prime Minister, the Rt. Hon. Arthur Henderson, the Minister of Education, Lord Haldane and others expressing interest in the subject and regret at inability to be present. He also read a letter from Dr. Charles Carpenter, who emphasised the great value of women's labour in the South Metropolitan Gas Co.'s work, extending even to their employment in the retort house.

The Chairman then called upon Miss A. M. Anderson to open the discussion.

Miss ANDERSON (H.M. Chief Lady Inspector of Factories) gave an account of the comprehensive work of the Home Office in connection with women's work in the most varied fields. In many cases it was necessary to make very careful preliminary inquiries as to the kind of work which they could do, and the Factory department habitually advised on these matters. In some instances, notably where the work was of a heavy character, special precautions had to be taken against bodily overstrain, and there were naturally some kinds of labour for which women were physically unfitted. Speaking generally women had shown great care and zeal in the work they had undertaken; the instinct for personal tidiness and cleanliness extended to their job, so that in many cases they did the work in a cleaner and more finished way than men. In the employment of women human relations counted for a great deal. Almost anything could be done with them if the treatment of employers was kindly and considerate. Indeed, the danger was that they might overdo their exertions. In this connection we ought not to lose sight of the fundamental fact that whatever work women might do in an emergency their greatest sphere was the home. In the future it would be essential for the well-being of the nation to bear this in mind, and not to rely too much on women as a permanent source of labour in the same circumstances as men. While they would doubtless prove a valuable supplement to male labour their duties in the home and as mothers must receive first consideration and nothing must be done to impair their health and capacity in this respect.

Mr. S. R. CHICHESTER (Explosives and Chemical Department, M.O.M.) described his experience in explosive factories. He had been surprised to find that women could be well employed in this class of work. The use of this kind of labour entailed danger to (1) the factory and (2) to themselves. Women were, however, found to be quite as careful as men. No disasters that had occurred could be attributed to women, and in his opinion the dangers had been much exaggerated. The question of moral dangers had been raised, but this presented no real difficulty. It had been supposed that women were useless on emergency, but this had not been found to be the case where fires had occurred. As a rule the men had not shown any objection to teaching the women.

Miss MONKHOUSE stated that shop organisation was an important factor in the employment of women. Foremen were not always successful in the management of women and it was better to have forewomen rather than foremen. The choice must be judicious. In many classes of work only educated women were suitable and these should be selected as forewomen. Moreover, it was desirable to have a foreman above the forewoman, and tact was necessary along with ability to work with a foreman. The object of the Ministry was to give employers confidence in women and to offer assistance; a certain number of women dilution officers were kept by the Ministry to give assistance. These had personal experience and also the accumulated experience of the Ministry. Their work had been found most successful.

Mr. ATTWOOD thought that the biggest trouble was at the top; the employee was what the employer made him. The first difficulty was to educate the employer. It had sometimes been said that specialisation meant monotony, but monotony of this kind could be overcome. Mr. Attwood gave an instance of the advantages of specialisation, viz., the manufacture of splinter mattresses made up with asbestos. In a certain factory by means of specialisation wages rose by 50 per cent., but the wages cost went down in the ratio of 8·6 to 6·4. For an interval of one hour twice a week the women workers in this factory were taken from their work and were given a lecture to illustrate the methods of handling and dealing with their work. This was found to be a great advantage. In several cases it was desirable to have a man in authority somewhere. It was found that women responded wonderfully when the employer had their good will. Men were suspicious on account of the past, and the employer must not expect labour to change its point of view as quickly as the employer changed his. This was impossible.

Mrs. ARTHUR WEBB referred to factories run entirely by nuns as examples of success in this direction by women alone.

Miss COOKE (Employment Bureau, Ministry of Labour) was rather afraid that a good deal of trouble had been due to a lack of realisation that the Ministry was there to meet difficulties. She asked what was to happen to girls after the war who were now earning large wages. Our object normally should not be to send women into the factory, but should aim at women's work in directions for which men were not suitable.

Canadian Society of Civil Engineers.—It is proposed to change the name of the Canadian Society of Engineers to the Canadian Institution of Engineers and to extend the aims of the Society so as to include electrical, chemical, mining and mechanical engineers.

FACTORY INSPECTOR'S REPORT.

The annual report of the Chief Inspector of Factories and Workshops for 1916 has been issued by the deputy chief inspector (Mr. H. M. Robinson), in the absence of Sir Arthur Whitelegge through illness. We give the following extracts from the report, which is much shorter than usual, but on this occasion reasons of economy are responsible for the omission of the report of Mr. G. Scott Ram, H.M. Electrical Inspector of Factories:—

The inspectors have again been largely employed on special war work, much on the lines indicated in last year's report. Fourteen more of the staff have joined the Forces during the year, bringing up the number to 45, and three more were lent to other Government departments, making this total 43. The medical inspectors have been actively engaged in dealing with the investigation and prevention of poisoning caused by the dope with which the wings of aeroplanes are varnished, and also by the materials used in the manufacture of high explosives. Mr. Bellhouse, Dr. Collis and Miss Squire devoted much time to the work of the Health of Munition Workers Committee, and assisted in the preparation of the numerous memoranda issued during the year by that committee. Mr. Sydney Smith has given assistance from time to time to the Reserved Occupation Committee; he has also done much work with a view to the prevention of accidents and dust explosions in munition and other factories, but the bulk of his time has been devoted to securing adequate ventilation in aeroplane works. The whole of the staff has been working at high pressure, and a great deal has been done in securing suitable fencing of machinery, adequate means of escape in case of fire, good sanitary and welfare conditions in factories and workshops generally, &c. The need for better arrangements in regard to accommodation for clothing, preparing and taking meals, first aid in case of accident, &c., has been long recognised by the factory department, and much has been done by the inspectors bringing these matters before occupiers in the course of their inspections. The question has been brought more prominently forward by the great increase in the number of women employed in factories during the war, and in many of the large munition works excellent provision has been made for the health, comfort and social welfare of the employees. Outside the ordinary range of duties, the most important work done by our department during the year has been in connection with the substitution of women in manufacturing industries. Again, as in 1915, considerable use has been made of the powers under sec. 150 of the 1901 Factory Act to allow latitude in the period of employment and hours of work of protected persons. Although applications for relaxation of the law have been numerous and the inquiries involved have thrown a large amount of work on the inspectors, there has been a notable decrease in the requests for the long hours that were common in the early months of the war. The general tendency has been to restrict the weekly hours of work to an amount very little, if at all, in excess of those allowed under the Factory Act, and to arrange for more elasticity in the daily limits. This has enabled a number of applications to be dealt with by the general orders authorising various schemes of overtime and night shifts, but limiting the weekly total in most cases to 60 hours and restricting the overtime to a certain number of days a week. Such of the previous general orders as it has been necessary to re-issue have been considerably modified, and new orders have been made covering a few other trades. In many of the munition factories and in machine-tool and similar works full use has been made of the overtime allowed, while in shipbuilding, marine engineering and in some of the textile trades overtime has been intermittent, especially in those cases where special orders have been issued, many of these being only required to meet a sudden emergency. It is fairly well recognised now that continuous and excessive overtime very soon produces lassitude and slackness among the workers, and injuriously affects efficiency and both the quality and quantity of work. In one weaving factory special records were kept when the normal hours of 55½ a week were increased for 16 weeks to 57, and for four weeks to 65½. The output did not increase in proportion, and the difference was more marked when working the 65½-hour weeks. On the other hand, a moderate amount of overtime judiciously arranged has given satisfactory results. Some Sunday work of women and boys has been necessary in certain of the more important munition factories, and also in works where the processes are continuous and the loss of men has been heavy—*e.g.*, mineral oil, explosives works and electric generating stations—but, as a rule, in these cases it has been possible to give the workers another day off instead during the week.

Accompanying the report is one by Miss Anderson, H.M. Principal Lady Inspector of Factories, on the effect of the third year of war on industrial employment of women and girls.

The Electric Vehicle as a Load for Central Stations.—In the "General Electric Review" for May, Mr. C. A. Rohr points out the desirability of the electric vehicle as a load for central stations. The electric vehicle, he claims, is cheaper than any form of animal transportation. In New York alone there is a minimum revenue of something like £2,000,000 to be derived by the substitution of electrical vehicles for horse traction. The load factor of electric vehicles is uniform at 30 to 35 per cent. and, for the same plant equipment, the electric vehicle has 8½ times the earning capacity of the electric flat-iron.

Digitized by Google

LEGAL INTELLIGENCE.

Mr. A. Ellis and Another v. R. Birkett.

At Southend County Court recently Judge Tindal Atkinson heard this action, in which plaintiff and his son (Henry H. J. Ellis) claimed £100 damages from Robt. Birkett, electrical engineer, for alleged breach of an indenture of apprenticeship. There was a cross-action for £50, said to be due under the indenture.

Plaintiff's case was that Ellis, jun., who was indentured for three years, had received no proper training; in fact, that he got practically no instruction, and according to a witness he was only capable of filling the position of switchboard attendant at 25s. a week.

DEFENDANT, giving evidence, said the training which Ellis, jun., had was such as to give him acquaintance with the whole of the working of an up-to-date electricity station. At the end of two years the boy was well acquainted with the work. He considered that the boy's knowledge was adequate.

Mr. H. FOULDS, Birmingham, and Mr. FRANK AYTON, Ipswich, stated that the method of training Ellis was usual and proper; and evidence for defendant was also given by Mr. Jonas Dobson, rolling stock supt., and by Mr. Arthur Hoopel, an assistant engineer at the electricity works.

The jury found for plaintiffs, awarding £50 to the father and £25 to the son. They also found for Mr. Birkett for £50 in the cross-action, the Judge having advised them that there was no defence to the claim, the contract not having been cancelled.

Judgment was given in accordance with the jury's findings.

Alien Enemy Patent.

Last week in the Patents Court, Messrs. Croft Bros. applied for licence to use the German patent 11,898 of 1908 (granted to Franz Tacke), for an elastic coupling.

For applicants, Mr. ARMSTRONG explained that the coupling, by a neat contrivance, gave a very desirable resiliency in joining up the driving to the driven shaft, and because of its quality was very useful in electrical works. In driving a dynamo it was advantageous to have a coupling by which the vibration was not communicated to the proximate shaft. The one covered by the patent effected a saving in respect of renewals as compared with other couplings. Messrs. Croft Bros. made many kinds of couplings and they had lately had specific inquiries for that type.

For the opponents, Mr. JUSTICE said the patent was assigned to one Habermann in 1909 and a licence (sole and exclusive) was granted to the Power Plant Co., Ltd., who had been manufacturing the coupling under it and supplying the market. They were able to meet all the demands and to supply Messrs. Crofts into the bargain. The agreement by which they manufactured was not on the register; it was a document prepared and executed in Germany. He was prepared to show it to the Controller, together with the books of the company disclosing the firms for whom they manufactured

The CONTROLLER said it was a misfortune that they did not get all these documents affecting the title of a patent on the register. There was nothing to force a man to place his name on the register and therefore there was nothing to show who was the owner of the patent.

Mr. JUSTICE protested against this view. He thought cross-examination would show that applicants were not altogether in the dark. The Power Plant Co. was a purely British concern. Not only had it paid a 5 per cent. royalty, but it had paid the income tax on the royalty. It had built up the goodwill and applicants wanted to collar our business.

The CONTROLLER, after examining the documents, said he was afraid that was one of the rare cases where the agreement disclosed was fatal to the applicants. There was a firm working under exclusive licence covered by document, who had gone to the expense to build up the English and Colonial trade and were coping with the demand. They were not disposed to interfere with an arrangement made before the war.

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. S Clay, V.D.

Orders for the week :—

Officer for the Week.—Platoon Commander C. Campbell.

Next for Duty.—Platoon Commander A. Gerard.

Monday, June 4th.—Technical for No 3 Right Half Company at Regency-street. Drill No. 3 Company Left Half Company. Signalling Class. Recruits' drill, 6.30.

Tuesday, June 5th.—Lecture 6.30, Physical drill and bayonet fighting, 5.30 to 6.30.

Wednesday, June 6th.—Drill, No. 1 Left Half Company, 6.15.

Thursday, June 7th.—Drill, No. 3 Company, Left Half Company. Ambulance class by M.O., 6.30. Signalling class.

Friday, June 8th.—Technical for No. 2 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' drill at 6.30 to 7.30.

Saturday, June 9th.—N.C.O.'s Class. 2.3. Company Commander Hyman and the Instruction of Musketry.

Sunday, June 10th.—Parade Clapham Common Station (Tube Railway), 9.45 a.m., for work at Bombing School. Uniform. Rations to be carried.

Armlets.—Members are warned that armlets must be worn at all plain clothes parades.

Musketry.—For all Companies, see Notice at Headquarters.

NOTE.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street, W.)

PATENT RECORD.

APPLICATIONS FOR PATENTS.

*NOTE.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

March 19, 1917.

3,937 STIRK. Power traverses in electrically driven lathes, &c.
3,956 WENGERS. Magnetic separators.
3,958 COOKE. Magneto-electric generators.
3,974 & 3,975 CLARKE. Sound-wave receivers.
4,001 GORDON. Self-contained electric lighting apparatus.
4,002 GORDON. Medical induction coils.
4,003 GORDON. Electric heating apparatus.
4,005 RYMER-JONES. Galvanometer for use on ships, &c.

March 20, 1917.

4,014 PILKINGTON. Telephone. &c., diaphragms.
4,036 CONRADI. Fusible cut-outs.
4,042 TAYLOR. Electric globe manipulator.
4,047 OZMAIR (LTD.) & JOSEPH. Ozone generators.
4,074 HARDIE. Supporting indirect or semi-indirect inverted shades.
4,082 CARNEY. Magnetic compasses.
4,083 CIE GENERALE ELECTRIQUE. Producing metallised brushes for electric machines. (22/5/16, France.)

March 21, 1917.

4,097 OGILVIE. Permanent electric flash lamp.
4,116 WHEATLEY. Coupling magneto-generator with internal-combustion engine.
4,118 GANDOLFO. Electric welding machines.
4,142 AMMENTORP. Imitation electric candle lamps. (20/5/16, Denmark.)
4,144 PLETSCHER. Magnetic electric machines.
4,146, 4,147 & 4,148 DUCKHAM & Co., & BOWREY. Oil insulated electric apparatus.

March 22, 1917.

4,162 WARD & GOLDSTONE. Electric cables, flexible cords, &c.
4,174 BEIN. Continuous-current electric generators.
4,177 BROUGH. Glands for electric cables. &c.
4,188 IGRANIC ELEC. Co. (Cutler-Hammer Mfg. Co.) Electric circuit controllers.

March 23, 1917.

4,196 HARRIS. Electrical transmitting apparatus.
4,202 VERITYS (LTD.) & IONS. Globes for glow lamps.
4,225 WOOD. Railway signalling systems.
4,228 STONE & Co. & DARKER. Electric generating and battery-charging installations for railway, &c., vehicles.
4,237 PHILLIPS-BRINTON Co. Electric condensers. (23/3/16, U.S.)

March 24, 1917.

4,260 GOLL. Overhead trolley guide.
4,288 MARKS. (Volta Soc. Anon.) Electric driving of submarines, &c.

March 26, 1917.

4,311 MACEY. Lamp shade carriers.
4,335 B. T.-H. Co. & SUGDEN. Starting switches for motors.
4,336 BRITISH WESTINGHOUSE ELECTRIC & MFG. Co. Systems of electrical control.
4,341 DAVIDSON. X-ray localisation.
4,356 BERRY. Electric lamps.
4,370 KENNINGTON. Electric ignition devices. (10/14/16, U.S.)

March 27, 1917.

4,405 SWENSON. Electric marine depth indicator.
4,418 ANGOLD, RAILING & SOLOMON. Arc lamps for projectors.
4,427 MARCONI. Wireless telegraphy and telephony. (28/3/16, Italy.)
4,444 IGRANIC ELECTRIC Co. (Cutler-Hammer Mfg. Co.) Driving and control mechanism of planing, &c., machines.
4,445 GORDON. Electric pocket lamp.

March 28, 1917.

4,456 MCINNES. Diaphragms for telephones, &c.
4,464 WARDLE ENGINEERING Co. & WILKINSON. Lanterns or fittings for incandescent lamps.
4,479 EFANDEM Co. & WILLIAMS. Switch apparatus for pocket electric lamps, &c
4,480 EFANDEM Co. & WILLIAMS. Electric connection between cells or batteries and bulbs of pocket lamps, &c.
4,481 EFANDEM Co. & STEPHENSON. Storage of dry cells and batteries.
4,485 BUCKLAND. Magnetic ship raising apparatus.
4,488 COURSE & GUISE. Catenary suspension of conductors for transmitting and transforming electrical energy.
4,491 B.T.-H. Co. (G.E.Co.) Gear wheels, rolls, &c.
4,493 SOC. DES MOTEURS SALMSON-SYSTEME CANTONE MUSIE. Rotating shield magneto. (10,5/16, France.)
4,506 FOKES & LAMBOURNE. Electric signalling systems.

March 29, 1917.

4,526 HALL. Electric flash lamps.
4,532 TROUNSON. Electric artificial horizon.
4,568 HAYMAN & MORTEN. Electrically operated toy, &c.
4,580 B.T.-H. Co. (G.E.Co.) Transformers.
4,585 SANDBERG. Heat treatment of railway and tram rails.
4,588 ROUND. Electrodes for electric arcs for medical, &c., purposes.
4,595 GARDE. Electric lamp holders and cord grips.
4,598 BROCKELBANK. Indicators and transmitters, &c.

March 30, 1917.

4,629 WHEELER. Securing shades &c. to electric lamp holders.
4,638 B. T.-H. Co. (G. E. Co.) Gear wheels.
4,644 GULLETTE & VANDERVELL. Magnetos.
4,651 BAKER & HEYL. Rendering water radio-active
4,659 HOBDAY & MANN, EGERTON & Co. Control of electrical mechanism.
4,661 AUTOMATIC TELEPHONE MFG. Co., SMITH & WOODLAND. Telegraph system.
4,662 INTERNATIONAL ELECTRIC Co. & ROOSE. Electrical apparatus.

March 31, 1917.

4,676 WARR. Primary batteries or cells.
4,679 ROBERTS. Electric switches.
4,683 STUDD. Electric wall socket.
4,701 HARRISON & RUSSELL. Incandescent electric lamps.

April 2, 1917.

4,720 MORRISON. Automatic device for wireless signalling.
4,738 MCQUIRE. Electric instruments for transmission and for reproduction of sound
4,739 PEARCE. Protective gear for dynamos.
4,758 DAVIDSON, DEARLOVE & PERRY. Telegraph systems.

April 3, 1917.

4,806 GENERAL ENGINEERING Co. Power plants. (8/4/16, U.S.)
4,808 BEAVER & CLAREMONT. Manufacture of electric cables.
4,810 DE ROS. Generation and utilisation of power.

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Electricity Supply in Victoria. At a recent meeting of the Victorian Institute of Engineers the President (Mr. H. R. Harper) gave some interesting figures concerning the development of the power load in Victoria. At the end of 1915 there were 1,915 factories using electric power and 26,385 H.P. was in actual use, compared with 1,782 factories and 22,584 H.P. in 1914, and 1,579 factories and 18,732 H.P. in 1913. In 1905 there were only 349 factories in which the electric drive was employed and the horse-power of electric motors was only 2,174. Some idea of the rapid progress made by the electrical industry in the State may be gathered from the abstract of Mr. Harper's interesting address which is given in another column.

* * * *

Lord Balfour's Committee. The following members have been added to Lord Balfour of Burleigh's Committee on Commercial and Industrial Policy :—

Sir Charles Henry, Bart., M.P., Mr. J. A. Roxburgh, Sir William Pearce, M.P., Sir William Priestley, M.P. and Sir Archibald Williamson, Bt., M.P.

These members take the places of former members of the Committee who are now members of the Government.

* * * *

Alien Enemy Businesses. It has been announced that the Advisory Committee on alien businesses consists of Mr. Ernest Moon, K.C. (Chairman), the Hon. J. D. Fitz-Gerald, K.C., Mr. A. A. Allen and Mr. Gershom Stewart. The Committee has considered 771 cases; they have recommended that orders should be made for winding up in 436 cases and that in 111 cases the enemy interest should be vested in the custodian.

* * * *

A Trade Union Entrance Examination. A somewhat unusual suggestion has recently been made by a member of the Amalgamated Society of Engineers, namely, to compel candidates for membership of trade unions to pass an entrance examination.

In this way he hopes to safeguard trade unions against the influx of unskilled labour. In regard to his own union he suggests that candidates for membership should pass a searching examination in mathematics, including algebra and trigonometry, drawing office practice, applied mechanics, a working acquaintance with an up-to-date engineering workshop, and a knowledge of the commercial side of the business. We have every sympathy with the object in view, but we think that the scope of the examination might be extended. We should like to add Papers on social science, citizenship and the economics of industry to the above.

* * * *

Rate Aid by Trade Departments. About this time of the year, when local authorities are considering their estimates for the coming year we hear much of the allocation of the profits of electric supply, tramways, and other municipal undertakings for the relief of rates. Apart from the fact that the expedient of taking money from trading departments is resorted to when there are no genuine profits to allocate, we think it an imprudent course to take money until there are strong reserves and until contingency and obsolescence funds have been built up. It is especially inadvisable to raid the reserves of electric supply undertakings at present when funds are urgently needed for extensions of plant, for power supplies, &c. There was an interesting discussion on this subject at the recent meeting of Manchester Corporation.

The chairman of the Finance Committee (Ald. Goldschmidt) stated that the rates would have to be increased by 4·3d. in the pound. The increase was more than accounted for by the large reductions in the proposed contributions from the trading departments which were equal to a rate of 5·65d. The Gas Committee proposed to give only £9,112 (against £50,000), the Electricity Committee £16,570 (against £30,000), and the Tramway Committee £50,000, compared with £100,000. It was impossible to say what would be the effect of the war on local finance. A great deal of municipal work was being deferred, and there would have to be a considerable expenditure when hostilities ceased. He strongly advised the Council to go slowly when war ended, and to extend the expenditure over several years.

When the estimates of the various committees were being dealt with Ald. Goldschmidt moved an amendment to the Electricity Committee's proposal that their contribution should be £30,000 instead of £16,570. He pointed out that the Finance Committee had passed a resolution requesting the chairman to move an amendment to the proposals of the Gas, Electricity and Tramway Committees that their contributions should be similar to those given last year. The Finance Committee wished to avoid an increase in the rates, and looking at the accounts of the Electricity Committee he thought they were justified in asking them to provide £30,000.

In the course of the discussion Mr. McLachlan said he thought they ought to organise a campaign for larger State aid for various public services. If they were going to starve their trading departments by a policy of drawing their life's blood they were acting directly contrary to the best interests of the city. Over and above that, they were acting as enemies to their country, because they were handicapping it in the race for industrial supremacy which would come later on.

Replying for the Electrical Committee, Ald. Walker said it was all very well for people to talk of increased prices, but he reminded them that the department had customers with contracts extending over several years. Any increase in the price would therefore fall upon the small consumers, who were already paying a high price. If the Council determined that the Electricity Committee's contribution should be £30,000 it would certainly mean increased prices for someone.

Ultimately, the Council adjourned for a fortnight without coming to a decision.

* * * *

Alien Enemy Property. In the annual report of the Public Trustee's Department it is stated that the Public Trustee's statutory duties as custodian of enemy property in England and Wales have been extended by the Trading with the Enemy (Copyright) Act, 1916.

Under the Proclamations issued soon after the war began and in September last, all persons having any claim against any enemy estate, or in regard to any debt due to them from enemy estates, were directed to register those claims with the Public Trustee. Particulars of some 40,000 separate claims have been recorded and placed at the service of the Enemy Debts' Committee.

The returns made of property in this country held by British persons for enemies, and of debts due by British persons to enemies, number over 35,000. It is not yet possible for the Public Trustee to state whether British persons hold more German property than Germans hold in this country. The Vesting Orders made by the Court and by the Board of Trade under sec. 4 of the Trading with the Enemy Amendment Act, 1914, have the effect of transferring to the Public Trustee property belonging to, or held or managed for, enemies or enemy subjects. The value of all property so vested amounts approximately to £12,000,000. The Public Trustee has also received from Controllers appointed by the Board of Trade under the proviso of sec. 1 (3) of the Trading with the Enemy Amendment Act, 1916, approximately £2,000,000, representing the proceeds or the partial proceeds of enemy capital in companies and businesses, or amounts due to the enemy creditors of such companies or businesses, in course of being wound up.

* * * *

Sulphuric Acid Control. In virtue of his powers under the Defence of the Realm Regulations, the Minister of Munitions has ordered that no person shall as on and from the 11th inst. until further notice manufacture sulphuric acid except under a licence issued by or under his authority.

No person manufacturing sulphuric acid shall, until further notice, use during any one calendar month more than 10 tons of 95 per cent. sulphuric acid (or its equivalent in acid of other strengths) for the purpose of all other manufactures, trades and businesses carried on by him except under and in accordance with the terms of a licence issued by or under the authority of the Minister of Munitions.

No person shall supply sulphuric acid (including waste sulphuric acid) to any person except under and in accordance with the terms and conditions of a licence. Provided that no licence shall be required to supply not more than 56 lb. of 95 per cent. sulphuric acid (or its equivalent in acid of other strengths) to any person during any one calendar month.

No manufacturer of sulphuric acid or agent of such a manufacturer shall charge or receive in payment for any sulphuric acid supplied by or through him a price exceeding the maximum price specified for sulphuric acid. The maximum prices do not apply to—(*a*) Sulphuric acid supplied to persons outside the United Kingdom under export licences ; (*b*) sulphuric acid manufactured outside the United Kingdom ; (*c*) sulphuric acid made wholly from brimstone ; and (*d*) sulphuric acid specially purified for laboratory purposes.

All persons engaged in producing, manufacturing, selling, distributing or storing sulphuric acid, &c., shall make such returns with regard to their businesses as may from time to time be required. For the purpose of the Order the expression sulphuric acid shall include sulphuric acid of all strengths up to 100 per cent., H_2SO_4, but shall not include acid containing free SO_3 (commonly called oleum or fuming sulphuric acid). Applications in reference to the Order should be addressed to the Director of Acid Supplies, Ministry of Munitions, Department of Explosives Supply, Storey's-gate, Westminster, S.W. 1.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Aylesbury.—The L.G. Board has sanctioned the borrowing of £6,000 for extensions of the electricity generating plant and mains.

Croydon.—The Council have authorised the laying of a new main from the electric supply works to a factory of Messrs. Gillett & Johnston at an estimated cost of £2,000, and application has been made to the L. G. Board for sanction to a loan of this amount.

Finchley.—As the Ministry of Munitions does not consider the proposed extensions of the electricity undertaking necessary, the L.G. Board has refused sanction to an application for a loan of £14,000.

Hayes.—The Uxbridge Electric Supply Co. has notified Uxbridge Rural Council of its intention to lay a power cable to supply works in Hayes.

Ilford.—Recently the L.G. Board, in reply to an application for sanction to borrow £10,000, wrote that the proposed additional generating plant was not required, as the Board was advised that all that was necessary was to install converting plant at Ley-street, and transmit by new cables to the works concerned.

The electrical engineer (Mr. A. H. Shaw) has now submitted a proposal to install a 250 kw. converter at Ley-street to convert from l.-t. d.-c. to high-tension three-phase current, and to lay a h.-t. cable from Ley-street to the works, and also to install a 250 kw. converter in Grove-road sub-station to convert from h.-t. a.-c. to l.-t. d.-c. The estimated cost is £5,800 and the Electricity Committee has adopted the proposal.

Willesden.—The Council has renewed its application of last January to the L. G. Board to lay an additional h.t. cable from the power station to certain proposed new works.

The reduced scale of charges for current supplied to shopkeepers for outside lighting has been abolished during the period of the war.

On the recommendation of the electrical engineer (Mr. A. W. Blake) the scale of wages for the technical staff has been revised as follows :—

Senior charge engineer and meter tester, 40s. per week, rising to 50s. maximum ; shift engineers, 35s. to 47s. 6d. ; junior engineers, 20s. to 30s. ; works foreman, 50s. to 60s. ; plumber jointers, 45s. to 52s. 6d. ; mains ganger, 40s. to 47s. 6d. ; arc lamp mechanic, 37s. 6d. to 45s. ; arc lamp trimmers, 30s. to 37s. 6d. : and installation inspectors, 37s. 6d. to 47s. 6d. In all cases the annual increments are 2s. 6d. per week.

GENERAL.

Belfast.—Out of the applicants for the position of mechanical engineer at the electricity works the following six have been selected for interview by the Tramways and Electricity Committee : Messrs. John R. Davison (Manchester), J. Fairbairn (Bradford), R. H. Patterson (Barnes), Wilfred Yorke (Sunderland), Robert Lyle (Belfast) and W. G. Moffatt (Belfast).

Bexley.—The Urban District Council have increased the salary of their electrical engineer and tramways manager (Mr. H. P. Stokes) by £100 per annum as from Jan. 1, 1917.

Birmingham.—The Electric Supply Committee has decided to increase the amount allocated to relief of rates this year from £25,000 to £27,700.

Board of Trade Electric Power Committee.—In addition to those mentioned in previous issues, Aberdeen, Hornsey and Willesden Councils have passed resolutions protesting against the inadequate representation of municipal undertakings on the committee.

Bolton.—The electricity department has decided to grant £2,000 in aid of rates. Last year no contribution was made.

Chichester.—In connection with the proposal to adapt the County Hall, Chichester, for the use of the Council, plans are being prepared for an electrical installation, &c., at a cost not exceeding £500.

Crompton.—The Councils of Crompton and Royton are in negotiation with Oldham Corporation for a supply of electric current in the two districts.

An agreement has already been arrived at on certain points, including the compulsory area, the cost of obtaining the order, and the suggested term of 30 years for the duration of the agreement.

Ewell.—The Board of Trade has granted the application of the South Metropolitan Electric Tramways & Lighting Co. for a provisional order to enable them to supply electricity in the parishes of Cuddington and Ewell in the Epsom Rural District.

Keighley.—The Mayor (Mr. F. W. L. Butterfield) inaugurated the recent extensions of the electricity undertaking yesterday.

The first power station was opened in 1901, with a plant of 440 kw. Owing to the increasing demand for power several additions were made to the plant until, at the end of March last, the outlay on the works had reached a total of over £146,000. A souvenir booklet issued by Mr. Harry Webber, borough electrical engineer, gives a history of the department. For the past five years the department has been entirely self-supporting, with a fairly reasonable margin of profit going to reserve, while paying a fair proportion out of revenue towards the general district fund. With the latest additions the price of the plant is now only £15·38 per kilowatt, which is probably as low as any undertaking of the kind in the United Kingdom. The price per unit obtained during the year ended March, 1916, was 0·86d., averaging the returns of traction, lighting and power, the rates of charge varying from 5d. per unit for lighting to a little under ½d. for power. In 1910 the plant capacity of the undertaking was only 740 kw. ; now it is 10,000 kw.

Liverpool Strike.—The Liverpool electric wiremen, who have been out on strike for a fortnight, have resumed work, the Minister of Munitions having agreed to receive a national deputation.

Mexborough-Swinton Electric Supply.—Rawmarsh Council has decided to obtain expert advice as to the purchase from the Mexborough and Swinton Tramways Co. of the Rawmarsh and Swindon electric supply undertaking. Subsequently a joint conference of the Councils of Swinton, Mexborough, Greasborough and Rawmarsh will be convened to consider the matter.

Reading.—The Corporation has increased the salary of the engineer and general manager of the tramways (Mr. C. F. Craven) from £600 to £800 per annum.

Stafford.—The Electricity Committee has increased the salary of the electrical engineer (Mr. W. H. Robins) by £50 per annum, with a further increase of £50 in two annual instalments.

Wolverhampton.—The Industrial Development Committee reports that a number of new industries have been and are being brought into the town. Various factory sites have been purchased and old works have been enlarged. During the last two years the Corporation have passed plans for 140 alterations and additions to existing works in the borough. These developments should mean a greatly increased demand for electric power.

HYDRO-ELECTRIC NOTES.

Canadian Water Power.—The Imperial Trade Correspondent at Calgary (Mr. J. F. Sweeting) states that some preliminary work, which will probably include the laying of a light railway, is being done in connection with the development of water power at Rocky Rapids, about 150 miles west of Edmonton on the North Saskatchewan river.

Hydro-Electric Power in Bombay.—It is proposed that an official of the Public Works Department should report upon the development of water-power in the Bombay Presidency, and the possibility of erecting further hydro-electric plants.

Swiss Water Power Legislation.—A Federal Law, dated Dec. 22, 1916, laid down the principle of the general supervision by the Federal authorities of the utilisation of hydraulic power derived from public or private watercourses in Switzerland, leaving, as heretofore, to the cantonal and other local authorities the granting of concessions. At least two-thirds of the directors of a concessionaire company must be Swiss citizens and domiciled in Switzerland, and no transfer of the concession may be made without the consent of the conceding authority.

The " Feuille Fédérale " of April 25 contains the text of a circular sent by the Federal Council to the Cantonal Governments relative to the drawing up of local regulations to give effect to the above-mentioned law, and fixing Jan. 1, 1918, as the date of its coming into operation.

Water Power in Italy.—The Supreme Council for Public Waters has granted concessions to three local companies for increases in water-power to be derived from the river Nera in the province of Perugia, and from the rivers Piave and the Cordevole, in the province of Belluno.

The Council is considering applications for similar concessions, and studying the water-power possibilities of various streams in the Cuneo and Rome districts and the lakes of Albano and Nemi.

Digitized by Google

LIGHTING AND INDUSTRIAL POWER.

Burton-on-Trent.—It has been decided to illuminate the streets during the autumn and winter by means of electric lamps suspended over the tramway routes.

Electric Power in Madras.—The demand for electric power in the Madras area is increasing in a satisfactory manner, and at present about 50 industrial undertakings use electric power, including saw-mills, oil and flour mills, printing works, cement factories, &c. It is stated that if the local electricity station could meet the demand a number of other works would take a supply. Large extensions are, however, contemplated, but there is a difficulty in obtaining the necessary plant and materials from England.

Electric Propulsion of Battleships.—It is announced that contracts totalling approximately about $2,000,000 have been placed by the New York Shipbuilding Co. for supplying the necessary electrical equipments for the propulsion of the new super-dreadnoughts "Colorado" and "Washington." The equipments will be practically duplicates of those for the U.S.S. "Tennessee." The four propellers, instead of being mechanically connected to turbines, are to be driven by individual motors. The current for the motors will be supplied by two turbine generators. In addition to the main generating equipments and propelling motors, the contracts include auxiliaries for the main turbine generators and smaller auxiliary turbine generators for supplying light and power.

St. Austell.—The Council has decided that it cannot vary the Lighting Committee's recommendation of December last not to pay the electric company in respect of the lighting of 95 public lamps discontinued for 12 months.

ELECTRIC TRACTION.

Ashton-under-Lyne.—The Tramways Committee has decided to abolish halfpenny fares, to introduce penny stages on shorter routes, and to increase the price of workmen's tickets. The Stalybridge, Hyde, Dukinfield and Mossley Joint Tramways Board are also revising their fares.

Birmingham.—The Tramways Committee recommend the Council to approve of a general revision of tramway fares.

The Council is asked to sanction the broad principles of a revision, leaving the details to be worked out subsequently. The price of workmen's tickets will also be reconsidered, the desire of the committee being to revise the schedule of fares so that sufficient income will be derived in future to meet the ever-increasing expenditure of the department, particularly in the cost of materials and advancing wages.

Glasgow.—The Corporation have been informed by the Lord Advocate that the sale of tickets on the Corporation tramcars for a prize "sweep" scheme in aid of the war charities, known as the "tramcar lottery," is illegal, and must be stopped.

A reply is being framed by the tramway manager (Mr. J. Dalrymple) and in the meantime the sale of tickets will continue.

The following increases of salary have been granted to officials of the tramways department: Mr. T. W. Christall, claims superintendent, £365 to £380; Mr. J. Grierson, civil engineer, £305 to £320; and Mr. D. I. Laddell, outdoor traffic superintendent, £325 to £340.

Leyton.—Owing to the present crowded condition of the tramcars the Council finds that it is difficult to collect all fares, and it has arranged to provide boxes on the tramcars, so that passengers whose fares are not collected can drop in money as they alight.

London Electric Railway.—The Board of Trade have extended for one year from July 8, 1911, the time limited by the company's Act of 1914 for the compulsory purchase of lands, &c., for the construction of works described in sec. 6 and the additional lands referred to in sec. 14 of the Act.

Metropolitan Railway.—The Board of Trade has extended for one year from Aug., 1917, the times limited by the Metropolitan Railway Act, 1912, for completing railways Nos. 2 and 3, and the times limited for completing the works authorised by the company's Act of 1911 and the compulsory purchase of lands for railway authorised by the 1913 Act.

Vancouver.—The British Columbia Electric Railway Co. has announced that the British Columbia Legislature has amended clauses of the Vancouver City Incorporation Act, which protected the company against municipal competition with respect to the supply of electric current for light and power. The amendments seem to provide that, after June 1, 1919, the city will have the right to compete with the company.

ELECTRIC VEHICLE PROGRESS.

Last week Surbiton Urban Council was informed by the Public Health Committee that the contractors for the new electrically-propelled dust vans had been unable to obtain the sanction of the Ministry of Munitions for steel for the bodies and tipping-gear.

The chairman of the committee, the District Surveyor and the Clerk were authorised to arrange for the vans to be provided with temporary wooden bodies.

Derby Council recently decided to purchase an Edison electric omnibus for £825. Mr. Eaton said an effort should be made to avoid the loss on the Mansfield-road service. They had an opportunity to purchase an omnibus from the Loughborough Road Car Co., which seated 22 passengers, and was licenced to carry 28. They would run a 30 minutes' service, and a 20 minutes' service at busy times on Fridays and Saturdays. It would take eight minutes for the journey each way. They would be able to dispose of eight or nine horses.

Before purchasing a motor dust van East Ham Council in committee, which has just considered a report on the advantages of electrically-driven vehicles, will visit Isleworth and Ipswich, where similar vehicles are in use.

Croydon.—The Roads Committee is endeavouring to secure an electrical sprinkler as it is unable to hire horses.

Ilford.—The electrical engineer (Mr. A. H. Shaw) has presented a satisfactory report to the Electricity Committee on the running of the electrical coal wagon for the 12 months ended March 31.

The electric coal wagon started work in January, 1916, and has continued to run satisfactorily throughout the whole of the past year. The total amount of coal transferred from railway trucks to bunkers or store was 9,568 tons 15 cwt. and the mileage was 3,096, and the total time employed was 2,304 hours. The units taken by motor generator for charging battery were 8,736, the average units per ton delivered being 0·91 and the average units per mile travelled 2·82.

The total cost, including wages, current, maintenance, sinking fund, interest and insurance was £376. 10s., and the average cost per ton delivered 9·44d. In addition to carting coal the wagon has been used in removing ashes. The approximate quantity removed is estimated at 1,530 tons, the mileage run 509, and the time employed 565½ hours. The units used were 1,485: the total cost was £87. 8s. 2d., or 1s. 2d. per ton. The wagon was also employed on carting for the surveyor's department for 22 hours, travelling 51 miles, and using 136 units. Allowing for six days during which the wagon was out of use during the year and for Sundays and holidays, the wagon was employed on an average 9·6 hours per day for 301 days.

Mr. Shaw estimates that the saving effected during the past year by the use of the wagon has been not less than £250, not to mention the great difficulty the department would have experienced in obtaining sufficient carts for their requirements.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says the lighting department of the City of Buenos Ayres recently settled the terms for inviting tenders for the supply of electric light to Boca, Barracas and Palermo.

Chili.—A decree has been issued granting to Don D. Ortuzar permission to establish an electric lighting and power system, and to use overhead lines, in Quinta de Cailloma and in Guacarhue and La Vina. The works must be begun within six and completed within a further 12 months of Feb. 17, 1917.

Swedish Export Prohibitions.—Among the articles, the export of which is prohibited by the Swedish Government, are the following:—

Insulating composition, such as asbestos, asphalt, &c., and manufactures of the composition, as slabs, segments and other shaped pieces.

Celluloid, celloidin, galalith, ambroin, eburin and other similar artificial plastic materials not specially mentioned.

Vulcan fibre and other chemically prepared fibre board in tubes or rod.

Locomotives for Decauville railways, even if electric.

Carborundum and other carbides.

Resin, turpentines, &c.

MISCELLANEOUS.

British Trade with Canada and Newfoundland.—Mr. C. Hamilton Wickes, H.M. Trade Commissioner in Canada and Newfoundland, who has been already interviewed by firms in various towns of the United Kingdom, will after the present week attend at the Chambers of Commerce in Leeds, Bradford, Huddersfield, Sheffield, Chesterfield, Derby, Nottingham, Leicester, Coventry, and Birmingham, in the order named.

Dilution in the Electrical Trades.—The Minister of Munitions (Dr. Addison, M.P.), with Mr. Kellaway and officials of the Ministry, have recently had a conference with the Executive of the Electrical Trades Union and representatives of strikers' committees in various areas in order to discuss the abolition of the trade-card scheme and dilution on private work.

Digitized by Google

Enemy Firm Wound Up.—The Controller of the Bakelite Co. (Ltd.) has applied for a release. Objections to be sent to the Board of Trade before June 6.

Fire.—On Saturday evening last a fire occurred at the Smethwick generating station of the Shropshire, Worcestershire & Staffordshire Electric Power Co.

The outbreak occurred about 11 o'clock. The local fire brigade was quickly in attendance, and valuable help was also rendered by the Handsworth and Albion-street contingents of the Birmingham Brigade. The flames spread to the roof of the extensive building, and the brigades were at work for about four hours before the fire was got under. Engineers and assistants from all the stations in the district were at once summoned to start the work of repairing the damage. The plant supplies current for nearly the whole of the tramways in the Black Country, as well as to many large factories. Owing to the stoppage of current the tramcar service was interrupted for a time.

The station engineer (Mr. Bentham) explained that the fire was due to a short-circuit on a rotary. The work of repairing the damage was put in hand promptly; the tramcars were soon running as usual, and by the time the local factories resumed operations power was available for them.

A fatal accident occurred at the works on Sunday when men were engaged in putting tarpaulin over the roof to protect the machinery. The plank on which Robert Henley (17) was standing slipped, and he was thrown to the floor of the power house. He was conveyed to the General Hospital, where he died soon after admission.

Masonic.—The regular meeting of the Electric Lodge, No. 2,087, was held on Saturday last, at the Mitre Hotel, Hampton Court, when Mr. W. E. Reid was ably installed in the chair for the ensuing year by his successor, Mr. E. J. Willcock.

Priority Certificates for Restricted Exports.—In a recent extraordinary issue of the "New Zealand Gazette" it is announced that all orders to secure supplies of materials and stores required for maintaining the continuity of production and the means of transport, for industries of national importance, as well as orders placed by Government Departments and municipalities, should be on special forms (obtainable from the Munitions and Supplies Department, Union Steamship Company's Buildings, Wellington) and submitted for consideration to the Minister in Charge of Munitions and Supplies, who is the local authority in New Zealand.

Two copies of each order will be returned to the importer for transmission to his principals or representatives in the United Kingdom, who will place a copy of the order before the Priority Branch of the Ministry of Munitions in London.

The April issue of the "South African Commerce and Manufacturers' Record" states that the Union Government has appointed local committees at Johannesburg, Cape Town, Durban, Port Elizabeth, East London and Bloemfontein, to whom all applications (with certain exceptions) must, in the first instance, be made for priority certificates for the importation of restricted goods from the United Kingdom. Restricted goods include steel and tin plates, all copper and brass, wire rope, shafting, machinery generally (including mining and textile machinery), presses, hammers, cranes, labour-saving devices, belting, rivets, bolts, nuts, small tools, screws, chemicals, &c. Applications should be addressed to the secretary of the local priority certificates committee.

Radio-Telegraph Notes.—It is announced that a German wireless station has been established at Buenos Ayres and will begin experimental operations in a few days.

The Federal Holdings Co. (of New York) holds a concession from the Argentine Government for the erection of a high-power radiographic station, and proposes to erect the station at or near San Isidro.

Royal Assent.—On May 24th the Royal Assent was read to the following Acts of Parliament:—

Companies (Foreign Interests), South Staffordshire Mond Gas (Power and Heating) Co. and Aluminium Corporation (Conversion of Shares Acts.

Training of Disabled Soldiers.—The new electrical workshops which have been provided by the Trustees at the Joseph and Jane Cowen training school for the electrical training of Disabled Soldiers and Sailors at Benwell Grange, Newcastle, are now well equipped and in full working order.

There was some unavoidable delay in getting delivery of the necessary plant and material, but all obstacles have been overcome and the whole system is working very satisfactorily. The arrangements made provide for training 20 men in the department. The main workshop is on the ground floor of the building and has a floor area of 700 square ft. It is equipped with a number of long work benches and the walls are provided with large demonstration boards for instruction in the erection of miniature installations of electric light, telephones, bells, signals, &c. Wood casing is used, but there are also steel conduit and other systems. The equipment of the workshop in addition to a number of complete sets of wood and metal working tools, includes telephones, arc lamps, instruments and switchgear. The lighting and power plant is housed in an out-building and consists of a National gas engine, which will give out 10 B.H.P., driving, by means of a belt, a Westinghouse 6-kw. 110 to 150 volt, d.c., shunt-wound, protected type generator. The switchboard, also of Westinghouse manufacture, consists of generator and distribution panels, the former being arranged with charge and discharge battery switches for a 60-cell storage battery, which is now in course of erection, and which has been presented by the Tudor Accumulator Co. and five other accumulator manufacturers. The distribution panel has four main circuit switches, one to control the supply to the house, and the others to control motor circuits which may be required for the engineering workshops.

The men, whose physical incapacity includes the loss of the use of fingers, paralysis of the leg, head wounds, frost bite, &c., have had no previous experience in electrical work, and in civil life were miners, brass-finishers, shipyard riveters, furnacemen, &c. Although the nature of their injuries precludes their employment in their own trades, in most cases it does not in any way militate against their training and subsequent employment in carrying out electrical work. They are developing a remarkable aptitude for the work on which they are now engaged, and are very keen to learn. The course of instruction has been specially arranged on practical lines, and a syllabus has been drawn up which takes three months to complete, and includes a certain amount of theory in addition to practical work. The course covers interior wiring for electric light and power, electric bells and signal installations, telephones, dynamos and motors, including construction and management, cinematograph projector operation, &c. In the initial stages the men are taught the various methods of jointing electric wires and cables, and when proficient in these branches they proceed to erect various miniature installations on the demonstration boards. When thoroughly proficient the men are employed in fitting up a section of the building with a complete and independent installation under practical conditions. The men also erect complete installations of telephones, bells and signals, &c.; they dismantle the gas engine, clean up the piston and cylinder, valves and other parts, and re-assemble the parts, &c. The combined capacity of the electrical plant is equal to an output of 600 incandescent lamps of 16 c.p. each. Reports as to the individual progress of the men are prepared fortnightly. Special note is taken of the work for which a man is best fitted so that he can be recommended for any suitable vacancy when his course is finished. Amongst the possible openings for men who have passed through the course of training are the care and operation of country house and factory lighting plants, wiring for electric light and power, switchboard operation in power stations and sub-stations, wiring for bells and telephones, dynamo and motor attendance, &c.

The Committee will gladly receive notice of any situations which may be vacant and for which men may be fitted. The first lot of men commenced their training on Jan. 12, 1917, and have now been recently passed out of the school, having all obtained suitable employment. The Trustees have expended over £250 in providing this department of the school with suitable plant, machinery and material to enable efficient tuition to be given in electrical engineering. The course is entirely free to disabled soldiers and sailors, some of whom are housed in the Cowen Home, while others are daily boarders. A number of firms and gentlemen have kindly presented material or rendered other services, including: Mr. A. Andrews (F. Reid Ferens & Co.), British Westinghouse Electric & Mfg. Co., Callender's Cable & Construction Co., Fletcher Bros., Newcastle & District Electric Lighting Co., A. Reyrolle & Co., Sanderson Bros., Simplex Conduits (Ltd.), Sterling Telephone Co., Tudor Accumulator Co., Chloride Electrical Storage Co., the D.P. Battery Co., the Hart Accumulator Co., the Premier Accumulator Co., Ltd., Pritchett & Gold & E.P.S. Co. and T. G. Usher & Co. The Council of the Institution of Electrical Engineers (through the Chairman of the Local Section), the electrical section of the Newcastle Chamber of Commerce, and also the Newcastle-upon-Tyne Electric Supply Co., and several local firms, have offered their support, and a number of local gentlemen have volunteered to lecture in the evenings on subjects in which they are specialists.

The trustees will be glad to hear of vacancies for the men who have been trained.

TENDERS INVITED AND ACCEPTED.

Tramway Construction.

Newport (Mon.) Corporation require tenders by 10 a.m. June 9 for the construction of the Newport Light Railway, section No. 2. Specifications, &c., from the borough electrical and tramways engineer, Mr. A. Nichols Moore, Town Hall, Newport, Mon.

Electrical and General Stores.

The TRUSTEES OF THE CLYDE NAVIGATION require tenders by 10 a.m. June 9 for three, six and 12 months' supply of Electrical Stores, Asbestos, Packing, Rubber, Iron and Steel, Specifications from the Superintendent of Stores, Robertson-street, Glasgow.

AYLESBURY.—The Council have accepted the tender of the Premier Gas Engine Co. for gas engines, and that of the General Electric Co. for dynamos.

HAMMERSMITH (LONDON).—The Borough Council received the following tenders for the supply of induced draught plant:—

Musgrave & Co. (*recommended*), £1,563. 15s.; J. Keith & Blackman Co., £2,720; Matthews & Yates, £2,260; Davidson & Co., £2,945; and Underfeed Stoker Co., £3,271.

The tenders of Musgrave & Co. and Matthews & Yates do not include the cost of an electric motor for driving the second fan, so that £560 (the amount quoted by J. Keith & Blackman Co., as the cost of the motor) must be added to above prices for comparison purposes.

Digitized by Google

Government Contracts.—The following tenders were accepted by the British Government Departments during April :—

War Office.—General Electric Co., W. T. Glover & Co., C. Macintosh & Co., and Siemens Bros. & Co., electric cables; India Rubber, Gutta Percha & Telegraph Works Co. and Siemens Bros. & Co., electric cells; C. Macintosh & Co. and Siemens Bros. & Co., Ebonite; Cable Accessories Co., General Electric Co., H. J. Gray & Son, S. Heath & Sons, S. & F. Hodgetts & Co., Jowett Bros., S. D. Page & Sons, C. Roe & Sons, T. Saveker, Simplex Conduits (Ltd.), Sun Electric Co. and Leif Sundt & Co., electric light fittings and accessories; British Thomson-Houston Co., Cryselco (Ltd.), General Electric Co., Pope's Electric Lamp Co. and Siemens Bros. Dynamo Works, electric lamps; Austin Motor Co., X-ray plant; Edison Swan Electric Co. and General Electric Co., hand switches; Edison Swan Electric Co., Efandem Co., General Electric Co. and Westwood Electrical Co., electric torches and lamps; Cavendish Electrical Co., electrical plant.

India Office.—General Electric Co., elements; Automatic Telephone Mfg. Co., exchange equipment; London Electric Wire Co. & Smiths, wire.

Post Office.—British L. M. Ericsson Mfg. Co., protective apparatus; George Plumpton (Ltd.), wire repairing apparatus; India Rubber, Gutta Percha & Telegraph Works Co., telegraph apparatus; Gent & Co., Peel Conner Telephone Works, Siemens Bros. & Co. and Western Electric Co., telephone apparatus; T. Gabriel & Sons & Burtons, air line arms; W. D. Tucker & Sons, battery boxes; Bullers (Ltd.), c.i. brackets, clamps, &c.; Telegraph Construction & Maintenance Co., British Insulated & Helsby Cables, General Electric Co., W. T. Henley's Telegraph Works Co. and Union Cable Co., telegraph cable; Siemens Bros. & Co., dry cells and telephone cords; Western Electric Co., extension, &c., of telephone exchange equipment, Edinburgh; India Rubber, Gutta Percha & Telegraph Works Co., galvanometers; Taylor, Tunnicliff & Co., insulators; Eyre Smelting Co., zinc rods; Tudor Accumulator Co., battery repairs; T. Bolton & Sons, British Insulated & Helsby Cables and F. Smith & Co. (inc. in London Electric Wire Co. & Smiths), bronze wire; T. Bolton & Sons, British Insulated & Helsby Cables, Elliott's Metal Co., R. Johnson & Nephew, Shropshire Iron Co., F. Smith & Co. (incim. London Electric Wire Co. & Smiths) and J. Wilkes, Sons & Mapplebeck, h.-d. copper wire; British Insulated & Helsby Cables, tinned copper wire; C. Macintosh & Co., enamelled and flameproof wire.

APPOINTMENTS VACANT.

A teacher of engineering subjects is required by the Bristol Education Committee for the Temple Junior Technical School (Engineering). Salary £170, rising to £200. Forms of application from the Secretary for Education, Guildhall, Bristol. Applications by June 16.

A teacher of physics is required for the Woolwich Polytechnic, Woolwich, S.E. 18. Salary £180 to £200 per annum.

BUSINESS ITEMS.

Messrs. C. A. Vandervell & Co. (Ltd.) announce that their telephone number is now Chiswick 2,000 (eight lines).

Messrs. H. Tinsley & Co., have removed to Werndee Hall, South Norwood, London, S.E. 25.

The business carried on by Messrs. E. Cleaton Rees & Co. has been converted into a limited company, under the title of Reesoils (Ltd.), and the address is now 1, Eldon-square, Newcastle-on-Tyne.

The Bureau Technique Industriel, 63, rue des Bois de Colombes, La Garenne (Seine), France, advertise that they desire to represent manufacturers of electrical plant and appliances.

The Commercial Attaché to the Russian Embassy (Mr. A. S. Ostrogradsky) announces that the premises of the agency of the Russian Ministry of Commerce and Industry have been transferred to the Eighth Floor, Empire House, Kingsway, London, W.C. 2.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of June 14. *Further particulars are set out in an advertisement.*

Plant for Sale.—Oldham Corporation Electricity Committee advertise for sale two Willans-Siemens 740 kw. sets, shunt-wound 450-480 volts. Particulars from Mr. F. L. Ogden, joint engineer and manager.

Messrs. M. Hingley & Sons (Ltd.), Netherton Ironworks, Dudley, advertise for sale two electric capstans for railway works use.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Submarine Cables' Trust.

The forty-sixth ordinary annual meeting was held on May 24, Sir John Denison-Pender, K.C.M.G., one of the trustees, presiding.

The SECRETARY (Mr. Sidney Collett) having read the notice convening the meeting and the minutes of the last annual meeting,

The CHAIRMAN, after making a feeling reference to the death of Lord Allerton (who was trustee since January, 1912) said: Our total receipts for the year ended April 15 last amounted to £29,304, and after deducting £1,745 for expenses, and adding £77 brought forward, we had an available balance of £27,636. Of this amount £15,432 has been distributed as usual to our certificate holders in half-yearly interest, at the rate of 6 per cent. per annum net, and the surplus of £12,204, has been utilised in the acquisition of certificates. Accordingly we have redeemed and cancelled 102 certificates. That, I may say, is the largest number we have acquired in any single year for more than 40 years. A balance of £66. 10s. has been carried forward. As I have already indicated, our receipts for the year under review are considerably more than those of the preceding period. This is entirely accounted for by the increased dividends which are now being paid by the Eastern, Eastern Extension and Western Telegraph Companies. Each of these Companies, as you probably know, are now paying 8 per cent. as against 7 per cent. which they had been paying for many years past. These increases represent in the aggregate a total of about £4,400. You will, however, observe that there is a considerable drop in our receipts from the Central & South American Telegraph Co. The explanation of this is, that last year this company increased their dividend from 6 per cent. to 9 per cent. This year, however, they have reverted to the 6 per cent. dividend; but they have issued bonus shares to the extent of 46 per cent. of that company's capital. This will ultimately make our income at 6 per cent. on the increased holding practically the same as 9 per cent. on our former holding, while it gives us nearly half as much again capital; only the dividends on the new shares will not commence until our next financial year. You will also notice that our receipts from several other companies where income tax is deducted from warrants in which we are invested show a diminution. This year we not only feel the full effect of the 5s. rate of our own income tax, but, in addition, there is now an American tax of 2 per cent. on all American investments. This question of income tax is strikingly illustrated in the case of the Mackay Companies, which have increased the dividend on their common shares from 5 to 6 per cent., yet, owing to the increased tax deducted, the net amount that we received on this occasion is actually less than last year. I may mention that the shares of these Mackay Companies are amongst those that have been listed by the British Government. We have, therefore, handed over our certificates to them, and we hold their receipts. Meantime our Government pay us the dividends, adding ½ per cent. to the amount received. There is a diminution in the small dividend we receive from the West India & Panama Telegraph Co., as this year they paid only 6d. per share, as against 1s. 6d. last year. But our interest in that concern is very small, and the amount involved is negligible. The certificates which we acquired to date amount to 1,727, out of the original 4,200, leaving 2,473 certificates outstanding. I move that the report and accounts be adopted.

Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E., seconded the motion, which was carried unanimously.

Messrs. Deloitte, Plender, Griffiths & Co. and Messrs. Gane, Jackson, Jefferys & Freeman were elected auditors, and a vote of thanks to the trustees and staff terminated the proceedings.

ALTRINCHAM ELECTRIC SUPPLY (LTD.).—Mr. C. J. Ford, who presided over the meeting last week, stated that in the past year the net profit had dropped by £674. 10s. 11d., owing to the lighting restrictions and to the increased price paid for coal and higher costs of production generally. The percentage of units unaccounted for had been reduced to about 15 per cent. on the total current generated, which showed a marked improvement over all previous years, and he was hopeful that that would be still further reduced in the future. The sale of current for power was satisfactorily expanding, but the company had not yet had time to receive any material benefit during the period covered by the accounts from several new consumers who had recently installed works in the district. The new 1,500 kw. turbo-generator had been in operation about 12 months, and was a highly satisfactory addition to the company's plant, and it might be necessary to install a further unit on a similar or larger scale in the near future, together with two additional water-tube boilers. The opinion of those able to judge was that the undoubted advantages accruing to manufacturers by placing their works in Altrincham and its neighbourhood was likely to continue, and he looked for satisfactory developments from this source of revenue in the future. Upwards of £10,000 had been expended during the past financial year on additional plant, mains, &c., the plant item absorbing £7,575, mainly in connection with the installation of the new turbo-generator, and that sum had been provided out of the company's general resources. There was now a sum of upwards of £20,000 standing to general reserve and reserve for depreciation, which amounted to about 25 per cent. of the total share and debenture capital issued.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—The gross receipts for 1916 amounted to £2,714,226 and working expenses (including various items amounting to £96,000 carried to depreciation renewals reserve in addition to £257,366 expended on ordinary maintenance) were £1,956,669. With interest on investments and deposits, transfer fees, &c., and amount brought forward the available total is £891,685. Deducting annuity to City of Buenos Ayres Tramways Co. (£70,660), interest and sinking funds on debenture stocks (£587,821), sinking fund for redemption of preferences and ordinary shares (£6,236) and dividend on 5½ per cent. cumulative first preference shares (£176,000), the balance is £50,969. The traffic receipts as compared with those for 1915 show an increase of £5,588, and the number of passengers carried an increase of 1,437,360. The abnormally high cost of fuel still continues to prevail, the increased traction charges, notwithstanding economies in consumption, being £161,477. In view of the foregoing conditions, the directors regret they have been unable to distribute any dividend for the year on the 5½ per cent. cumulative second preference shares. In his annual report the

Digitized by Google

General Manager states: "The task of forecasting with anything like accuracy what our prospects are for traffic for 1917 is almost as difficult as last year. The great unknown factor is, of course, developments in Europe. As regards local affairs, whilst on the one hand the past few months have shown a very slight improvement in some ways, we have before us the fact that all classes of crops have been exceptionally poor this year owing to the prolonged drought. If we maintain our traffics of last year, with perhaps an increase of one per cent., it is about as much as we can expect. The cost of coal was never a more uncertain factor than at present; I can only say that, excluding the fuel question, we shall, I am sure, compare favourably with last year."

BUENOS AYRES LACROZE TRAMWAYS CO. (LTD.)—For the year ended June 30, 1916, the gross receipts were $5,885,262, a decrease of $217,589 compared with 1915, and the working expenses, which in 1915 were $3,895,787, are $3,760,781, an increase of $135,005. The balance is $1,987,475, from which must be deducted the amount of debenture interest and amortisation of municipal concessions, &c., leaving $644,519, which, added to $83,638 brought forward, makes a total of $728,157. The board propose to place 5 per cent. to reserve, to pay 5 per cent. to directors, ½ per cent. to the syndic and $625,000 to the shareholders, leaving to be carried to next account $35,483.

CALCUTTA TRAMWAYS CO. (LTD.)—The revenue for 1916 was £119,681, and with balance brought forward (£6,812) the total available is £126,493. Interest and dividends absorbed £48,891, leaving £77,602. The directors propose a final dividend of 6s. 6d. per share, making 9½ per cent. for the year, and to carry forward £9,595. In addition to the ordinary reserve, the directors have opened a separate reserve fund for depreciation of investments, to which they propose to transfer this year £2,000.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—The chairman (Mr. E. Pope) stated at the recent meeting that the higher cost of stores and supplies, increased taxation, &c., had affected their profits. There had been a shortage of labour, due partly to the large number of men who had joined the Colours and partly to the action of the dominant Labour Party, who insisted on the internment of all technically enemy aliens. That shortage of labour had interfered with the efficient working of the mines, and by reducing the output of ore had lessened the demand for electric power. Under the new arrangement with the trustee they had to find before the end of the year £3,600 for interest and £31,200 for repayment of principal. Next year they would require £2,100 for interest and £7,500 for repayment a total of £9,600. With these payments to make the shareholders must not consider the directors unduly timid if they hesitated to pay the usual preference dividend next October. In normal times they could undoubtedly negotiate a new debenture issue to pay off the old. The financial position improved considerably during the year. The money, extra to that provided by the usual allocations, was obtained partly from smaller expenditure on repairs and renewals upon plant and machinery, and partly from a sale of copper wire which they had on hand and did not require. They had not been doing well during the four completed months of this year, but he was glad to say that the result was rather better than in the corresponding period of 1916. The general position of the mines on the Kalgoorlie goldfield was not as good as it was 12 months ago.

LISBON ELECTRIC TRAMWAYS (LTD.)—The result of the operations for 1916, after deducting interest and amortisation due on the debentures of the Cia Carris de Ferro de Lisboa and after payment of £24,565 for interest on and redemption of debentures of this company and also payment of London office expenses and directors' remuneration, shows a net profit of £51,021, which, added to £8,736 brought forward, gives £59,757. From this amount the sum of £25,000 has been passed to credit of depreciation reserve, leaving an available balance of £34,757, out of which the usual 6 per cent. preference dividend (£25,533) has been paid. The balance of £9,224 remaining to credit of profit and loss has been carried forward. To make this year's appropriation to depreciation reserve up to the sum of £30,000 considered necessary, £5,000 was transferred from the exchange reserve for the purpose. During the year 76,620,194 passengers were carried and earnings were Es.2,324,655$58,5, compared with 67,101,249 passengers and Es.2,022,142$93,5 in 1915. The working expenditure has increased out of all proportion, and exceeds the figure for 1915 by Es.336,896$730, chiefly due to the persistent rise in the price of coal and all other supplies, and also the higher cost of labour due to the war. The profits are further affected by the lower rate of exchange, the average of which has fallen from 35·97d. to 33·73d. These adverse conditions are more pronounced at present and there is every probability they may yet become more severe. In view of the very heavy increase in working expenditure every endeavour has been made in the past year to secure an increase in the tariff, but all efforts in that direction were opposed both by the Municipality and the Government. Steps, however, are again being taken in this connection in the current year. Notwithstanding the increased traffics the company has sustained a very heavy diminution of profit compared with pre-war years. In 1913, after payment of debenture and preference interest the available balance was £78,153, against £25,488 in the year under review. It is, therefore, essential to secure the company's financial position against all contingencies, and the directors regret to have to forego the usual recommendation of a dividend on the ordinary share capital.

PENARTH ELECTRIC LIGHTING CO. (LTD.)—At the meeting last week Mr. Geo. J. Somerville presided and stated that there had been a slight increase in the number of units generated, and the receipts were £163 in excess of the previous year. Expenses had also increased, chiefly owing to the cost of coal (which had advanced by £396) and other items. There had been a total increase in expenses of £561, which made the net balance less than in 1916 by £398. The directors, therefore, proposed that the balance, having taken into account the amount brought forward (£1,288), should be allocated as follows:—To renewals account, £750; to dividend of 1 per cent. on the ordinary shares (£250), leaving to be carried forward £289.

SWANSEA IMPROVEMENTS & TRAMWAY CO.—The report for the past year states that the revenue of the tramway undertaking was £72,342, an increase of £7,258 over 1915. After deducting expenses and setting aside £5,500 for renewals the surplus was £13,571. Although traffic receipts showed a considerable increase nearly the whole had been required to meet the enhanced cost of material and war bonuses to employees. The directors propose that £3,000 be placed to reserve, that dividends at rate of 6 per cent. for the year be paid on the first preference and at rate of 5 per cent. on the second preference shares, and at rate of 6 per cent. for the year on the ordinary shares in respect of which last named an interim dividend at the rate of 5 per cent. was paid in October, and that £2,587 be carried forward.

TORONTO RAILWAY CO.—The gross earnings for 1916 were $5,973,161, charges for operating maintenance, &c., were $3,350,657, and net earnings $2,622,503. Dividends absorbed $958,826 and bond interest, &c., $156,122. The increase in gross passenger earnings was $270,208. The charges against the earnings for operation, maintenance, &c., amounted to $3,350,657, the percentage of operating cost being 57 per cent. of the passenger earnings. Payments made to the City of Toronto throughout the year amounted to $1,113,009, an increase of $48,937.

NEW COMPANIES.

BRITISH LIGHTING & IGNITION CO. (LTD.) (147,508.)—Private company. Reg. May 19, capital £100,000 in £1 shares, to carry on business as manufacturers of and dealers in motor and other carriages, railway and tramway rolling stock, &c. The Board of Trade has authorised this company to acquire the undertaking of the Bosch Magneto Co. (Ltd.), the books and documents of which are liable to inspection under the Trading with the Enemy Act.

BURTON, GRIFFITHS & CO. (LTD.) (147,487.)—Private company. Reg. May 17, capital £120,000 in £1 shares (75,000 preference). Mechanical, electrical and consulting engineers, dealers in wood and metal working machines, founders, metallurgists. First directors: M. Griffiths and T. S. Catmur. Secretary: H. G. King. Reg. office: 1-3, Ludgate-square, E.C.

CITY NOTES.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The directors have decided to place £15,000 to reserve and to recommend a dividend of 3 per cent. on the ordinary stock (the same as in 1916), carrying forward £97,598.

CASTNER-KELLNER ALKALI CO. (LTD.)—The directors have declared an interim dividend of 9 per cent. for the half-year ended March.

COLOMBO ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—A dividend of 10 per cent. (20s. per share) tax free, has been declared for the past year; £15,000 has been placed to general reserve and renewal fund, from which £4,000 has been written off special renewal account, and £8,805 carried forward.

CREED & CO. (LTD. AND REDUCED).—A petition for confirming a resolution reducing the capital of this company from £130,000 to £90,000 has been presented to the High Court.

ELECTRO-BLEACH & BY-PRODUCTS (LTD.)—Although the audit has been completed, the directors are not yet able to present the balance-sheet for 1916, as the Ministry of Munitions have not yet been able to adjust the duties payable by the company.

HOLSWORTHY GAS & ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the chairman (Mr. Dickson) said that the net result of the year's working did not admit of a dividend being paid. The Board of Trade had granted permission to increase the charges for electrical energy.

A. REYROLLE & CO. (LTD.)—The net profit for 1916, after providing for debenture interest, and including £2,896 brought forward, was £16,579. A dividend of 12 per cent. has been declared on the ordinary shares, together with a bonus of 10 per cent. on both the preference and ordinary shares. A sum of £5,000 has been transferred to reserve, and £3,779 carried forward.

TAUNTON & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The receipts for 1916, including £9. 10s. 6d. brought forward, amounted to £2,900. 5s. After deducting expenses (including debenture interest) and making a provision of £250 for renewals, the balance of £19. 7s. 6d. has been carried forward.

UNITED RIVER PLATE TELEPHONE CO.—A final dividend of 5 per cent. has been declared on the ordinary shares, making 8 per cent. for the year 1916, tax free. A sum of £6,990 is carried forward against £6,234 in the previous year.

WOLVERHAMPTON DISTRICT ELECTRIC TRAMWAYS (LTD.).—The directors have declared a dividend of 2 per cent. on the ordinary shares for the past year. A sum of £4,000 has been set aside for renewals, £1,000 added to reserve, and £772 carried forward.

Digitized by Google

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—Many electrical men of long years' experience receive "'black' certificates of protection!"

* * * *

"Another Increase in Gas Charges," says a Birmingham newspaper headline; just as if an ordinary charge of gas was not sufficient for any one!

* * * *

Another case of the "Unseen Hand":—

A German wireless station has been established here, and will begin experimental operations in a few days' time. Some of the newspapers are urging that steps should be taken to prevent its working.—REUTER.

* * * *

One of the "Safety First" advertisements of the London General Omnibus Co. advises the public to "Look both ways in crossing the road." To an A.C. engineer this will present no difficulty, because he might do it by putting one eye 90 deg. out of phase with the other, or a railway engineer might have articulated eyeballs for the occasion, but with the man in the street, who knows nothing of such matters, how is it to be done? Mr. Blain, please exblain.

* * * *

An inquest was held recently upon an unfortunate workman who became entangled in a loop of the rope of an electric capstan. The matter is of more than ordinary interest, because the accident took place in a gasworks, which is the last spot in which one *ought* to find an electric capstan. This fact probably accounts for the absence from the report that the man was killed by an electric shock. Electrical papers please also refrain from stating that the man was overcome by gas fumes.

* * * *

Sir J. J. Thomson's lectures on "The Electrical Properties of Gases" have provoked an interesting correspondence in the "Engineer." I select the following from among the letters published:—

SIR: The articles on Sir J. J. Thomson's lectures remind me of the "Relativist" correspondence which appeared in your columns a few months ago; and I agree with "An Earnest Student" as to the present generation of physicists going beyond what Tyndall called the "scientific use of the imagination."

As children we loved fairy tales; but try to realise the mental condition of "grown-ups" who see nothing silly in such remarks as appear on p. 478 in the current issue of "Engineering": "By applying to such a gas a suitable electric field it was, however, possible to make each charged particle 'breed'—becoming thus the ancestor of a very numerous family. Under such conditions we might, in fact, get from the original particle a million of descendants."

Is the President of the Royal Society really responsible for this statement? SESAMY.

I sincerely hope that the Allies will retain the monopoly of this remarkable property of breeding; civilisation will again be in danger if the Huns get hold of it!

* * * *

I cannot give Mr. C. H. Wordingham a Hot Plate upon his election to the Presidency of the Institution of Electrical Engineers, because he already has THE ELECTRICIAN Hot Plate No. 1; at least I hope he has. None the less, I would like to add my congratulations to the many he must have received upon what is undoubtedly a well-merited honour and recognition of his services to the industry. He belongs to that virile but unfortunately at present too limited number of men in the electrical industry who are best described in the words of advice to after-dinner speakers, "Get up, speak up, shut up."

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, May 29, 1880.]

THE BRITISH ELECTRIC LIGHT COMPANY.—What may be termed the inauguration of the electric light in the City took place on Friday evening, at the vaults of the Royal Exchange, which have been fitted up by the British Electric Light Company. We shall truly describe the work in our next.

PUCK.—We have before us the copy of this paper, of May 8. The two-page cartoon of that represents "The Decadence of the Wizard of Menlo Park. From the Photograph to Polyform." There is one disturbing feature in Mr. Edison's career which his friends and foes do not sufficiently appreciate—his plodding nature. He does not give in, but continues his attempts to surmount his failure, and however adversely we may criticise what he has done we cannot be sure but he may be successful to-morrow.

THE ACHARD ELECTRIC BREAK.—A railway break, which is instantaneously applied and continuous in its action, and which the inventor proposes to render automatic, is described by M. Hospitalier in "La Nature." It is worked by means of two of the secondary batteries of M. Plante, each of these being charged by three Daniell cells. The action of the apparatus is dependent upon the adhesion of an electro-magnet to the axle of the wheels, by means of which two chains, attached to levers carrying friction blocks, are wound upon a drum. In some experiments upon a train of 13 carriages, travelling at the rate of 73 km. per hour, the train was brought to a standstill in 21 seconds, moving through a distance of 215 metres after the break was applied.

Illuminated Signs.—In order to check the consumption of electricity and gas for illuminated signs, &c., the Home Secretary has made an Order entirely prohibiting the use of sky signs and other illuminated advertisements and lights outside or at the entrances to shops or theatres, cinemas and other places of amusement, excepting such as may have been approved by the police as necessary for the safety of the public. The prohibition applies at all hours before or after dark. The Order also prohibits the retention of the interior lighting of shop windows after the shops are closed for the serving of customers.

Electric Furnace Steel.—According to the "Engineer," the electric furnaces of Sheffield alone can now produce 90,000 tons of steel per year, and in 1918 it is anticipated that the output from these furnaces alone will be 150,000 tons.

Electricity in Rolling Mills.—The "Sheffield Telegraph," in announcing that local industrial conditions remain much as before, and that the leading feature was the enormous consumption of all kinds of raw materials, states that the local rolling plant is being increased by a couple of new mills, which will be driven by electrical power.

Electric power is also being adopted in connection with various extensions, and there are numerous plans under consideration for electrifying existing steam plants. This tendency, coupled with the rapid development of electric steel melting, will necessitate a big increase in the near future of the resources of the Corporation's electric power works.

Telephony & Telegraphy in Argentina.—The "Review of the River Plate" says the Government of Cordoba have forwarded to the President of the Local Board of the United River Plate Telephone Co. (Dr. L. M. Drago) a petition signed by a large number of agriculturalists, stock farmers, traders, industrialists and other residents of Jesus Maria, asking for the construction of a telephone line between that town and the City of Cordoba.

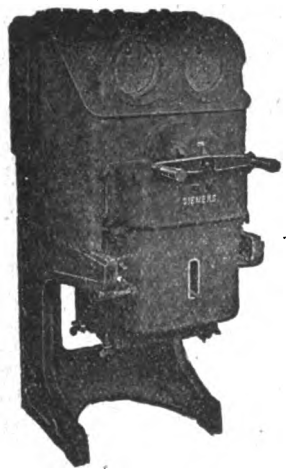
In their report for 1916 the directors of the Compañia Telegrafico-Telefoncia del Plata say that although the abnormal situation became further aggravated during the year, affecting appreciably the economic development of the country, the revenue of the company from telegraphs and telephones shows a slight increase, and there is a surplus of $15,172.88 m/n., which it is proposed to carry forward.

TUNGSTEN FOR ELECTRICAL CONTACTS
MORE EFFICIENT AND MUCH CHEAPER THAN PLATINUM.
Recommended for use for X-Ray Targets, and as Contacts on Induction Coils and Tapping Keys, Magnetos and similar devices where there is frequent making and breaking of Electric Current. Also suitable for Gas Engines, Circuit Controllers, and like purposes.
Write for Particulars:—
THE L.P.S. ELECTRICAL COMPANY, 14, Howick Place, Westminster, S.W.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

Digitized by Google

SIEMENS



IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars
Distribution Boards
Main Switchboards

Write for particulars to —

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept. 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

THEIR lasting qualities, and the fact that they retain to the end their initial brilliance, make them equally suitable for Street Lighting, Factory Lighting, Train Lighting, the Hotel or the Home.

For Street Lighting

POPE

ELASTA

(*British Made*)

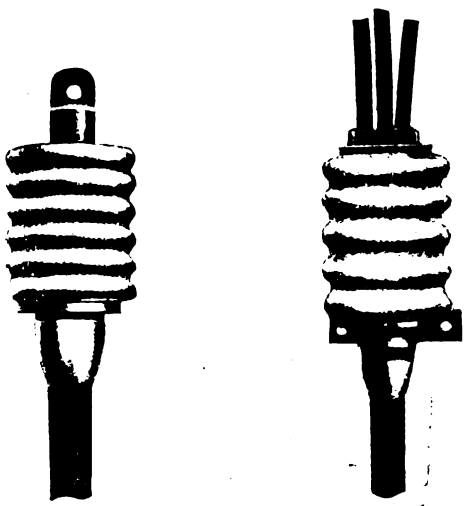
WIRE LAMPS

Strong. Brilliant. Economical.

Advt. of Pope's Electric Lamp Co., Ltd., Hythe Road, Willesden, N.W. 10.

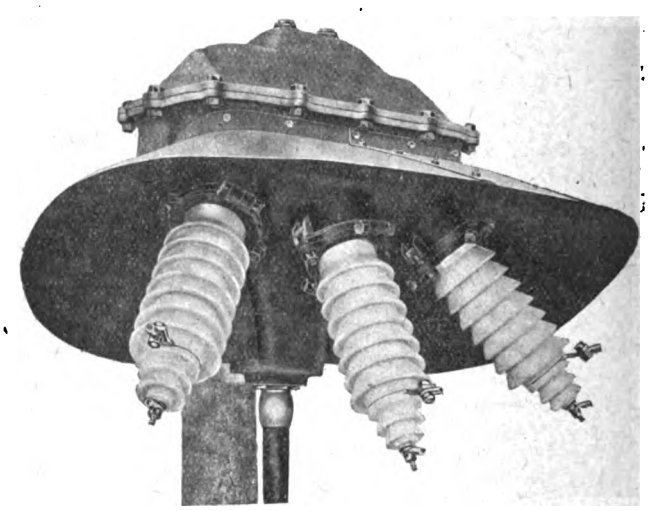
CALLENDER'S DIVIDING BOXES.

Messrs. Callender's Cable & Construction Co. have just issued a 90-page catalogue and price list describing their standard dividing boxes for use in electrical power distribution for low tension, high tension and for extra high tension cables. These dividing boxes have been carefully designed and will be found by power distribution engineers to cover all ordinary requirements. In design and construction they are essentially modern. The make up of the catalogue is one which will conduce to easy reference to the particular type of box required. The list is divided into two main sections, the first of which deals with dividing boxes for low tension cables



and the second with a dividing box for high tension and extra high tension cables. Illustrations of typical examples of these are given herewith.

The makers call special attention to the Woodhouse patent dividing box which is designed for use on extra high tension cables up to a maximum pressure of 11,000 volts. This embodies a number of useful features, among which we may mention maximum clearance between exposed conductors, a small and light box, the outgoing glands are arranged so that the insulation will not fail should the outside porcelains be broken, and there is a large head of compound



for the internal connecting fittings. This patent box is intended for use on three-core conductors.

Distribution engineers will find of value the comprehensive series of porcelain sealing ends of which special illustrations are given in both sections of the catalogue. For export purposes useful particulars are supplied at the end of the book of shipping weights and measurements and the quantities of compound required. We understand that this list has been widely distributed, but those engineers who have not yet received a copy should apply to Callender's Cable & Construction Co., Hamilton House, Victoria Embankment, London, E.C.4.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

Our prices are not necessarily always the lowest.

The Manufactures of the B.I. are designed, not for the man who chooses the low priced article because it is "good enough," but for him whose motto is:—"The best is good enough for me."

The other man will probably be one of our good friends later, when he has had a little more experience.

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Vicmaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.
ELECTRICAL MACHINERY
Engineers, Edinburgh.
See our Illustrated Advt. next week.

Digitized by Google

Electrical Engineers and Manufacturers

The House for Electric Heating.

Special Offer of "Quead" and "Ensign" Fires from Stock. Be Patriotic and Save Coal.

Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.

Telephone: Gerrard 7601 (2 lines)

Petrol Engine Sets.

Manufactured in sizes from 2 kw. to 20 kw.

Quotation for larger sizes on application.

F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON

FOR

High and Low Tension

SWITCHGEAR

THE

NEW SWITCHGEAR CONSTRUCTION CO., Ltd.

SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

Manufacturers of

PHOSPHOR BRONZE,

GUN METAL, MANGANESE BRONZE

Brass & Copper

Tubes and Sheets.

BRASS CONDENSER TUBES FOR STANDARD SHIPS, &c.

CHARLES CLIFFORD & SON, LTD..

BIRMINGHAM.

LEWIS'S SCIENTIFIC CIRCULATING LIBRARY.

ELECTRICAL, MECHANICAL & GENERAL ENGINEERING TEXT BOOKS & TECHNICAL WORKS.

New Works and New Editions can be had from the Library immediately on Publication. Telephone: MUSEUM 1072.

SUBSCRIPTION, Town or Country, from ONE GUINEA.
READING ROOM open Daily to SUBSCRIBERS.

H. K. LEWIS & Co. Ltd.,

136, GOWER STREET, and 24, GOWER PLACE, LONDON, W.C.

EMPLOYERS AND WORKERS' ALLIANCE.

Last week the Lord Mayor of Newcastle presided over a representative Northumberland and Durham conference in connection with national Alliance of Employers and Employed.

The LORD MAYOR said that next to the successful prosecution of the war there was no matter which could be more profitably discussed. They wanted to create an atmosphere making possible such an alliance, which would see that any breaches now existing are not widened during the war and would assist in dealing with demobilisation problems.

Mr. A. H. PATERSON, general secretary, having explained the proposals, Sir PERCY GIROUARD moved a resolution affirming that the cordial and whole-hearted co-operation of employers and employees would be a most important element in the success of any scheme for dealing with the reinstatement in employment of men in the forces and munitions works, and for the promotion of national prosperity, and the welfare of industrial workers. The alliance would be largely consultative at present. There was a great opportunity for co-operation between executive and workpeople. At Elswick they had done so well by having a joint committee on the question of dilution, and also in the management of canteens, &c. He thought that after the war hours might be possibly reduced, for he was not sure that the present hours conduced to most efficiency. He thought that at the conclusion of peace every one should have a month's holiday. They must also pay such reasonable wages as the industries will stand, but they could not do this unless assured of satisfactory output.

Mr. J. N. BELL, secretary of the National Amalgamated Union of Labour, seconded the motion, and in doing so expressed preference for the scheme suggested rather than compulsory arbitration, or any more Government interference, of which they had had far too much.

The resolution was carried unanimously, and it was decided to have a trades union conference for further consideration of the question.

ELECTRICITY SUPPLY IN VICTORIA.

In his recent presidential address to the Victorian Institute of Engineers, Mr. H. R. Harper, city electrical engineer of Melbourne, gave an interesting address on the progress of electricity supply in the State of Victoria, and quoted statistics from the Victorian Year Book to illustrate the rapidity with which electricity is coming into use for power and lighting in factories throughout Victoria.

Mr. Harper pointed out that the horse-power quoted was not the total capacity of the motors, but that portion estimated by factory owners as being actually used, and would, therefore, differ somewhat from the records of the electric supply authorities. In 1905 there were 349 factories using electric power with motors of 2,174 H.P. actually in use; by 1910 these figures had increased to 954 factories and 9,629 H.P. In 1913 there were 1,579 factories and 18,732 H.P.; in 1914, 1,782 and 22,584 H.P.; and in 1915 1,915 factories and 26,385 H.P. Assuming that the population of Melbourne in 1925 would be 925,000, the estimated consumption would average out at 260 untis per capita: and, assuming that 130 million units would be generated by the Railways department for the operation of the suburban railways, the total consumption per capita for all purposes would be 400 units. There was a distinct problem arising in the very near future as to the means by which the necessary power was to be produced to meet the requirements already stated. The existing power-houses of the electric supply authorities in Melbourne had severe limitations for the production of power economically and on a large scale. In view of the necessity for larger plants, absolute bed-rock costs of fuel, unlimited water for cooling purposes, it would be necessary to provide in the near future for one, and later on perhaps two, large power-houses for light, power and tramway requirements in the metropolis.

The most important item governing the working costs of a steam power-house was coal, and before any scheme for a new power-house for the Melbourne area could be decided upon the question whether brown coal could be economically used would have to be given very careful consideration. If the Victorian brown coal fields were in the possession

GENUINE
M & M VULCANISED FIBRE.
MOSSES & MITCHELL, 122 & 124 GOLDEN LANE, LONDON, E.C.

INSULATION BEADS

The only satisfactory substitute for [illegible] also for [illegible]
[illegible] SAMPLE STOCKS

HOLDER-HARRIDEN, LTD.

Digitized by Google

PRE-WAR STOCK

OF

MOTOR STARTERS

(as Illustrated)

½ to 2 H.P. (110-v. to 440-v.)

No-volt Release Magnetic Blowout on All Steps.

CHEAP BUT RELIABLE.

AT **PRE-WAR PRICES**

ALSO MANUFACTURERS OF FOLLOWING

SIX SPECIAL LINES

(1) **500-v. IRONCLAD SWITCH FUSES.** →

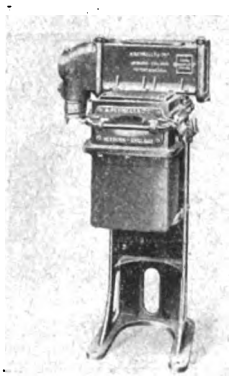
(2) **MOTOR STARTERS.**

Drum Type with Free Handle Circuit Breaker (interlocked), also Lever Type.

(3) **WALL PLUGS.** W.T., for outside use, as supplied to Admiralty, and Dustproof for Works use.

(4) **H.T. ARMOURCLAD SWITCHGEAR.**

(5) **MINING SWITCHGEAR.** →



(6) **PROTECTIVE DEVICES.** to isolate faulty sections on Power Supply Systems without interruption of supply through Sound Sections.

A. REYROLLE & CO., LTD.

HEBBURN-ON-TYNE.

Digitized by Google

of Germany they would long ago have been turned to commercial use in some form or other; they were well situated for the production of power. The most serious handicap that brown coal in Victoria had been burdened with was the comparatively low price at which superior imported black coal had been available, but the greatly increased price in recent years of black coal gave the brown coal a great opportunity to compete with it. Another disadvantage affecting brown coal had been the lack of any scheme for utilising it in sufficient quantities in the initial stages to place the industry on a sound commercial basis. The position was entirely different, if the development of the brown coal industry was associated with a large scheme for the supply of electricity to Melbourne, and if possible throughout some portion of the State. The industry would then be able to start in a large way, with its future assured, and payable from the start.

Mr. Harper estimated that, without any of the benefits to be derived from by-products, electric power produced at the Morwell field could be delivered in Melbourne in the form of 20,000-volt energy at about ¼d. per unit, with a load factor of 40 per cent. For a 24-hour daily supply the cost for each high-tension unit would be about ½d. per unit. The prices were based on a limited output of 50,000 kw. The cost of power from Altona would be 0·35d. a unit. With such a scheme of cheap electricity it would be practicable, by means of 110,000-volt overhead transmission, to convey electricity considerable distances throughout the State. Towns like Ballarat, Bendigo and Geelong could be supplied at a less cost than electricity could be produced in those centres. The production and distribution in bulk of electricity would seem a reasonable activity for the State Government to undertake, but Mr. Harper would allow the retail distribution of electricity to remain in the municipal authorities or private companies.

ELECTRIC HEAT STORAGE IN BOILERS.

According to "Engineering" the Swiss Association of Boiler Proprietors conducted experiments in October last on an electrically-heated steam boiler.

The boiler was a cylindrical one with flat ends, 1,250 m. long, 600 mm. diameter, provided with 38 tubes of 27 mm. internal diameter. Up to 34 of these tubes were electrically heated by inserting spirals of 0·9 mm. nichrom wire in the tubes. Continuous current was supplied at 226 volts the mean current intensity was 142 amperes (ranging from 92 to 200); steam was generated at about two atmospheres, and in the test case 10,207 kg. of water of 0°C. were converted into steam of 100 deg. per kilowatt-hour. Assuming a theoretical evaporation of 859 cal. per kilowatt-hour, the evaporation efficiency realised was 90·5 per cent., which was satisfactory considering the difficulties of insulation and of prevention of heat losses. Notwithstanding the actual high fuel prices in Switzerland, Mr. E. Hohn, of Zurich, discusses (in the "Schweizer Bauzeitung" of April 28) whether it would be advisable to store the spare energy from electric and hydro-electric power stations in steam boilers, and he arrives at the conclusion that this storage in thermally well-insulated boilers larger than the one mentioned would be recommendable. The boiler tubes he would make of hard-drawn brass; iron would not be suitable for alternating currents.

ELECTRICITY IN GAS WORKS.

An account of the reconstruction of the York gasworks was given by Mr. H. E. Bloor at the meeting of the North of England Gas Managers' Association at Newcastle.

The retort house in the newer part of the works was a fine building, but owing to bad foundations and other reasons it was impossible to reconstruct the carbonising plant on modern lines. The house was therefore put out of action, and attention concentrated on the old works. A combined stoker coal-breaking and elevating plant and two hoppers were delivered in the middle of 1915. The elevator was 61 ft. high, and is driven by a 29 H.P. motor. A telpher plant for putting the coke into stock or wagons as required being impracticable, an electric railway was constructed along the hopper side, thence running through the coke yard and into the coal store at a suitable height to fill railway wagons on the line of rails on which was the coal-tipping point. The motor of the locomotive is of 15 H.P., the gauge 24 in., the gradient 1 in 18, and the length of track 431 ft. Electric current is taken from two trolley wires.

ELECTRIC LAMP SALES IN THE U.S.A.

According to "The Times" the total number of electric lamps sold by the Edison Lamp Works of the General Electric Co. of America last year amounted to 73,500,000, or one-third more than in preceding year. About 85 per cent. were metallic filament lamps. The small hand flash lamp and the motor-car were mainly responsible for an increase of over 60 per cent. in miniature electric lamps.

FERRY FERROZOID
CONSTANTAN CHRONIC
WRITE FOR PARTICULARS OF FOURTEEN GRADES OF
British-Made Resistance Materials
TO:—
MAKERS:
HENRY WIGGIN & CO., Ltd.
George Street, Birmingham.
TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."
AGENT:
LIONEL ROBINSON,
3, Staple Inn, London, W.C.
TELEPHONE: 6328 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,038. [Vol. LXXIX. No. 19] . FRIDAY, JUNE 8, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 377
Arrangements for the Week 379
The New High-Speed Three-Phase Locomotives of the Italian State Railways. By P. Verole and B. Marsili. Illustrated.. 380
The Present Position of Electric Cooking Apparatus. Illustrated 385
Measurements of Radio Antenna on Shipboard and Some Interesting Comparisons. By F. A. Hart 388
Physical Society 389
THE PROGRESS OF ELECTRIC COOKING APPARATUS 390
A Resistance Bridge for Workshop Use. By Oscar de Wette. Illustrated 393
Shall Great Britain and America Adopt the Metric System? By W. R. Ingalls 394
CORRESPONDENCE 395
A System of Remote Control for an Electric Testing Laboratory. By P. G. Agnew, W. H. Stannard and J. L. Fearing. Illus... 396
British Westinghouse Switchgear. Illustrated 397
The Nernst Vapour Lamp. Illustrated 397
LEGAL INTELLIGENCE 398
Volunteer Notices 398
Patent Record 398
COMMERCIAL AND INDUSTRIAL SECTION 401
Electricity Supply 402
Tenders Invited and Accepted 405
Financial Matters 406

NOTES.

The Paper Situation.

WE feel that a word of explanation is due to our readers in regard to the diminished size of THE ELECTRICIAN during the last few months, for, although everyone is accustomed to see the daily papers diminished in size from time to time, it may be felt that the technical journal is in a different category. It will be agreed that, from the patriotic point of view, it is the duty of everyone to economise in paper as far as possible, so that the use of shipping for importing wood pulp is reduced to a minimum. Apart, however, from the patriotic aspect, it is a question whether those who are using paper lavishly at the present time will not have their supplies drastically cut off in the near future. The fact that the Government has recently taken over several paper mills to meet war requirements makes the position very difficult, and we are at present faced with the fact that paper makers are refusing to quote for paper three months ahead. On this account, therefore, we have felt it necessary to reduce the size of THE ELECTRICIAN in order to maintain our stocks of paper; and, even so, these have continued to diminish. Under these circumstances, we can only hope that we shall not be faced by still further reduction. We need scarcely say that, once normal conditions are re-established, THE ELECTRICIAN will revert to its normal size.

Some Objections to the Metric System.

PEOPLE often ask vaguely—What are the real objections to the metric system? Therefore, we have pleasure in publishing on another page an abstract of a Paper read recently by Mr. W. E. INGALLS before the Institution of Mining and Metallurgy in this country against the adoption of this system in Great Britain and America, at least by compulsion. Since Mr. INGALLS is one who, in his own opinion, has seen the error of his ways, who was formerly in favour of the metric system, and has now changed his mind, this Paper merits more than usual attention. Moreover, Mr. INGALLS is President of the American Institute of Weights and Measures, which has been lately organised to meet the propaganda in favour of the metric system. First of all, let us admit that any change of the kind contemplated would result in a good deal of inconvenience for the time being, and we have to balance up these inconveniences against those which we necessarily suffer by continuing our present methods. From this point of view we are inclined to think that a change to a decimal money system is more important than a change in our weights and measures. But although there may be a good deal to be said against adopting the metric system as a whole, there is certainly very little to be said against decimalisation. The chief objections pointed out by Mr. INGALLS refer to surveys, to gauges and to engineering drawings. Undoubtedly the change from the mile to the kilometre would introduce a good deal of complication in linking up past and future surveys, but probably the scrapping of gauges is the most important objection. A large amount of money is here involved. On the other hand, we think too much is made of the point that drawings when converted from one system to the other must not merely be re-dimensioned but re-drawn. If a drawing in the metric system is used in this country it is generally sufficient to re-dimension the main parts. The dimensions so obtained are probably not those which would have been normally adopted owing to the fact that a dimension such as 90 cm. is not exactly 3 ft. But conversely, there is no difficulty in working to an odd number of millimetres; in fact, it is the usual thing to mark all dimensions in millimetres, even where these dimensions are large. On the other hand, no attempt would be made to use anything but standard bolts.

Effect on Foreign Trade.

EMPHASIS is laid by Mr. INGALLS on the point that foreign trade by Great Britain and America should not depend upon the system adopted, but upon the inherent merit of the goods supplied. Up to a point we quite agree with this view. A motor made according to either system should work satisfactorily in any country. On the other hand, if machinery made up on the inch system is used in a country where the metric system is the standard, there may obviously be considerable inconvenience when odd screws, bolts or nuts are required for replacements. Every one knows the annoyance caused by the use of bastard threads and special fittings which can only be obtained from the original makers. In fact, it is now generally realised that the use of such odd parts, which were originally adopted to prevent replacements being supplied by other firms, are of little value and merely limit trade harmfully. Between different countries the same line of argument applies as between different makers. In this connection decimal coinage is probably of greater importance. At the end of his Paper Mr. INGALLS refers to the difficulty experienced by children in learning the metric system, and points out that the natural method of sub-division is always by 2 progressively. We quite agree that the primitive method is to divide up units in this way, but it does not follow that this is necessarily the best way. We think it will be found that the difficulty lies in the method of teaching rather than the children. Prof. JOHN PERRY advocates the practical teaching of decimals

Digitized by Google

by setting children to measure in tenths and then in hundredths, and we believe that when this method is adopted very little difficulty is found. At all events there is no sense in victimising grown-up people because the first steps in childhood are a little more difficult by means of decimals than by vulgar fractions; indeed, we think the average child would very willingly be spared the endless complications to which they have to submit in solving problems involving vulgar fractions and our antiquated tables of weights and measures.

Radium Luminous Compound.

A VALUABLE Paper on this subject was presented by Messrs. C. C. PATERSON, J. W. T. WALSH and W. F. HIGGINS at the last meeting of the Physical Society on May 25th. As is well known, paints of this kind, composed essentially of specially prepared zinc sulphide with a small percentage of radioactive material, have found many applications during the war. Comprehensive tests of their brightness and "life" have been made at the National Physical Laboratory. The authors described the photometric methods employed, including the arrangements for testing painted dials. A number of curves showing the rate of decay of the paint, and the effect of altering the radium content were also given. These, we believe, are the first detailed "life-curves" published in this country, although some indications of the duration of the luminous effect were given at the meeting of the Illuminating Engineering Society early this year. Increasing the percentage of radium accentuates the brightness, but hastens the rate of decay, and, of course, materially increases the cost. The most striking fact about the life-curves is the tendency for original differences in brightness to become much less marked in course of time, so that after a few months the advantage of the higher radium content is very much less, and the rate of decay becomes very gradual. It is this later period that mainly settles the utility of the paint in practice. The authors draw the conclusion that paint containing 0·2 milligramme of radium per gramme of sulphide gives the best results in relation to the cost of manufacture, a rather striking example of the utility of laboratory tests in determining a point of commercial importance.

The Birthday Honours.

IT has been our lot on several occasions to criticise the way in which honours are distributed in this country, and we fear we cannot regard the present Birthday Honours List as any improvement on its predecessors. Considering that the war is acknowledged to be very largely an engineers' war, taking the term engineer in the broadest sense, we can only regard the list which appeared on Monday as disappointing. We are glad to see that Sir ROBERT HADFIELD, Dr. R. T. GLAZEBROOK and Mr. J. A. F. ASPINALL have received recognition of their labours; but, considering the lengthy character of the list in other respects, we surely have a right to expect the appearance of more than these three names. It must be admitted that without the work of the engineer, with whom we would associate the physicist, for one is complementary to the other, it would be quite impossible to wage a war such as is at present in progress. Perhaps this lack of recognition is due to the fact that engineers as a body do not search the lime-light of popular publicity, but even so those in authority should know the value of their work.

Allied Scientific Mission to U.S.A.—The Franco-British Scientific Commission, which is to co-operate with American scientists in the study of problems connected with the conduct of the war, arrived in New York on the 29th ult. The mission consists of Sir Ernest Rutherford, Commander Bridge, R.N., Commandant Fabry, M. Henri Abraham, Captains de Grammont and Dupoing, and Lieutenant Paterno. The members of the Commission will work with the National Research Council.

Empire's Mineral Resources.—It is announced that Dr. Addison, M.P., Minister of Munitions, has made arrangements for the appointment of an Inter-Departmental Committee to prepare a scheme for the establishment in London of an Imperial Mineral Resources Bureau:—

(*a*) To collect information in regard to the mineral resources and metal requirements of the Empire, and

(*b*) To advise what action, if any, may appear desirable to enable such resources to be developed and made available to meet requirements.

The Committee consists of the following gentlemen:—Sir James Stevenson, Bt. (chairman), Lord Islington, G.C.M.G., Sir T. Mackenzie, K.C.M.G., Hon. Sir G. H. Perley, K.C.M.G., Rt. Hon. W. P. Schreiner, C.M.G., K.C., Sir A. Duckham, K.C.B., Prof. W. R. Dunstan, C.M.G., and Messrs. C. L. Budd, C. W. Fielding, J. F. N. Green, L. J. Kershaw, C.I.E., and W. S. Robinson. The secretary to the Committee is Mr. Oswald C. Allen, and communications on the subject should be addressed to him at the Ministry of Munitions, Whitehall-place, S.W. 1.

A New Form of Insulator.—In the "Electrical World" Mr. Lincoln Nissley describes an attempt to construct insulators out of some material other than porcelain, and without its drawbacks. A new and promising type of insulator consists of a micarta core on which glass discs are assembled, separated by asbestos washers, and held in position by a simple interlocking device and cotter key. After the parts are in place the whole is heated to 100°F. Compound is poured into the core with a view to preventing moisture entering the shell, and also as a precaution against puncture by arcs. Corresponding parts of insulators, regardless of size, are interchangeable, and the weight is comparatively small. From a series of tests it was found that these insulators do not arc over until 310 kv. are applied, when in the dry state; when wet, 240 kv. are necessary. This form of insulator is being used on a line connecting Wisconsin and Minneapolis, and also on a number of 60,000-volt lines in Minnesota.

Birthday Honours.—In the list of the King's Birthday Honours we notice the following names of persons connected with engineering and science:—

BARON.—Sir Frederick Smith, Bart., chairman of Chas. Macintosh & Co., the Macintosh Cable Co., Wm. Rickard (Ltd.) and other companies.

PRIVY COUNCILLOR.—Mr. H. Pike Pease, M.P., Asst. Postmaster-General.

BARONETS.—Sir Philip Magnus, M.P., and Sir Robt. Hadfield, chairman and managing director of Hadfields (Ltd.).

KNIGHTS.—J. A. F. Aspinall (general manager of the Lancashire & Yorkshire Railway Co.), Francis H. Barker, R. M. Hyslop (managing director of Bayliss, Jones & Bayliss), T. Gregory Foster (Provost of University College), R. T. Glazebrook, C.B. (director of the National Physical Laboratory), Wm. Peck, F.R.S.E., Prof. W. J. Ashley, and Graham Balfour (Director of Education for Staffordshire).

K.C.B.—W. F. Marwood, C.B. (Second Secretary, Board of Trade), and H. F. Heath, C.B., Ph.D. (Secretary Department of Scientific and Industrial Research).

C.B.—C. Hipwood (Asst. Secretary, Marine Department, Board of Trade).

I.S.O.—Lieut. J. A. Hamilton, R.E., and Capt. D. W. M. Gunbley, R.E. (Indo-European Telegraph Department), and W. R. Morris (Secretary Post and Telegraph Department, Dominion of New Zealand).

Electric Wires and Cables.—Mr. Llewelyn B. Atkinson, secretary of the Cable Makers' Association, writes to say that he is authorised by the Department concerned to communicate the following notice:—

Revised regulations have been issued by the Ministry of Munitions as to the manufacture and supply of insulated electric wires and cables. Under these regulations (dated June 1, 1917) the exemption from the terms of the Copper Order (dated Dec. 8, 1916) under which wires and cables of small size used for interior wiring could be manufactured and supplied outside of the terms of the Order has been withdrawn.

As from the above-mentioned date consumers not entitled to priority certificates Class A and Class B (P5) may obtain supplies of insulated copper wire without a priority certificate, provided that they are able to satisfy the manufacturer or supplier that the goods are to be used solely for the purposes of repairs and maintenance. The Cable Makers' Association (Sardinia House, Sardinia-street, Kingsway, W.C. 2) have been granted permission to obtain a limited monthly supply of copper for distribution among manufacturers, whether they be members of the Association or not, for the purpose of manufacturing insulated wires required for repairs or maintenance. The Association has been appointed the controlling authority, and is held responsible for the dis-

Digitized by Google

tribution of this monthly ration of copper. Manufacturers requiring copper for this purpose should apply to the Cable Makers' Association.

The regulations provide that in respect of new orders existing stocks of insulated copper wire may be used only for repairs and maintenance, unless required for a Government contract, or for work covered by a Class A or B5 priority permit. Copies of the Regulations may be obtained from the Ministry of Munitions, Priority Department, 1, Caxton-street, Westminster, S.W. 1.

The Eye in Relation to Practical Lighting Problems.—At the Optical Society on May 8 a short address was given on the above subject by Mr. J. S. Dow, who summarised some of the most recent investigations, in the United States and elsewhere, on glare and acuteness of vision. It is now understood that "glare" is much affected by the condition of adaptation of the eye. By experiments on fields of measured brightness it has been found possible to determine what degree of contrast is sufficient to cause glare at different orders of illumination. In ordinary circumstances the contrast begins to become painful if the ratio between the brightness of adjacent objects much exceeds 100 : 1. At low illuminations the ratio may be safely exceeded, while at high illuminations the contrast permissible becomes gradually less until, at about five times the brightness of a white surface illuminated by direct sunlight, we have "absolute glare," *i.e.*, a surface which is itself glaring, even with a ratio with surroundings of unity. It was also shown how the ability of the eye to perceive small contrasts increases with rising brightness, and then eventually falls owing to glare. With the aid of these data it seems possible to map out roughly the order of illumination required for various kinds of work. For very rough work only a comparatively large contrast needs to be detected and therefore the illumination may be small; at the other end of the scale we have such operations as watchmaking, engraving, sewing with dark materials, lace-making and fine textile operations, where a very high illumination is really needful in order that small contrasts in light and shade may be perceived. In the course of his address Mr. Dow also remarked that the properties of the eye, as regards illumination, appear to be influenced by the graduation from moonlight to full sunlight, and pointed out how, given the latter value, it is possible to calculate roughly the value of moonlight and thus verify approximately the distance of the moon from the earth.

Skin Effect at Radio-Frequencies.—Entitled "Skin-Effect Resistance Measurements of Conductors at Radio-Frequencies up to 100,000 Cycles per Second," an important research by Prof. A. E. Kennelly and Mr. H. A. Affel, of the electrical engineering department of the Massachusetts Institute of Technology, was reported in a recent issue of the "Proceedings" of the Institute of Radio Engineers. The object of the research was to obtain experimental data on the alternating current resistances of various electrical conductors at frequencies up to 100,000 cycles per second. The following conclusions were reached from tests on straight conductors, shielded from proximity effects, and of cross-sections up to 6 sq. mm.

1. The skin-effect resistance-ratio of round copper wires has been found to conform to standard Heaviside-Kelvin Bessel-function formulas, within the limits of experimental error.

2. The skin-effect resistance-ratio of a copper conductor formed of seven equal and parallel round bare strands (six surrounding a central seventh) was found to be the same as that of the equisectional solid round wire up to 100,000 cycles, within the limits of observational error. It is, therefore, inferred that the subdivision of a round wire into a round cable of uninsulated contacting strands does not alter the skin-effect.

3. The effect of simple spiralling in the same direction increased the resistance ratio.

4. The resistance ratio of a subdivided wire, with parallel insulated strands, fell below that of the equisectional solid wire, and diminished rapidly with the spacing or degree of strand separation.

5. The braiding of strands, so as to effect their transposition in the cross-section at frequent intervals, was found to diminish the skin-effect.

6. The skin-effect in copper strips was found to be usually, but not invariably, less than that of equisectional round wires.

7. Increasing the width of a copper strip within the limits reported was found to increase the skin-effect resistance ratio, owing to what may be called "edge-effect."

8. A pair of parallel going and returning flat strips, separated by a thin insulating layer, was found to have a skin-effect depending only on the strip thickness; that is, without perceptible edge-effect.

9. Rolling a flat strip into the form of a split tube destroyed the edge-effect, and reduced the resistance ratio to a minimum, dependent only on the strip thickness.

10. Cutting longitudinal slits with a sharp knife in a thin flat copper strip was not appreciably to affect its skin-effect resistance ratio.

11. In order to employ a stranded wire of minimum skin-effect at radio frequency it seems desirable to employ thick insulation on the strands, such as double cotton, to transpose the strands by braiding, and to avoid spirality in one and the same direction.

12. In order to employ a flat strip conductor most effectively it is necessary to stop rolling it out laterally when the increasing edge-effect more than offsets the reduction in skin-effect.

13. The thin hollow tubular form seems to be the most efficient type of radio-frequency metallic conductor, since, with proper mechanical interval support, the skin-effect can be indefinitely diminished by diminishing the wall thickness, and the edge-effect is absent.

OBITUARY.

W. H. STONE.—The death in Tokyo of Mr. W. H. Stone, M.I.E.E., who had been for 40 years secretary and adviser of the Japanese Ministry of Communications.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported:—

Capt. Hands (R.E.), formerly in the electric light department of the India Rubber Co., was recently killed in France. Capt. Hands joined the Territorials as a Sapper in the Electrical Engineers about 12 years ago. He went to France in October, 1914, with a wireless section, and remained there for about eight months, first as sergeant and afterwards as sergeant-major. He then obtained his commission, and towards the end of 1915 was attached to the Air Lines, and last March obtained his captaincy. He was O.C. of a signal constructional corps, and met his death returning late at night from an advanced post.

Capt. Wm. Beardmore Stewart (R.F.A.), who has been killed, was a nephew of Sir Wm. Beardmore, served an apprenticeship in shipbuilding and engineering, and took a leading part in the extension of Messrs. Beardmore's works at Dalmuir.

Lieut. J. A. O'Sullivan, son of Mr. P. F. O'Sullivan, chief engineer of the Dublin United Tramways Co., has been killed.

Pte. F. Royse (L.N.L. Regt.), a former Bolton tramways employé, has been killed in action. Of four brothers in the Army he is the second who has died on active service.

Lce.-Corp. J. Holmes (A. & S. Highlanders), formerly in the employ of the General Electric Co., has died of wounds.

PERSONAL.

Sir Richard McBride, K.C.M.G., Agent-General for British Columbia, has resigned on account of illness, and Mr. J. H. Turner will take over the duties of the London agency temporarily.

The friends of Mr. J. J. Inglis, chief electrical engineer for Messrs. D. Colville & Sons, will be sorry to hear that he has recently undergone an operation for appendicitis. We are pleased to learn that the operation was very successful, and that Mr. Inglis is progressing favourably.

WAR CASUALTIES.—The following casualties have been reported:

Lieut. T. Hamilton, son of Mr. J. B. Hamilton, manager of the Leeds tramways, is missing, and believed wounded and a prisoner.

Corp. E. H. Trowbridge (London Regt.), formerly in electric light dept. of the India Rubber Co., Silvertown, was severely wounded on May 16.

Pte. H. A. Barr (London Scottish), formerly in the buying department of the India Rubber Co., has been wounded a second time, and Pte. J. Brennan (Duke of Cornwall's Light Infantry) formerly in the general office of the same company, was also recently wounded.

Gunner E. Bawcutt (R.F.A.), formerly in the cable testing department of the India Rubber Co., Silvertown, has been wounded in France.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, June 8th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, S.W. Papers to be read on "A Bridge Method of Comparing Fixed Inductances," by Mr. T. Parnell, M.A.; "The Radiation from Loaded Antennæ," by Mr. Van der Pol. A demonstration of a method of preventing sparking at a rapid "make and break" will be given by Dr. A. Griffiths.

SATURDAY, June 9th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, Piccadilly, W. Lecture on "The Electrical Properties of Gases," by Prof. Sir J. J. Thomson, O.M. (Lecture VI.).

Digitized by Google

THE NEW HIGH-SPEED THREE-PHASE LOCOMOTIVES OF THE ITALIAN STATE RAILWAYS.*

BY P. VEROLE AND B. MARSILI.

GENERAL.

The type of locomotive recently supplied to the Italian State Railways by Brown, Boveri & Co. (Milan), for dealing with high-speed traffic on heavy gradients and curves, presents many interesting features.

These locomotives work on a three-phase system with 3,000 to 3,700 volts pressure and a frequency of 15 to 17 periods per second, Two of the conductors are aerial, the rails supplying the current in the third phase. The locomotive has a gross weight of 90·5 tons and an adhesive weight of 48·7 tons. It carries two motors operating three pairs of coupled driving wheels of 1,630 mm. diameter. At each end of the frame there is a swivelling bogie truck.

The synchronous values of the four normal speeds, at a frequency of 16·7, are 100 km., 75 km., 50 km. and 37·5 km. per hour. The tractive forces at the periphery of the wheels are 9 tons at the speeds of 37·5 and 50 km., increasing to 9·5 tons at 75 km. and diminishing to 6 tons at 100 km. per hour. At starting the maximum value of the adhesion (with a coefficient of $\frac{1}{4}$) may reach 12 tons by sanding the track. The efficiency of the motors is 93·5 per cent. with a power factor of 0·85, at the speeds of 75 km. and 100 km. per hour. In fixing upon the normal speeds four steps were found to be desirable in order to deal with express and stopping trains on heavy and light tracks. Apart from the time-table requirements, there were important technical reasons for the adoption of four normal values. Had there been two only, *i.e.*, from rest to 50 km. per hour, and 50 km. to 100 km. per hour, the heat losses in the rheostat would have been doubled. This would have entailed not only a considerably lower efficiency, with frequent stoppages, but also the inconvenience of larger resistance units. In spite of the electrical equipment being much simpler with two steps only, the balance of advantages rests with the present design.

MECHANICAL CONSTRUCTION (FIG. 1).

The three coupled axles giving a wheel base 3·6 m. long have no lateral play, but the leading and trailing bogies may swivel 50 mm. out of centre, and the locomotive can thus run smoothly over the sharpest curves on the line.

The under frame is built up of two steel side plates 32 mm. thick heavily braced and tied together so as to give a rigid bed-plate for the motors which are attached directly to it. Great attention was given to the design and construction of the cross-tie above the centre of the wheel base of each bogie. This not only carries the pivot for the bogie itself, but its ends support the bearings of the intermediate shaft transmitting the power to the driving wheels.

The bogie truck has wheels of 960 mm. diameter with the axles 2 m. apart. The method of suspending its oscillating bar and of returning it to the centre by means of springs does not differ substantially from that in a steam locomotive.

Motors and Transmission.—One of the main objects kept in view in the general design was to mount the traction motors on the frames, so as to have the centre of gravity as far as possible from the point of application of the lateral stresses due to the track. The position of the motors necessitated the transmission of the power, by inclined connecting-rods, to two intermediate shafts. In the direct-current type already in successful use on the Italian State Railways, the position of the countershaft rendered it impossible to have a less inclination than 60° for the connecting-rod, but in the present three-phase design the inclination is reduced to 33°. This is a material advantage, as the stresses on the countershaft and bearings are proportional to the sine of the angle of inclination. The bearings are spherical, which ensures the parallelism of the motor and intermediate shafts, in spite of slight elastic distortions of the frame or any inaccuracy in fitting.

The three pairs of driving wheels have horizontal coupling-rods. The rods, which connect the cranks on the intermediate shafts to those of the nearest driving-wheel axles, have a slight inclination to the horizontal, the geometrical centres of the intermediate shafts being about 20 mm. higher than the latter. All the connecting rods on one side of the locomotive are in the same plane and have spherical coupling heads to allow for the slight play of the frame relatively to the axles.

Brakes and Sanding Apparatus.—Automatic brakes, worked by compressed air, are applied to all the wheels. Their application is controlled by three separate cylinders, one for each bogie and the third for the set of driving wheels.

Two air reservoirs are mounted horizontally on the outside of the frame, under the projection of the cab. One of these supplies the air for the brakes, the other being for the electrical control gear. The braking effect on the driving wheels, with a mean air-pressure of 3·5 kg. per square cm. in the cylinders, is equal to 60 per cent. of the adhesive weight, whilst for the bogie wheels it is 35 per cent. of the weight carried. The hand-brakes, which can be worked from either of the drivers' cabs, are applied only to the driving wheels. The track sanding gear, of the Leach type, worked pneumatically, distributes the sand under the leading and middle driving wheels for both forward and backward running.

Housing.—As the housing has to contain within it not only all the controlling and regulating gear, but the main traction motors as well, it is somewhat bulky and presents much the same appearance as that of the passenger carriages. As it is shorter than the frame, this permits of a landing plate at each end for the four service steps and a means of communication to the nearest carriage.

The interior is divided into three compartments. The two end ones are the drivers' cabs, entered directly from the service steps and containing all the control mechanism for starting and running. The middle and largest compartment accommodates the traction motors and the electrical and auxiliary apparatus—resistances, regulators, compressors, transformers, &c. It has two doors at each end communicating with the drivers' cabs.

Traction Motor Mounting.—For the direct mounting of the motors on the under body the side frames are strengthened by the addition of four massive cast-steel brackets of inverted "L" section. These are fastened to the outside of the frames, and their horizontal flanges constitute the bed plates for the motors. Each side of the motor body is in two halves jointed in a horizontal plane passing through the centre of the axle. Each lower half is provided externally with a flanged projection forming practically a horizontal beam, which rests directly on the flange mentioned above. The fixing of the motor to the frame is completed by bolting together the corresponding flanges on the motor body and the brackets. The exact position is secured by adjusting four wedges inserted between the motor body ends and suitable vertical projections on the "L" brackets. The whole arrangement, besides providing a rigid bed-plate for the motors, adds considerably to the strength of the frame by the cross bracing effect of the motor carcase bridging its main members.

ELECTRICAL EQUIPMENT (FIG. 2).

The four synchronous speeds of the locomotive are obtained by connecting the two traction motors in tandem or in parallel, and also by changing the number of poles. The following schedule gives the arrangements for each speed, with a mean frequency of 16·7 :—

Speeds.	*Motor Connections.*
37·5 km. per hour	Motors in tandem each with 8 poles.
50 „ „	Motors in tandem each with 6 poles.
75 „ „	Motors in parallel each with 8 poles.
100 „ „	Motors in parallel each with 6 poles.

The stator of the *primary motor* is always connected to the line direct. The *secondary* stator may be fed direct from the line, or the secondary rotor circuit may be put in series with that of the primary motor. In this case the stator of the second machine carries the induced currents. Both motors have their stator windings star connected when they work in tandem with 6 poles, and also when they are in parallel, with either 6 or 8 poles. On the other hand, when the motors are running in tandem with 8 poles the windings of the secondary stator are changed over to delta connections, so as to prevent the tension on the adjustable resistance exceeding 2,000 volts at starting. The alteration in the number of poles is produced by suitably interconnecting the windings, while the system remains permanently three-phase. This is in contrast with the method employed in the earlier type of locomotive, where by suitable transformation the current was made either three-phase or two-phase for speed regulation.

The main control gear includes :—

1. Two change-over switches for the stator windings to obtain either 6 or 8 poles.

2. Two change-over switches for the rotors which have similar functions to the above, but in this case they form part of the rotor itself and revolve with it.

3. Speed regulator for connecting the two motors in parallel or in tandem

* Abstract of an article in "Rivista Tecnica delle Ferrovie Italiane."

Digitized by Google

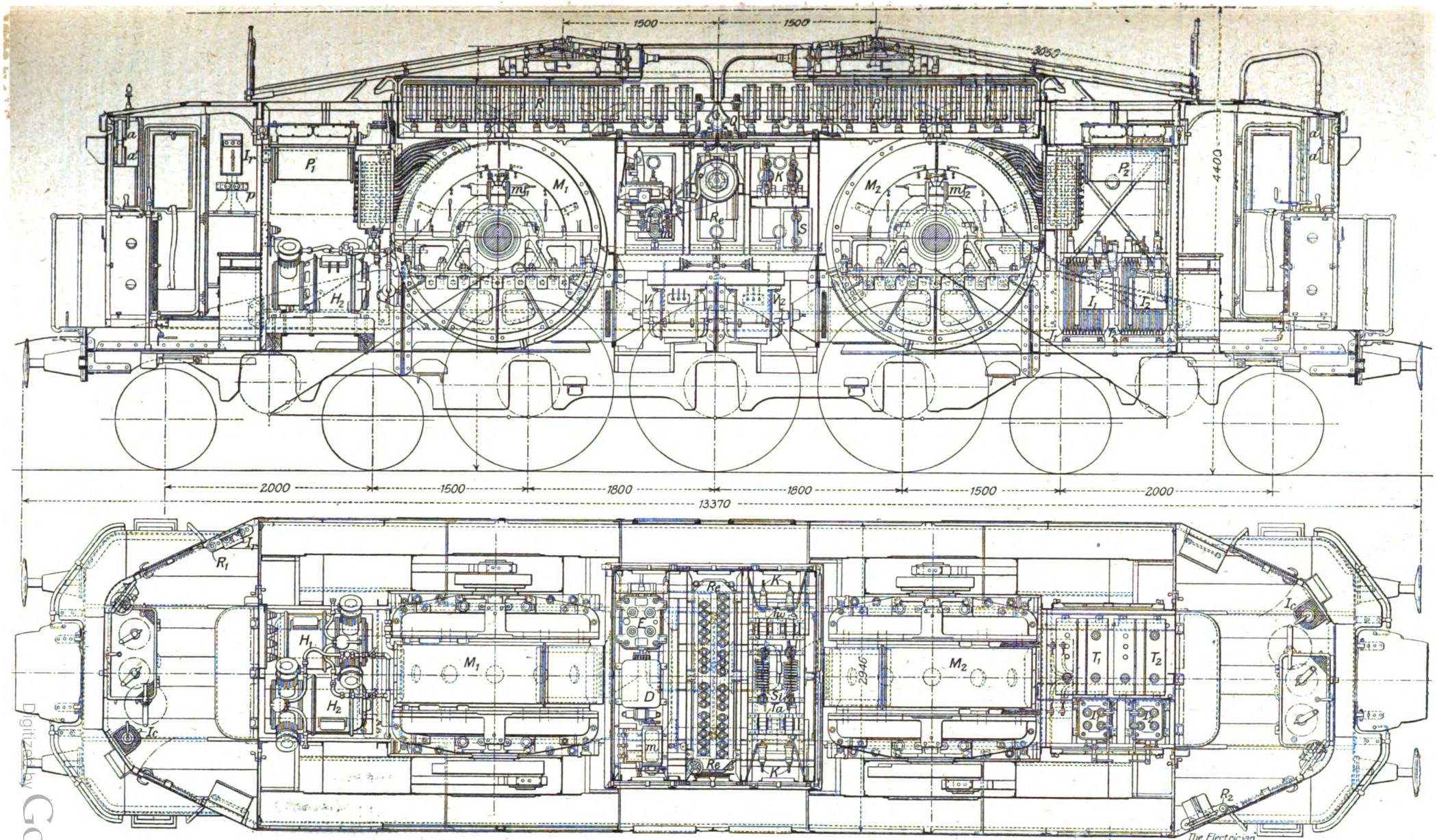


FIG. 1.—ARRANGEMENT OF ELECTRICAL APPARATUS IN THE LOCOMOTIVE.

a, a = Primary motor ammeters.
a' a' = Secondary motor ammeters.
D = Reversing switch.
E = Main circuit breaker.
H_1 H_2 = Air compressors.
I_1 I_2 = Circuit-breakers for auxiliary transformers.
Ic Ic = Switches for compressors.
Ir = Switch for heaters in drivers' cabs.
K K = Isolating switches.
M_1 = Primary traction motor.
M_2 = Secondary traction motor.
m = Compressed air motor operating the rheostat controller.
m_1 m_2 = Air cylinders for operating the pole change-over switches of the rotors.
P_1 = Change-over switch for primary stator.
P_2 = Change-over switch for secondary stator.
p = Plugs for portable lamp.
Q = Rheostat change-over switch.
R = Starting rheostat.
R_1 R_2 = Heating apparatus.
R_e = Rheostat controller.
S = Lightning arresters.
St = Choking coils.
T_1 T_2 = Transformers for auxiliary circuits.
Ta = Instrument transformers (ammeters).
Tw = Instrument transformers (wattmeters).
V_1 V_2 = Fans for traction motors and rheostat.

Digitized by Google

4. Star-delta switch for the stator of the secondary motor. When delta connected at the moment of starting the line pressure is reduced in the ratio $1/\sqrt{3}$, giving 2,000 volts approximately on the rheostat.
5. Circuit-breaker for the traction motors.
6. Reversing switch.
7. Starting rheostat, which is of metal.
8. Rheostat controller for adjusting the resistance during starting or speed alteration.
9. Change-over switch for the rheostat by means of which the requisite amounts of resistance can be inserted to suit either the tandem or parallel connections.

In addition to the above there is the following auxiliary equipment:—

1. Two transformers with 1/30 ratio.
2. Two motor-driven air compressors for the operation of the brakes and the various apparatus enumerated.
3. Two fans for cooling the motors and the rheostats.
4. Four isolating switches on the leads from the bow collectors (two on each phase).
5. Choking coils and lightning arresters.
6. Instrument transformers.

The whole of the high-tension apparatus is locked up on the "block" system, and access is obtained to it only by using the same key, which releases the bow collectors from the lines.

Traction Circuits.—From the bow collectors the current passes through the four isolating switches and main circuit-breaker to the reversing switch; thence one phase goes to the speed regulator and the stator of the primary motor, while the other phase goes to the speed regulator and the pole change-over switch of the primary motor. The speed regulator, besides establishing the tandem or parallel arrangement, connects up, while starting or accelerating, the stator of the secondary motor, or both the rotors with the rheostat. It is thus electrically connected with the rotor slip-rings, the rheostat and the stator of the secondary motor. The last-mentioned connection is not made directly, but by means of the pole change-over switch and the star-delta switch. For simplicity the speed regulator will now be referred to as *F*, the pole change-over switches as *P*1 and *P*2, and the star-delta switch as *G*. The apparatus *F*, *P*1, *P*2 and *G*, and the others working under high pressure, are all of the oil-immersed type.

The essential features of *F* are similar to those of the usual traction controller of the cylinder type. When the motors are working in tandem the stator windings of the primary are always star connected, but the stator of the secondary is delta connected with eight and star connected with six poles.

To throw the two motors into parallel the operating handle of *F* is given a quarter turn. When running in parallel, *F* connects in delta the three sets of resistance units in the rheostat, and similarly connects them in star when running in tandem. The switch *G* alone is not sufficient in all cases to determine the star or delta disposition of the secondary stator coils, but it works in conjunction with *P*2 or *F*. Thus, in the case of the 50 km. speed, the star connections are established by *P*2 alone without the use of *G*.

The rheostat controller consists of 30 pairs of contacts in two series. A shaft carrying 30 corresponding cams and rotating between the contacts can produce 12 different arrangements. Each pair consists of a fixed and a movable part; the latter works against a spring, and by the operation of the cam it can either insert or short-circuit the section of the rheostat to which it is connected. Each series of fixed contacts is subdivided into three equal groups, which are connected directly with one of the two extremities of each of the three sets of resistances in the rheostat. The movable contacts are similarly connected to the other extremities of the three resistances and to various intermediate points of these, either directly or through the rheostat change-over switch.

The main circuit-breaker is of the maximum and minimum type and has a two-point break on each of the aerial phases. The minimum coil operates should the line become dead. The reversing switch transposes the two aerial phases in the usual way, and thus reverses the rotation of the motors.

Auxiliary Electrical Circuits.—These start from the supply side of the main circuit-breaker, and feed two transformers, which are protected by their own circuit-breakers. The two groups of secondary windings are connected in parallel to a change-over switch, which permits supplying the auxiliary apparatus either from the transformers themselves or from the plant in the locomotive sheds. A three-phase 'bus bar from this switch runs the whole length of the locomotive, with tappings for the various branch circuits.

To guard against the breakdown of one of the transformer circuit breakers there are installed in each cab two signal lamps fed from the secondaries of the transformers. As these work in parallel, small switches are placed in each lamp circuit, and are actuated by the circuit-breakers of their respective transformers, so that if either of the breakers should trip the lamp is extinguished. Two press-button switches, one on each driver's plate, actuate the no-volt release of the main circuit-breaker when required, independently of its ordinary operation.

Connections are also made from the auxiliary 'bus bar to the electric circuit controlling the "block system" for the driving mechanism generally. From the same 'bus bar are tapped off the leads for the air compressor and ventilating fan motors.

The ammeters measure the current taken by the primary and secondary traction motors from the line. When working in tandem, therefore, the ammeter on the secondary motor shows no reading.

Pneumatic Driving Mechanism.—The apparatus for the driver's use is quite simply arranged, in spite of the multiplicity of devices it controls. Three driving handles are provided: The middle one operates the switch for reversing the direction of running, and simultaneously the switch for the ventilating motors. The one on the right serves to close the main circuit-breaker and to work the rheostat controller. The one on the left simultaneously operates:

(1) The pole-changer; (2) the speed regulator; and (3) the star-delta switch.

The last is the most important handle, as it determines the speed variations of the locomotive. A press-button switch is provided for tripping the main circuit-breaker independently of the handle mentioned above. Each cab also contains a special tap for controlling pneumatically the position of the four bow collectors. For safety the same key is used to work this tap and to open the doors of the high-tension compartment. In the driver's cab there are, in addition, the usual measuring instruments and signal lamps to indicate the working condition of the electrical apparatus. The actual movements of the main switches and regulators are effected pneumatically by pistons in cylinders, the handles being merely relays in the transmission.

The supply of air to the working cylinders is governed by slide valves, which either connect up to the pressure vessel or open out to atmosphere. In the reversing switch mechanism the supply of air is governed by two disc valves, one in each cab. A pipe branching from the second reservoir operates the mechanism for raising or lowering the collector arms, and a second pipe serves the reversing switch. On the interlocking system, when one of the air valves is in position for raising the collector arm, it is only then possible for the air supply to reach the slide valve of the cylinder operating the main circuit-breaker. Before arriving at this slide valve the air passes through a stop valve, which cuts off when required the supply from the pipes running to the second driver's cab, and thereby minimises the slight leakages inseparable from the pneumatic system.

The driving handle controlling the speed is mounted on a vertical shaft carrying six horizontal cams, which, by means of tappets, operate the slide valves of the cylinders of its electrical apparatus. The third handle actuates in similar fashion the rheostat controller. The mechanical block system ensures that if the central handle is not in the "running" position the compressed air is cut off from the slide valves actuating the change-over switches and the rheostat controller.

By a further elaboration of cams and levers the rheostat controller handle is prevented from passing directly from position 0 to 11 of the resistance units, without the intermediate steps. It is free, however, to move in the reverse direction from position 11 to 0. This is convenient in changing from one synchronous speed to another.

Yet another cam and toothed disc, in conjunction with an intermediate gear, prevent the handle controlling the change-over switches from being operated unless that of the rheostat controller is in its position 0.

Finally, the arrangement of handles is such that the change-over switches cannot be moved from their position 0 unless the reversing switch is in a "running" position.

Electrical "Block" Circuit.—To supplement the mechanical interlocks, and to check the proper sequence of the movements of the driving handles, an electrical "block" system is also installed. From what has been said regarding the different handles it is clear that it might still be possible to close the main circuit-breaker, even if the movements of the handles of the reversing and change-over switches had not produced the corresponding rotations of the shafts operating the various contacts. The electrical block circuit, to guard against this possibility, is shunted from the secondary of the auxiliary transformers, and it has terminals mounted on all the change-over apparatus and the reversing switch. In the circuit are inserted, at each driving end, an electromagnet and two small controllers operated by the middle and left-hand handles respectively.

Digitized by Google

The circuit is so arranged that electrical continuity can only be obtained when these two handles are in the "running" position, and the main electrical mechanisms which they control have actually assumed their proper relationships. Further, it is only when the electromagnet referred to has been energised from the "block" circuit that the right-hand handle can be shifted from its zero position, and thereby close the main circuit-breaker. A little drawback to this is that it would not in the ordinary way be possible to test the mechanical working of the circuit-breaker, the rheostat controller and their associated pneumatic apparatus, without using the high-tension supply on the locomotive; but, by means of the key of the air valves for working the collector-raising gear the right-hand handle can be released from the electromagnetic interlock, and thus obviate the difficulty.

Traction Motors.—The general construction can be gathered from the illustration. Both stator and rotor are drum-wound, with the conductors in partly closed slots. They have both the same number of conductors, but those of the rotor are inclined to those of the stator, so as to avoid "cogging" and to ensure a starting torque. The mechanism of the pole change-over switch for the rotor (shown in Fig. 3) consists essentially of three sets of fixed contacts mounted at one end of the rotor. Corresponding to these is a group of contact strips, which can assume two positions, and thereby connect the middle group of fixed contacts to either of the groups on each side of it.

The contact strips are carried on insulators mounted on a steel sleeve threaded on the rotor shaft. The sleeve is keyed to and rotates with the shaft, but it is free to move axially. A fork working in a groove in the periphery of the sleeve and rocking about a pin centred below the shaft slides the sleeve in either direction along the shaft, so as to interconnect the fixed contacts suitably for six or eight poles. The guides of the fork are furnished with rollers to minimise the friction in the grooves. The arrangement is worked pneumatically from a cylinder above by means of a connecting rod, rack and pinion.

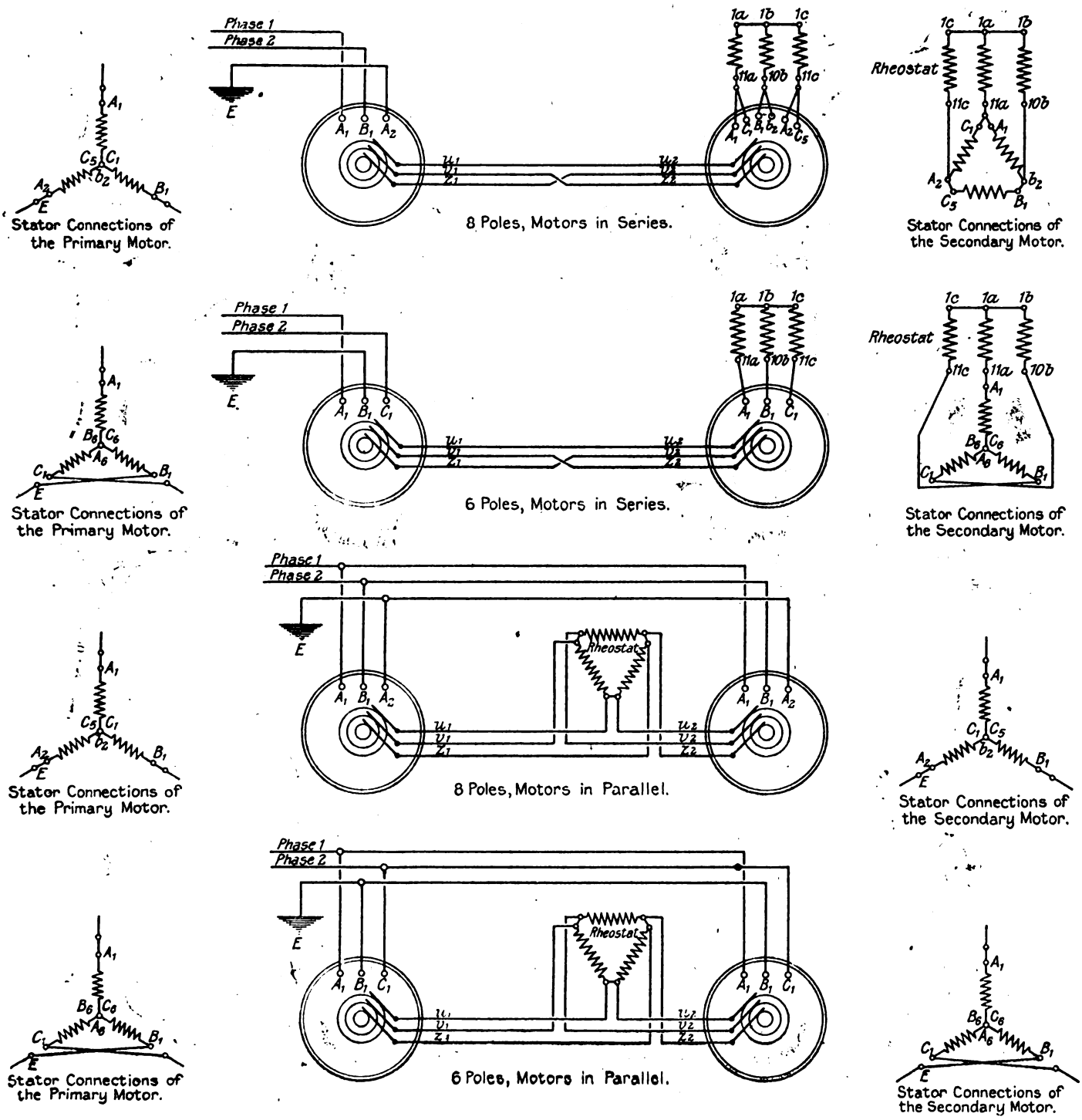

Phase 1
Phase 2
E
8 Poles, Motors in Series.
Stator Connections of the Primary Motor.
Rheostat
Stator Connections of the Secondary Motor.
6 Poles, Motors in Series.
Stator Connections of the Primary Motor.
Stator Connections of the Secondary Motor.
8 Poles, Motors in Parallel.
Stator Connections of the Primary Motor.
Stator Connections of the Secondary Motor.
6 Poles, Motors in Parallel.
Stator Connections of the Primary Motor.
Stator Connections of the Secondary Motor.

FIG. 2.—DIAGRAM OF CONNECTIONS OF THE TWO TRACTION MOTORS AND THE STARTING RESISTANCE FOR THE FOUR SYNCHRONOUS SPEEDS.

Digitized by Google

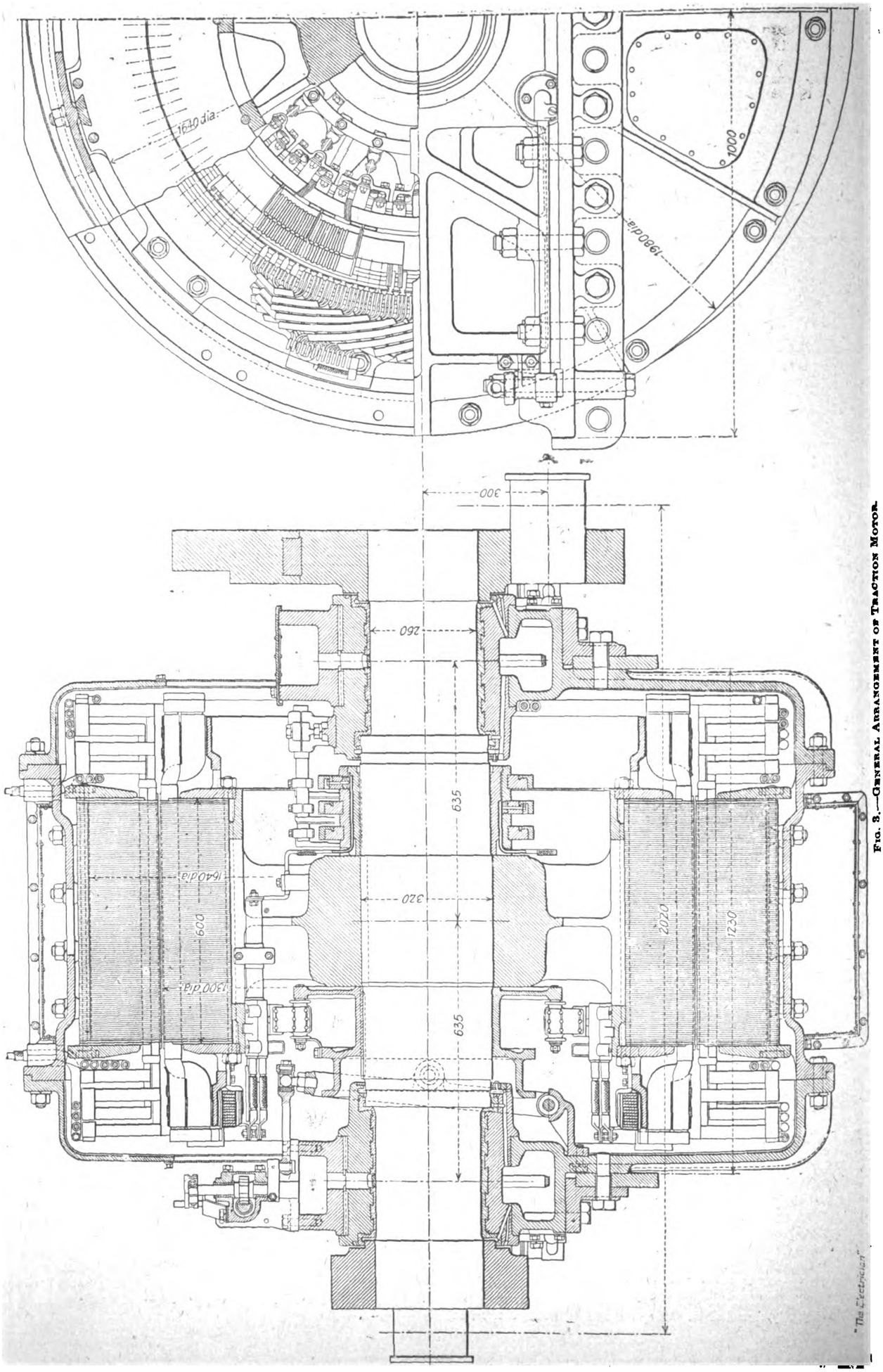


FIG. 3.—GENERAL ARRANGEMENT OF TRACTION MOTOR.

Digitized by Google

The motor is totally enclosed, with the exception of two semi-circular openings in the top halves for inspecting the slip-rings and the change-over connections The openings are covered by steel plates provided with inlets for the ventilating air currents.

Comparison With Previous Designs.—The essential difference in the electrical equipment of the present, in comparison with the former type of heavy high-speed locomotive on the Italian railways, consists in retaining the three-phase system at all speeds, instead of transforming from three to two phase at various values of the speed. Phase-changing transformers are not, therefore, required; but, on the other hand, there is a good deal of additional apparatus for altering the number of poles. A further point of difference is the arrangement, when running in tandem, of coupling up the two rotors in series, in preference to feeding the stator of the secondary from the rotor of the primary motor. Lastly, there is the use of a metallic instead of a liquid resistance for starting and speed regulation.

THE PRESENT POSITION OF ELECTRIC COOKING APPARATUS.*

This report is the result of investigations on cooking apparatus carried out for the S.E.V. and V.S.E., chiefly with a view to the improvement and standardisation of existing apparatus. The investigation consisted of two parts: (1) A series of tests on apparatus now on the market carried on in the laboratory of the S.E.V., (2) an inquiry, addressed to a number of electric supply companies, with a view to ascertaining their experience. The latter queries related chiefly to consumption, efficiency and best conditions of use. Fifty supply companies in Switzerland, including those that had made a speciality of heating problems, were invited to give evidence. Replies were received from 28 works, having in all 115,400 consumers, with a load of 220,000 kw. in the year 1914. Of these consumers about a third used electric heating appliances, the consumption of which was approximately 9 per cent. of the total output. Their requirements were distributed as follows:—

26·5 per cent. used only flat irons.
3·5 per cent. used heating apparatus.
1·6 per cent. used cooking apparatus.
1·4 per cent. used miscellaneous warming appliances.

It may be remarked, however, that since the war the use of heating appliances has increased considerably, and is now much greater than the above figures, relating to 1914, would suggest.

It is difficult to estimate the number of heating and cooking appliances in use, but according to the replies received there were about 25,000 irons, and 7,000 to 8,000 cooking and heating appliances of various kinds.

Nomenclature of Apparatus.—Apparatus covered by the investigations includes all appliances which make use of electricity for the generation of heat.

By "cooking apparatus" is meant apparatus which in the ordinary course is used for culinary operations, including roasting, baking, stewing, &c.

"Heating body" denotes the portion of an apparatus in which electric energy is converted into heat through the agency of an electric resistance.

"Cooking pots" refer to any apparatus in which the vessel heated is permanently connected to the heating agent. "Cooking plates" include apparatus in which the electric heating device, together with the flat heating surface forms one element; the vessel or object to be heated is separate and is placed upon the electrically heated flat surface in order that heat may be communicated to it. The term "Cooker" is used to describe any apparatus employed for culinary purposes in which boiling is involved, and a temperature of about 100 deg. is sufficient, as compared with "Roasters" which are used for baking, roasting, &c., where higher temperatures are required. "Economy cookers" are cooking apparatus in which slow heating on a large scale with as small an electrical consumption as possible is desired. "Ovens" are vessels used for baking and roasting in which special heat-insulation is applied. "Cooking ranges" cover a miscellaneous series of heating appliances which are used not only as "cooking plates" in the sense denoted above, but in combination with ovens, economy cookers, and apparatus for heating water generally.

PRACTICAL REQUIREMENTS OF COOKING APPARATUS.

The practical requirements of cooking apparatus in use include durability, freedom from derangement and low repair rate, adaptability to varied conditions, portability and convenience, to which must be added some purely technical requirements such as high efficiency.

Durability.—The replies to the inquiries issued show that considerable progress has recently been made in durability and freedom from repairs. This is particularly true of irons, for which laboratory tests have revealed great durability.

Tests of durability were conducted so as to simulate as nearly as possible practical conditions. Thus, the apparatus was used periodically at cooking temperature, allowed to cool, and heated again. In order to test resisting power to exceptionally severe conditions of use the voltage was progressively increased to a figure considerably above normal. In the case of cooking plates and so-called "quick-heaters," the period of use was taken as the time during which the apparatus could be filled with water, the current turned on, the water raised to boiling point, the water emptied out, and the apparatus allowed to cool to 20 deg. again. Frying pans were in each case heated dry—*i.e.*, without material to be cooked—and allowed to cool for 55 minutes. Similarly, cooking plates received current for 15 minutes, and were then allowed to cool for 45 minutes. Irons were treated in a similar way. In the case of wet tests the voltage was raised, after each 1,000 heatings and coolings, by 10 volts above the pressure of 120 volts, for which each utensil was constructed. In the case of utensils tested dry, the voltage was raised 10 volts above the normal 110 volts after each 200 heatings.

The results of these durability tests are given in the following table:

Defects revealed from start—	1.	2.	3.	4.	5.	6.	7.	
Cookers	1,080	2,360	3,370	3,400	4,090	6,700	7,250	Number of Periods of Use.
Frying pans ...	0	650	960	1,270	—	—	—	
Cooking plates	480	750	850	870	—	—	—	
Irons	285	701	735	785	990	1,120	1,375	

It is to be noted that, in view of the progressive rise in the pressure, these tests are more stringent than practical experience. Thus, in some cases apparatus was in the final periods subjected to an overload of 50 to 70 per cent. so that any latent defects, such as might in practice give rise to melting of the conductors, should readily be detected. This test refers exclusively to defects which revealed themselves owing to excessive temperature of the heating resistance, such as fusing of the conductors themselves or the leading-in wires, but not to defects originating from the effect of increased voltage in combination with insufficient insulation, leading to arcing through on to the heating body.

As regards the durability of the heating body itself and its immediate accessories, therefore, it can be deduced from the above data that, even when subjected to a double load, cookers lasted for 2 to 10 years, frying pans for 2 to 4 years, cooking plates for 1 to 2 years, irons for 2 to 8 years before a defect was revealed, and this durability in ordinary use would be at least doubled.

Practical experience in the main bears out these results. Defects in the heating body rarely occur; in the case of irons, particularly rarely. On the other hand, it is sometimes complained that the heating bodies of cookers are apt to fail when the latter are used dry, a condition which, although applied for the sake of severity in the above tests, is one for which such apparatus is not intended. In practice it is also found that the heating bodies of cooking plates and roasters last better than those in cooking pots, but the functions of the former involve a more robust form of heating body.

An additional test of the durability of a series of irons, cooking pots, frying pans, cooking plates and quick-heating appliances took the form of continuous heating, dry, and without cooling periods. With exception of the quick heaters, which are not intended for continuous work, the apparatus stood the test without revealing any defects for over two weeks, actually about 425 hours. The temperatures, measured on the outer surfaces of the articles, ranged from 360 deg. to 550 deg.

In many quarters the view is still held that cooking appliances should be provided with a fusible plug as a safeguard against improper use. But it may well be considered, at least as far as cooking plates and frying pans are concerned, that such a precaution against undue temperatures is not necessary, although it may be applied to pots and vessels which are merely designed for boiling. The ideal form for such a protection is, however, still to be found.

Seeing that the heater is such an important element in any cooking apparatus, special attention should be concentrated on its design.

* Abstract of First Report of the Commission on Heating and Cooking Apparatus, based on the experiments and experience of the General Secretary of the Schweiz. Elektrotechnischer Verein, "Bull." Schweiz. Elek. Ver., No. 1, January, 1917.

Digitized by Google

Difficulties arise from limitations of space and restriction in choice of insulating materials, such as can withstand heat. Asbestos is commonly used, but is decidedly hygroscopic, and in the moist atmosphere of the kitchen tends to deteriorate, so far as insulating qualities are concerned. It is also used in a secondary form, such as asbestos string, wound round an inner coating of some other insulating material. Here the hygroscopic qualities of asbestos are less important. It has, however, a tendency to disintegrate under the continuous action of heat. A better substance is pure mica. It appears, however, owing to the relatively high cost of mica, that substitutes such as micanite, in which scraps of mica are cemented with shellac, are often used. Such substances have yielded bad results for irons and cooking apparatus in general. The binding material not infrequently melts, with the result that the insulating materials fall to pieces. More recently, insulating masses composed of compressed clay, porcelain earths, &c., have been tried, and it is probably in this direction that the best solution of the problem of insulation will be found.

The mechanical strength of the heating resistance is small, especially in view of the very thin wires involved for the higher voltages. To-day nichrome, a material of about 100 microhms per centimetre cube, is almost exclusively used for cooking apparatus. Wires of about 0·3 mm. to 0·7 mm. diameter or bands 1 mm. broad and 0·1 mm. to 0·2 mm. thick are commonly used, the latter being insulated with mica plates. As the resistance rises with the square of the voltage the difficulties of the pressures now coming into use are evident, and it is found that complaints received are more common in the case of apparatus designed for 220 to 250 volts than of those for the customary 100 to 120 volts.

It has been shown that the latest cooking appliances can successfully stand repeated overloads of 40 to 60 per cent. As, however, individual complaints of over-sensitiveness to excess voltage are still received, it has been suggested that one should seek to use a material for resistance having a high temperature coefficient, such that the effect of excess of voltage is compensated by rise in resistance. This method, however, is open to the objection that such materials would be overloaded to a corresponding extent when switched on cold.

Electrical Insulation of Apparatus.

Direct tests of insulation were first tried, but the difficulty was experienced that apparatus in the cold state showed insulating qualities enormously different from that recorded when it was hot and moist. Apparatus using mica insulation appeared less sensitive to such conditions that when asbestos was used, but at different times variations from 10,000 ohms up to 10,000 megohms were recorded without assignable reason. In view of the conditions in which cooking apparatus is used a direct measurement of insulation appears to have little practical value.

The Verband-deutscher Elektrotechniker has met the difficulty by prescribing a test based on subjection to a high tension—namely, that the apparatus should withstand 2½ times the normal pressure and a minimum of 1,000 volts between heating resistance and metal parts. The duration of the test is not prescribed, but in these experiments the high tension was applied for five minutes.

In the case of most apparatus various signs of insufficient insulation such as crackling and small internal discharges began at about 2,000 volts. But with one exception—an apparatus from the beginning recognised as faulty—no permanent discharge occurred during a five minutes' exposure to 1,500 volts (in the case of irons, 2,000 volts). This behaviour persisted after the durability tests on over-pressure described above.

Complaints are sometimes received of short-circuits in the heating body of cooking pots. There are some types in which inadequate precautions are taken against the entry of damp. Sometimes the cases are screwed instead of being soldered. The chief source of trouble is entry of water where the wires are led into the heating body, especially where unreliable insulating materials are used.

In view of the danger of shocks in handling badly insulated cooking apparatus, special precautions in this direction of insulation should be taken. From the experience narrated above it would appear that the insulation of cooking apparatus might well be tested on 1,500 instead of 1,000 volts. Even on 2,000 volts the discharge commonly takes place *outside* from terminal to terminal, and not inside the apparatus.

Connections between Heating Body and Terminals.

Connections from heating body to terminals appear to form a much more frequent source of trouble than the heating body itself. A perfect connection is not easily made. The chrome-nickel used for the resistance cannot be soldered on account of the formation of oxide, quite apart from the high temperature necessary for the process. Recourse is, therefore, had to simple pressure in order to make a contact. In some cases this appears to answer well enough, but in others gives rise to trouble. Thus if a round chrome-nickel wire is in contact with a thin copper disc, the high temperature is apt to oxidise the copper and gradually impair the contact. It seems better to bring the chrome-nickel connection to a contact with steel or other good heat-resisting metal. Or the contact might be improved by coating the junction of the chrome-nickel and connecting wire with a thin metallic sheet by the Schoop process, or, possibly, in the case of strip, a junction made by electric welding. There is opportunity here for further experiment.

The insulation of conducting leads within the heating apparatus is commonly done by threading the wires through beads of glass, porcelain or steatite, and this method is an improvement on the use of non-heat-resisting insulating material formerly employed.

Accessories: Terminals, Plug-contacts, Leads and Switches.

In this section we come to the weakest point in the design of cooking apparatus, and the one most apt to give trouble. Where the connecting wires are brought to naked terminals, and no precautions are taken to ensure that these are tightly and safely screwed up, wires readily become loose and short-circuits occur. The proper insulation of parts of cooking implements involving continual exposure to high temperatures is one of the chief difficulties not yet completely solved. It is scarcely surprising that trouble occurs when such substances as ebonite are used, and micanite and many other materials having resins in their compositions are likewise unsatisfactory. Pure mica can not always be conveniently used, but porcelain and steatite, both good heat-resisting insulators, can be widely employed. The latter, on account of its much greater mechanical strength, is particularly serviceable. Contact pieces should also be sufficiently thick to withstand the heat. Moveable contact-pieces should be insulated with similar appropriate material. For the insulation of detachable conducting pieces porcelain is not suitable, as it breaks readily if allowed to fall. Copper conductors should also be attached at as great a distance as possible from the hot element, as the communication to them of a high temperature may in course of time affect them prejudicially. Plug-contacts and terminal connections should also be so placed that they are not liable to become coated with an overflow from the material cooked. As a matter of principle flexible wires should be avoided so far as possible for connections outside the actual heater in an electrically-equipped kitchen. They are unnecessary for ranges and apparatus permanently in position, but are commonly used with portable irons, cooking plates, &c. In view of the presence of moisture, single or multiple vulcanised rubber insulation should be prescribed, the insulation being protected by a strong woven outer covering, and the cord should have sufficient stiffness to avoid kinks. Choice of unsuitable materials not infrequently leads to breakage at the point of connection to electric irons. Another precaution necessary in view of the moist floors prevalent in kitchens and laundries is the earthing of the metal casings of all permanently installed cooking apparatus. This rule might even be applied to portable appliances without undue difficulty if the connection is provided with a light flexible wire covering which is permanently in contact both with the metal covering of the apparatus and with a suitable earth on the wall, to which it is brought to receive current. Earthing may not be convenient in the case of portable appliances used in dwelling rooms not devoted specially to culinary apparatus, but in such cases there is a wooden and probably carpeted floor, so that the danger of shock is less. In the kitchen itself there is no reason why it should not be habitually applied.

Various Practical Points in the Design of Cooking Appliances.

Complaint is often made of the form of cooking pots, as being inconvenient to clean. It is better to give the vessel straight inner walls (without bends), even though, with side heating, this will make the vessel thicker at the bottom than the top. As regards material for cooking pots, aluminium has the desirable strength, and is a good heat conductor, but is too easily dented. Owing to the present shortage of metals aluminium vessels strengthened with an outer covering of white metal have been used. With the return of normal conditions one would, wherever possible, use the best materials, nickeled brass or, preferably, pure nickel. The latter is certainly dearer, but pays in the long run.

The relative advantages of cooking pots and cooking plates have been much discussed. The latter are decidedly preferable in the completely equipped electric kitchen. Theoretically the efficiency of the cooking pot may be 20 to 30 per cent. higher than an apparatus with outside heating arrangements, but in practice this advantage is less evident. There are also practical advantages in the cooking plate as regards convenience of cleaning and adaptability.

Digitized by Google

EFFICIENCY OF COOKING APPARATUS.

Investigations have been undertaken on the efficiency of various cooking appliances. The electrical consumption is easily measured direct. The useful efficiency, in terms of the results secured, is more difficult to determine. In the case of vessels used for heating water the estimate of the heat usefully employed can be readily made, but in the case of vessels, frying pans, &c., used for raising more or less solid food to a high temperature it is less easy. With a view to approaching as nearly as possible to practical conditions a metal body, which, after the usual preliminary warming could be placed in position and raised to the desired cooking temperature, has been employed in some cases. It must also be remarked that the efficiency measured depends on such factors as the temperature of the room, the proportion of space in the heating vessel filled, and the amount of preliminary warming given. These conditions may cause variations as high as 10 per cent.

When the apparatus is switched on, the initial and final consumption of power is noted; the consumption when the resistance is cold is high, but equilibrium is quickly attained. The progressive rise in the temperature of the water is noted until the boiling point, after which it becomes stationary. By computing the energy required to raise a given volume of water to boiling point and evaporate a certain quantity subsequently the useful effect of the apparatus is determined, due regard being paid to the heat-capacity of the apparatus.

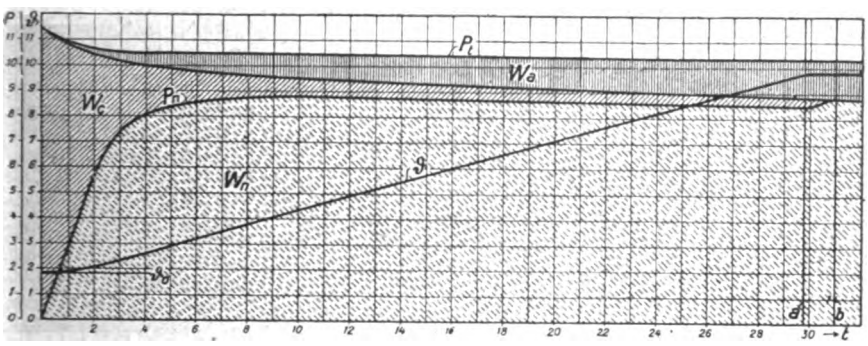


FIG. 1.—COOKING POT, 5 LITRES CAPACITY, ¾ FULL, ENCLOSED, 105 V.

(*a*) Water begins to boil. (*b*) Water boils *en masse*.
Scale of time, 1 division = 1 min. Scale of power, 1 division = 85·5 watts.
,, temp., 1 ,, = 10 C. ,, energy, 1 (divn.)² = 1·227 WE.
P_t: Power supplied to apparatus. W_a: Energy lost to surroundings. W_n: Energy usefully applied.
P_n: Power usefully applied. W_c: Energy stored in apparatus. δ: Temperature of water.

In Figs. 1 and 2 the typical processes in a cooking pot and cooking plate respectively are portrayed, the observed quantities being plotted as ordinates and time in minutes as abscissæ. The temperature rise is for a time almost linear, until the boiling point is reached. The useful power, which is proportional to the rate of rise of temperature, increases sharply from zero and then becomes approximately constant, diminishing, however, slightly afterwards, until the boiling point is reached. The total useful energy is indicated in the shaded diagram W_n, the energy stored in the vessel by the area W_c, and the energy given to the outside air by the area W_a. These three quantities add up to give the total energy given to the vessel.

The loss in conduction and radiation is naturally *nil* at the commencement of the test, but rises as the temperature increases, attaining a constant value when equilibrium occurs. It is practically proportional to the difference in temperature of the outer surface of the vessel and the surrounding air; the results are thus slightly affected by the initial temperature of the room.

The efficiency at any moment is obtained by the ratio between the useful power ordinates and the total power ordinates. It has been customary to quote only the maximum efficiency attained when conditions of heat equilibrium are arrived at. Strictly this would only apply to a case in which an appliance was being continuously used for cooking. In practice one has to deal with successive periods during which the vessel is first heated up, used for a time, and then emptied again. It is useful, therefore, in comparing appliances to compare the energy usefully applied, with the total energy given to the appliance during the entire process of heating up. This total energy efficiency is naturally considerably lower than the corresponding efficiency for continuous cooking, on account of the heat capacity of the apparatus. In judging cooking apparatus both forms of efficiency should be stated.

The following table summarises the distribution of energy as illustrated graphically in Figs. 1 and 2, and as applied also to a third class of apparatus—namely, rapid heaters:—

Distribution of Electric Energy Given to Apparatus (100 *per cent.*) *up to Boiling Point.*

	Rapid heaters. Per cent.	Cooking pots. Per cent.	Cooking plates. Per cent.
Useful energy received by material cooked	87·0	77·7	63·5
Energy accumulated in apparatus	8·0	11·5	29·0
Energy lost to surroundings	5·0	10·8	7·5
Mean consumption, watts	810	895	1,047
Mean efficiency up to boiling point	87·0	77·7	63·5
Max. efficiency in the course of heating	92·0	84·0	—
Efficiency during boiling	89·7	84·3	82·3

In the course of tests rapid heaters were found to have a working efficiency of 78 to 87 per cent., and an efficiency by continuous cooking of 85 to 90 per cent.; cooking pots, 70 to 81 per cent. and 80 to 89 per cent. respectively; an cooking plates, 40 to 65 per cent., and 70 to 80 per cent. respectively. The conduction losses of cooking plates are naturally greater than for cooking pots, on account of the larger surface presented. In the case of frying pans the efficiency cannot be easily stated with precision on account of the variation in the period of cooking, the necessity for preliminary heating and other complexities. There is little scope for diminution in the heat capacity of cooking vessels, as their mass has been reduced to the limit consistent with solidity and the material must be selected to meet various other supplementary considerations. In the case of rapid heaters and cooking pots, there also seems little opportunity for diminishing conduction losses. In the case of cooking plates, and in some cases frying pans, heat insulation of the sides might be worth while.

It is evident that the efficiency of irons is dependent simply on their temperature, and values have been recorded ranging from 90 per cent., with an average temperature of 120 deg. to 73·5 per cent. with a temperature of 200 deg.

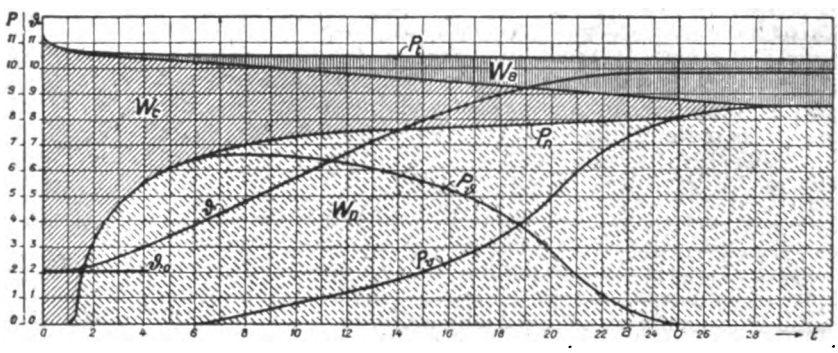


FIG. 2.—BOILING PLATE FOR 1,000 W., WITH ALUMINIUM COOKING UTENSIL, 2 LITRES CAPACITY, OPEN, 105 V., HEATED FROM COLD STATE.

(*a*) Water begins to boil. (*b*) Water boils *en masse*.
Scale of time, 1 division = 1 min. Scale of power, 1 division = 100 W.
,, temp., 1 ,, = 10°C. ,, energy, 1 (divn)² = 1·434 WE.
P_t: Power supplied to apparatus. W_a: Energy lost to surroundings.
P_n: Power usefully applied. W_c: Energy stored in apparatus.
P_δ: Power required to rain temperature of water. W_n: Energy usefully applied.
P_v: Power required to vaporise water. δ: Temperature of water.

The high momentary current taken by the cold resistance is worth consideration when it is recalled that in a house using a maximum load of only 250 to 350 watts for lighting, might require 2,000 to 3,000 watts for a completely equipped kitchen. In most cases it is not practicable to diminish greatly this initial load, but something might be done by the encouragement of the use of economy-cookers, to processes which require long heating. Heaters for roasting and baking processes are the worst in this respect, and attention might be directed to possible methods of reducing the consumption in these processes.

Finally, it is very desirable that manufacturers should make a practice of subjecting heating apparatus to rapid and inexpensive tests while in course of construction. Such tests might include a short overloading test with excess voltage and a subsequent insulation test at high tension.

Digitized by Google

MEASUREMENTS OF RADIO ANTENNA ON SHIPBOARD AND SOME INTERESTING COMPARISONS.

BY F. A. HART.

Variations of capacity, inductance and fundamental wave-length have been selected by the author from measurements taken on a large number of vessels, and covering at the same time as broad a range as possible. These data should be of interest to marine engineers and advanced experimenters, especially in the case of aerials erected on roofs, such aerials being under very similar conditions as regards effect from near-by metal, stays, &c., which materially effect the capacity of the aerial.

In connection with ship stations a great deal has been said about compass troubles, generally attributed by masters to the nearness of the aerial lead-in wires in each specific case. It might be well to point out that exhaustive tests have been made from time to time, and absolutely no disturbance noticed. On the other hand, the proximity of a motor-generator or other large mass of iron to the compass would tend to have some effect.

The lengths used in the table are given in feet, capacity in micro-farads, inductance in centimetres and natural wave-length in metres.

For simplicity, each type is designated by a number. The overall or total length of wire from apparatus of the "L" aerials is taken as the horizontal plus the vertical, and in the "T" aerials half the horizontal plus the vertical. All these aerials are comparatively small in actual amount of wire compared with aerials in coast stations, and a good many should compare very nearly with many amateur receiving aerials, some of which are of even greater length.

Aerials such as Nos. 6, 9 and 28 are the least efficient for 200 and 300 metre waves, as the fundamental is very large, the capacity low, the radiation resistance high; and in order to reduce the aerial to small wave-lengths the series condenser would have to be less than 0·0004 mfds. As both capacities are so small, the radiation from any set less than one kilowatt would probably not be greater than one-half ampere. Judging by the results, for those who wish to transmit efficiently on 200 or 300 metres, the aerial should be made a "T" where the horizontal length is 120 ft. or over. As a rule, the most efficient working wave-length where a series condenser is not used is about 0·9 of the natural wave-length. For instance, in the case of No. 23 the natural is 230; taking 0·9 of this value and adding it to 230 we get 437, which should give the greatest radiation for that particular size of aerial.

In the case of Nos. 15 and 16, these measurements are identical, with the exception of a trifle greater height and 55 ft. more wire in the horizontal length of No. 16. Everything being equal in both cases, except the relation of the vertical wires to the bridge railings and metal stay in No. 15, this apparently makes up for the 55 ft. of extra length in No. 16.

The most marked of deck and work effects is in Nos. 38 and 39, the vertical length in No. 39 running parallel with three stays from the top of the mast to the wireless cabin. In No. 38 they run practically the same, also considerably increased by the nearness of the funnel. The "T" type aerial has been found as a whole to give the best all-round results, and is less likely to be affected by foreign matters. The spring stay should be removed, and all other stays either grounded or broken up with insulators to ensure against induction and the most effective work from the radio apparatus.

Aerials in which stays, decks or other metal work figure largely are Nos. 18, 19, 20, 21, 22, 30, 33, 34, 35, 36 and 37, in every case affecting the vertical length. The ground lead in all examples given does not average over 3 ft., and is sometimes less.

No. 1 is a very good type of aerial for amateurs who wish to transmit. No. 40 is also in line with No. 1; the capacity runs higher, although the lengths are very small, and the nearness to all metal work and the large number of wires has helped to increase this.

One can readily see from the table how important it is to keep the overall lengths as small as possible where there is any possibility of metal increasing the capacity.

Two-wire Aerials.

No.	Type of aerial.	Height	Lengths.			Capacity.	Inductance.	Natural wave-length.
			Horizontal.	Vertical.	Total.			
1	T	92	130	50	115	0·00075	22,000	232
2	T	110	151	85	160	0·00090	26,363	290
3	T	90	210	50	155	0·00092	29,860	312
4	T	91	208	64	168	0·00096	30,975	325
5	L	86	216	65	281	0·00101	34,217	350
6	L	135	238	80	318	0·00095	61,434	455
7	T	100	240	80	200	0·00140	30,603	390
			Four-wire Aerials.					
8	L	68	127	90	217	0·00082	49,621	380
9	T	150	250	90	215	0·00096	53,210	426
10	L	70	90	90	180	0·00099	23,600	295
11	L	125	112	75	187	0·00105	41,932	395
12	T	128	178	100	189	0·00108	34,215	362
13	L	90	100	60	160	0·00110	30,100	340
14	L	80	120	50	170	0·00115	20,188	287
15	T	110	170	70	155	0·00115	28,333	340
16	T	100	225	70	182	0·00115	28,333	340
17	T	115	170	88	173	0·00116	22,184	320
18	L	112	220	105	325	0·00130	30,854	380
19	L	100	120	80	200	0·00135	30,784	384
20	T	100	260	58	188	0·00136	23,933	340
21	L	100	150	50	200	0·00140	26,952	366
22	L	105	204	64	268	0·00145	28,038	380
			Six-wire Aerials.					
23	L	55	125	50	175	0·00085	17,532	230
24	L	80	98	50	148	0·00100	33,246	345
25	T	135	150	90	165	0·00102	25,690	305
26	L	125	155	85	240	0·00109	36,272	376
27	T	96	200	85	185	0·00118	21,192	298
28	L	105	270	70	340	0·00120	55,902	488
29	L	94	138	50	188	0·00120	30,085	358
30	L	98	104	90	194	0·00120	20,428	295
31	L	125	225	80	305	0·00124	46,615	453
32	L	115	141	84	225	0·00125	30,335	367
33	T	60	165	35	118	0·00126	20,134	300
34	L	95	150	70	220	0·00128	30,946	375
35	L	115	190	95	285	0·00140	32,200	400
36	L	100	150	60	210	0·00145	38,451	445
37	L	120	200	70	270	0·00150	34,272	424
38	L	145	225	100	325	0·00180	27,343	418
39	L	98	200	60	260	0·00240	21,200	425
			Ten-wire Aerial.					
40	L	50	80	30	110	0·00068	16,639	200

L = mean standard inverted "T."

State Electricity Supply in Prussia.—In view of the appointment by the Board of Trade of the committee to consider electrical supply it is interesting to note that, according to "Engineering," the same question is being actively considered in Germany. The Prussian Government appears to be planning a State electricity supply, and it is understood that the other German states are making similar local arrangements. The plan of an Imperial electricity scheme throughout Germany appears, however, to have been abandoned. The entire control of the supply of electricity seems to be considered beyond the present resources of the Prussian Government. It is probable that, as in Saxony, the State will aim at securing a predominant position by producing current so economically that eventually all private consumers will find it advantageous to obtain a supply of electricity, directly or indirectly, from Government sources. The proposal for the moment is that the State should erect a large number of huge electric power stations, using water power, coal, lignite or peat gas, from which electricity can be transmitted to private works, which remain independent. The transformation and distribution of power to private consumers would be done by existing local works and stations, which will buy from the State in bulk. The scheme, however, finds many opponents, and there is apparently much difference of opinion regarding the prospective economies in generation to be produced in this way.

Digitized by Google

PHYSICAL SOCIETY.

A Meeting was held on May 25th, at the Imperial College of Science, Mr. W. R. COOPER, M.A., Vice-President, in the Chair.

A Paper entitled

"An Investigation of Radium Luminous Compound,"

by C. C. PATERSON, J. W. T. WALSH and W. F. HIGGINS, was read by Mr. PATERSON.

The paper contains the results of measurements made on various samples of radium luminous compound during the last two years. Determinations of the brightness of the compound in powder form and when made up into paint, and also after the application of the paint to instrument dials, were carried out; and curves are given showing the rates of decay of luminosity. The radium contents of the compounds were determined by comparison of their γ-ray activities with that of a preparation of pure radium bromide, which is periodically compared with the British radium standard. The various precautions which have to be observed and the corrections which have to be applied in making the various determinations are explained, and the considerations which should govern the proportion of radium employed for practical purposes are discusesd.

Mr. H. F. GLEW: The difference between some of Marsden's results and those of Dewar and Crookes had been attributed to some difference in the zinc sulphide employed; he could state that the sulphide supplied to the National Physical Laboratory was of different origin from either of these. Before the war we were almost entirely dependent on foreign sources for the supply of these materials, but we were now quite self-supporting. In Marsden's work the inside of the tube was completely coated with sulphide, so that the effects were observed by light transmitted through the material. It was better to paint only one half of the tube so that the inner surface, which was exposed to the bombardment, could be directly observed. In the photometer measurements, was there any advantage in placing the coloured filter between the light and the reflecting surface? He preferred to have it in the eye-piece. Earlier records of the coloration due to absorption would be of value. In testing sulphide for γ-ray activity he placed it in contact with the ionisation chamber. Less material was then required for the test; which was an advantage. The authors stated only the diameter of the tubes employed; but he had found that there were differences in the results obtained with tubes horizontal or vertical. The length of the tube, therefore, appeared to be an important factor. Further, the results given by a small quantity of sulphide in a large tube would be too high; for the space above the sulphide is filled with the emanation gas, and the γ radiation from it is not subject to the absorption of the sulphide, as is the radiation from the latter itself. The discrepancy between the observed and calculated values of the absorption was probably important. Was this due to some selective action, the sulphide transforming the γ radiation into radiation of some other type? It was singular that specimens prepared by the dry and wet methods should be so similar in their properties after only 4 days; for in the dry method the emanation and all its products were retained.

Dr. MAKOWER stated that by using an electroscope of small capacity good γ-ray measurements could be obtained with much less than 1 milligram of radium.

Dr. H. S. ALLEN asked if the zinc sulphide employed was wholly crystalline or partially amorphous. An investigation of its physical condition would be useful.

Prof. CLINTON said that the difficulties of these measurements were very great and the authors were to be congratulated on having overcome them so effectively.

Mr. J. S. DOW said the figures for the absolute brightness were what he would have expected. He was doubtful of the possibility of expressing the brightness accurately. Consistent results could be obtained, but they did not represent exactly what the eye saw. For instance, zinc sulphide and cadmium sulphide may be equally bright a few inches away, but the former will look much brighter at a distance. The information as to the correct proportion of radium to employ was important. What was the brightness physiologically necessary for these purposes? He thought that less brightness than was customary might be advantageous, as he sometimes experienced an appreciable glare from the markings, which detracted from their legibility. The selection of a proper coloured glass was important for these measurements. Had the authors noticed any change of colour as the compound got older? He thought it got greener as it aged. The initial rise in the luminosity curves for the weaker materials seemed greater than could be explained by the lower rate of decay.

Dr. LEVY said he had found the luminosity of different samples of zinc sulphide to vary perceptibly in tint when stimulated by daylight, but had not noticed this with α-ray stimulation. In his experience, if a sample of sulphide gave good results when stimulated by daylight, it would also be good when stimulated by radium. The reverse did not hold, however, as a specimen might be poor with daylight, but good with radium excitation.

Mr. T. SMITH thought the coloured filter used in the photometric measurements should have been placed as near the lamp as possible, since such a filter acts, to a certain extent, as a self-luminous source. If the tube containing the compound was not much wider than the aperture in the screen, a considerable loss of light would occur, near the edges of the aperture, due to obliquely internal reflection at the walls of the tube. For accurate work it was important to have a uniformly illuminated field, and he suggested the desirability of employing tubes with a flat side. Where the tubes were too small to fill the aperture satisfactorily, an optical system could be used to give an enlarged image of the tube and so avoid refractions at large angles. The absorption of the system could be found experimentally with a larger tube.

Dr. A. RUSSELL laid stress on the practical importance of the paper. He had at times been asked by manufacturers to measure the visibility of watch faces in the dark. The problem was so difficult that hitherto he had done nothing. The present paper suggested the required practical tests, and a first draft of a specification for securing a standard material could now be written. Progress would be delayed if they waited till all the associated physical and physiological problems were cleared up.

Dr. S. RUSS (in a communication which was read by the Secretary) said the decay curves differed appreciably from those of Marsden for Willemite under intense α-ray bombardment. Did the theory held by the authors as to the mechanism of the action differ from that advanced by Prof. Rutherford to explain Marsden's results? Had the authors any measurements of the rate of decay of efficiency of fluorescent screens under the action of X-rays?

Mr. WALSH, in reply, said that if the coloured filter were employed in front of the eye, as suggested by Mr. Glew, its co-efficient of transmission for the light emitted by the compound would require to be determined and introduced in the results as well as the co-efficient for white light. This would add to the uncertainties of the determinations. To detect change of colour with age would have been difficult in their experiments because of the continuous decrease in luminosity. They had detected differences in colour in samples sent by different makers; but were unaware whether these were from the same source, or made in the same way. They had no data on the relation between daylight and radium excitation, and Dr. Levy's remarks were of great interest. The order of accuracy (about one per cent.) was not found to be appreciably affected by altering the position of the coloured screen. The diameter of the smallest tubes usually employed was not less than about twice the apparent width of the aperture. It was not convenient to use a smaller aperture and they had to do their best with the tubes in which the material was sent.

Mr. HIGGINS, replying to Dr. Makower, said that they had to employ the radium standards which were available and these were not suitable for use with a small capacity electroscope. In reply to Mr. Glew, the tube should not be close to the electroscope. If it was 30 to 40 cm. away, the orientation of the tube was of little importance, and small corrections could be applied. The errors introduced by having it too close were similar in character to those produced if an extended source of light is used too near a photometer head. They suspected selective action to be at the root of the discrepancy in the absorptions, but could not definitely say. To investigate the physical properties of the sulphide would be a very long task, and they had not attempted it in the present research.

A Paper entitled

"The Resistance to the Motion of a Lamina, Cylinder or Sphere in a Rarefied Gas,"

was read by Mr. F. J. W. WHIPPLE.

The investigation is carried out on the assumptions that the free-paths of the particles of the gas are long compared with the dimensions of the moving body, and that the motion relative to the body of the particles which rebound from it depends only on its temperature. It is shown that if v, w be the components of velocity perpendicular to the surface of a lamina and parallel thereto the corresponding components of the resistance are

$$(4+\pi)\sqrt{\frac{3}{2\pi}}\frac{v}{V}p \quad \text{and} \quad 2\sqrt{\frac{3}{2\pi}}\frac{w}{V}p,$$

where V is the standard (root-mean-square) speed of the gas-particles and p is the gas-pressure.

The resistance to the motion of a cylinder or a sphere is found to differ very slightly from the resistance to a lamina occupying the central section. The formulæ are applicable to the problem of the damping of the oscillations of a system suspended in a rarefied gas.

Mr. G. D. WEST called attention to the fact that the author's value for the ratio of the normal to the tangential resistance of a lamina, was in good agreement with that previously obtained by Knudsen. This experimenter had also deduced a formula for the resistance of a sphere moving in a rarefied gas, and it would be interesting to see how this result compared with the author's. In connection with the damping of vibratory motion, a large amount of careful work had been done by Hogg.

Mr. D. OWEN was not sure that Knudsen had succeeded in proving the assumption as to the manner in which the gas molecules recoiled from the surface. As the difference involved was somewhat large, he would like to see an expression added for the case of elastic spheres rebounding off a perfectly plane surface.

The formula held only for values of λ large in comparison with the dimensions of the vessel. If the pressure was 1μ, λ = 19 cm., and if 10 μ it was 2 cm. Would this be called large in comparison with dimensions of 10 cm.? Exact measurements of pressure and damping would be interesting in view of the uncertainty of the exact constant.

A Paper entitled "The Effect of Stretching on the Thermal Conductivity of Wires," by Prof. C. H. LEES, F.R.S., was taken as read.

Digitized by Google

The Electrician.
FRIDAY, JUNE 8th, 1917.

CHANGE OF ADDRESS.
The Editorial, Publishing and Advertisement Offices of
"THE ELECTRICIAN"
are now at
8, BOUVERIE STREET,
LONDON, E.C. 4.

Telegrams: BENBROTRIC, FLEET, LONDON.
Telephone: 9854 CITY, 4 lines.

THE PROGRESS OF ELECTRIC COOKING APPARATUS.

It may be said that the present conditions under which manufacturing is carried on in this country are adverse to much progress in electric cooking from the domestic point of view, but in other directions a very considerable amount of work is being done. This applies particularly to canteens for munition workers and other work of a national or military character, where the convenience of electrical plant, as compared with other methods, has been fully recognised. We believe also that a good deal has been done in the United States; and from an abstract which we publish elsewhere of a report by the Swiss Electro echnischer Verein, progress in Switzerland has also been rapid during the last few years. The advance in Switzerland seems to have been due to the war, presumably on account of shortage of coal, for in 1914 not very much had been done in this direction, but the amount of plant now in use is quite considerable.

The report to which we have referred is of more than passing interest, because it deals with many points of detail and with the general reliability and efficiency of cooking apparatus. We think it will be agreed that great strides have been made during the last few years in the robustness of such plant. Where the greatest difficulty has been experienced is in boiling plates, but in ovens and in grills a very satisfactory state of affairs has been reached. This is emphasised by certain test figures given in this report. Apparatus was tested by switching on to the circuit for a certain time, followed by an interval for cooling, and after every 1,000 heatings in the case of apparatus used wet, and after every 200 heatings in the case of apparatus used dry, the voltage, which was normally 110 volts, was raised by 10 volts. In this way the apparatus in the final periods was in some cases subjected to an overload of 50 to 70 per cent., thus realising conditions which are much more serious than those generally found in practice. Nevertheless, on the basis of these tests, cookers were found to last from 2 to 10 years, frying pans from 2 to 4 years, boiling plates from 1 to 2 years, and flat irons from 2 to 8 years before a defect was revealed, and we think that the statement may be accepted that the durability in ordinary use would be at least double. The question of overloading is, of course, one of some importance, because, unfortunately, the watts absorbed vary with the square of the voltage, and consequently a 10 per cent. rise in voltage means 20 per cent. rise in load. There is a good deal to be said for the ideal of a heating alloy whose temperature coefficient would be so high as to cut down the current to a safe value notwithstanding a rise in voltage, but we very much doubt if such an alloy is to be found, and even if it were obtainable it would be necessary for the temperature coefficient to depart very materially from a straight line law in order to avoid heavy currents in switching on. Iron provides an example of a metal of this kind, but it is, of course, quite unsuitable for the particular purpose we have in mind.

Of course, such tests, however well devised, lack the effect of the wear and tear which arises in regular domestic and commercial use, and they therefore fall short of the ideal in this respect. Also questions of thermal efficiency, although important, may be unduly emphasized, since in practice this depends largely on the routine that is followed, and must be considered along with questions of convenience and the price at which electric energy is available.

In the report some stress is laid upon the necessity for good insulation. To some extent we think this point may be over-emphasised. For example, asbestos is used largely in work of this class, but it is well known to be hygroscopic, and consequently if apparatus in which this forms a part is left out of use for some time the insulation falls very considerably, but very soon regains its normal value in use. There is no great objection to this, provided that all metal work is properly earthed, as it should be, at least in the case of apparatus used in kitchens. Small utensils used in sitting rooms are another matter, and need not be particularly considered from this point of view.

It follows on account of the variable nature of some of the insulation employed, that ordinary figures of insulation resistance are of little value; therefore, reliance is placed upon subjecting the apparatus to certain electrical pressures. It is suggested that such apparatus may well be tested at 1,500 volts rather than at 1,000 volts, and the statement is made that even at 2,000 volts the discharge commonly takes place outside, from terminal to terminal, and not inside the apparatus. We doubt, however, the desirability of raising the voltage to this extent. It must be remembered that if such apparatus fails in use there is no very harmful result, and in this respect it differs from such plant as generators and transformers. Unquestionably it should be made as durable as possible, but we are inclined to think that tests of this kind may result in more harm than good.

In conclusion, we shou'd like to draw attention to the excellent work that is carried on from time to time by the Swiss Elektrotechnischer Verein in dealing with electrical matters that are in a state of transition. It is a great advantage to have authoritative statements and investigations of this kind as some guidance to manufacturers, and we think that our own Institution might with advantage take up this class of work.

The Nature of Metallic Resistance.—In a contribution to the "Physical Review" Mr. P. W. Bridgeman describes a series of investigations to determine the effect on metallic resistance of combined pressure and temperature. The most important result obtained is that variations in resistance of a normal solid metal are pre-eminently concerned with one factor only, the average amplitude of vibration of the atoms, whether the change in amplitude is brought about by a change in pressure or temperature. The proportional change in resistance is approximately twice the proportional change in amplitude. It is believed that these considerations throw important light on the nature of the atom. In order to explain them it is necessary to abandon the old conception of the atom as an assemblage of electrons little affected by the inert atom-framework. Temperature rise, by increasing the "gaps" between atoms, increases the resistance. Extreme pressure is powerless to change the temperature-coefficient of the metal, and it seems therefore necessary to assume a distortion of the atom under pressure.

Digitized by Google

A RESISTANCE BRIDGE FOR WORKSHOP USE.

BY OSCAR DE WETTE.

Fig. 1 illustrates the principle of a bridge for testing rapidly, against a pattern R_s, a number of coils of which the resistance is to approximate that of the pattern, the tolerance being within a given percentage.

The arrangement can also be used for controlling the resistance of coils during winding, when, in the absence of automatic winding machines, or owing to variations in the diameter of the wire, the same number of turns do not correspond to the same resistance.

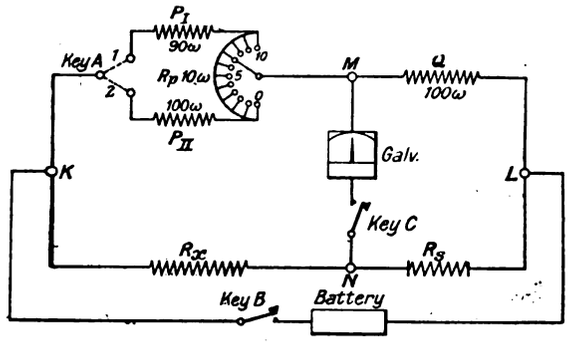


FIG. 1.

In the proposed arrangement there are two ratio arms P. If the resistance of Q is 100Ω, let arm P_I be 90Ω, arm P_{II} 100Ω, and both arms be connected by a resistance R_p of 10Ω, so that $P_{II}=P_I+R_p$. Let R_p be subdivided into, say, 10 sections of 1Ω each, inserted between the studs of a circular switch of which the dial gives connection with point M of the bridge. Such an arrangement will allow tests within limits varying from 0 to ±10 per cent., expressed in integers.

For instance, let the allowance be ± 7 per cent. The dial is turned to stud 7; then arm P_I is (100−7)Ω and arm P_{II} (100+7)Ω.

Let now key A make connection 1, and keys B and C be closed in succession: then

$$P/Q=(100-7)/100 \text{ and } R_x \gtrless R_s(1-0{\cdot}07),$$

i.e., the coil under test is compared with the lower limit of resistance. Repeat the same operation, except that key A now makes connection 2: then

$$P/Q=(100+7)/100 \text{ and } R_x \gtrless R_s(1+0{\cdot}07),$$

i.e., the coil is compared with the upper limit of resistance.

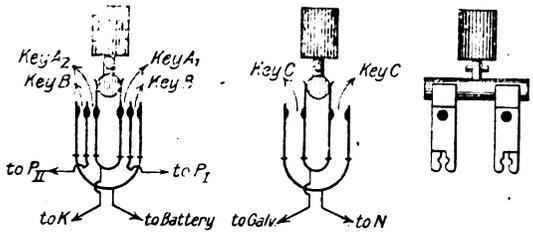


FIG. 2.

Keys A, B and C are suitably combined in a single key with a double system of springs, as shown in Fig. 2. Such a key is somewhat like the listening key of a telephone table. The contacts A_1 and A_2 should have negligible resistance, and therefore the contact plates be of a suitable size. Pressing successively the button of the key to the left and to the right results in testing against the lower and the upper limits respectively.

Fig. 3 shows the values that a resistance under test can have with reference to the standard resistance R_s of the pattern and to the limits determined by the tolerance, viz., $R_s(1-p')$ and $R_s(1+p')$.

Practically only the values R_{x3} within the limits are acceptable. Such values, when tested against the limits, cause the galvanometer needle—which should be dead beat—to deflect successively in opposite directions; and by suitably connecting the poles of the battery to the bridge, the needle can be made to deflect in the same direction as the key moves. Whenever this does not occur, the resistance under test is outside the

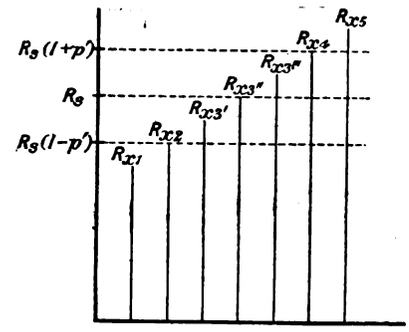


FIG. 3.

limits. The nature of the discrepancy shows to what category of values R_x the coil belongs. (This indication is particularly useful when the winding of a coil is still in progress.) Moreover, by turning the dial of the switch, the limits are enlarged or narrowed, so that, within the compass of the apparatus, it is possible to have an idea as to how far the coil is outside the limits.

The accompanying table shows the relative positions of the key and the needle for the values of R_x mentioned in Fig. 3. The most important, and at the same time the most frequent, cases are starred; they are easily remembered, even by unskilled people, for which the apparatus is chiefly intended.

Allowances	Values of Resistances under Test.	Positions of Key	Positions of Needle	Positions of Needle	Positions of Key	Remarks.
±1 to 10%	R_{x1}	↖	/	/	↗	✻ Resistance too low.
	R_{x2}	↖	|	/	↗	Resistance equal to lower limit.
	R_{x3}	↖	\	/	↗	✻ Resistance within limits.
	R_{x4}	↖	\	|	↗	Resistance equal to upper limit.
	R_{x5}	↖	\	\	↗	✻ Resistance too high.
0%	R_{x1} to R_{x3}'	↖	/	/	↗	✻ Resistance lower than standard.
	R_{x3}''	↖	|	|	↗	" equal to "
	R_{x3}'' to R_{x5}	↖	\	\	↗	✻ " higher than "

✻ The ratio arms must be constructed of the same material and must, of course, be placed in the same temperature conditions; the same applies to the pattern and the coils under test. An aperiodic pointer galvanometer, deflecting in either direction, forms a suitable detector.

The data and features of the arrangement, as described, obviously admit of alterations in order to meet special requirements. For instance, R_p may be varied within the range of the equation $P_{II}=P_I+R_p$; be subdivided, equally or unequally, in multiples or submultiples of the ohm; or be represented by a graduated slide wire with slider, which does away with the circular switch; and so on. In the latter shape the apparatus might be worked as a bridge for the measurement of resistance by simply varying the ratio.

Digitized by Google

SHALL GREAT BRITAIN AND AMERICA ADOPT THE METRIC SYSTEM?*

BY W. R. INGALLS.

(President, American Institute of Weights and Measures.)

The author has sent this Paper to the Institution of Mining and Metallurgy in the hope of opening the eyes of its members to a great danger with which it seems to him that both Great Britain and the United States of America are threatened by the present strong metric propaganda. Although in his Paper he has used American illustrations and references, and there are probably variations in British customs and practices, he feels sure that readers in Great Britain and the Colonies will find no difficulty in applying his argument to the things they know.

The discussion of the metric system at the meeting of the Institution on Nov. 16, 1916, prompts me to make a communication on this subject. In the United States there is a persistent and insidious effort by theorists to substitute the metric for the existing system of weights and measures. In order to combat this, the American Institute of Weights and Measures has lately been organised. The subject is of vastly greater importance than is commonly comprehended and therefore an earnest propaganda is necessary in order to arouse the people of Great Britain, her Colonies and the United States to the importance of preserving their interests.

Before entering upon any discussion of the metric system let a sharp line be drawn between it and the decimal system. The advantages of the decimal system are so manifest in many cases that the pro-metric party is wont to cloud the issue by making it appear as if the metric system were the only decimal system.

We find that the most ardent of the pro-metric party are those who have to deal with weights rather than with measures. The substitution of metric weights for English weights would create relatively little disturbance. Of course, the changing of all of our weighing scales would cost a huge sum, and the recalculation of schedules—such as railway rates—might come to something like the ransom of an empire, but after these were done, we might get on pretty well.

Personally, although I am strongly antimetric, I employ the metric system of weights in international statistics. Moreover, in laboratory work I use the grammes and cubic centimetres, or kilogrammes and litres; but when I pass to larger weights the pound means more to me than does the kilogramme. Similarly, out of habit I think of temperatures according to the Fahrenheit scale up to the boiling point; there is then a range whereof I have no conception; but from red heat upwards I think in terms of the centigrade scale. Of such mental habits and their bearing upon the substitution of the metric system, which I regard as a matter of major importance, I shall say more before concluding this contribution.

If weights and measures were employed merely as means of estimating and recording, there would be no great reasons why the metric system, or the Russian, should not be substituted for the English, save for the cost of providing the new instruments and the slight experience necessary to become familiar with them.

The metric advocates regard weights and measures simply as means of estimating and recording. They do not consider the *things* that are tied up with them, or the *knowledge* that is associated with them. By "things" I mean the standards that have become interwoven in our civilisation and industry, upon which indeed civilisation and industry are based.

Let me try to make my meaning clear by referring to land measure, a subject with which nearly everybody is familiar. In an unsurveyed country, like parts of Mexico, I can use a 100 m. tape as well as one of 100 ft., and can compute areas in square metres as well as in square feet. But suppose I am in the United States, where most of the land has already been surveyed in feet and miles and figured in acres and square miles, and I am compelled to divide metrically a Government quarter section, my troubles would quickly begin. Anybody who has had to tie up with old surveys in New England, recorded in rods, chains, &c., knows what these would be.

Let us consider the conditions that have been established in the railway business of the United States. The tracks are marked with mile posts. The railway gauge is 4 ft. 8½ in. We might in course of time get in the habit of thinking of the latter as 1,435 mm., but manifestly it would never be convenient to refer to the mile posts as being 1·60935 km. apart, and either we should have to continue to think of miles, or else pull up the posts and replant them at kilometre intervals, which would be something of a job. Incidentally, our posting of highways would have to be revised, and the automobilist would mourn the day when metric legislation was enacted.

Returning to the railway business, it is well known that the passenger and freight schedules, which fill great volumes, are based on cents per mile and cents per 100 lb. The railways have complained over the great expense involved in making alterations for the purposes of the Interstate Commerce Commission. What would it be if the entire fabric had to be torn apart and rewoven in order to please the advocates of the metric system?

Gauges are based on the inch. If the metric system were made compulsory it is obvious that there would be but two alternatives, viz., to restamp the gauges with strange and unhandy figures, and wait until people became accustomed to them, as, for example, to ask for a 6·35 mm. rod when they wanted a ¼-in. rod; or else to change the standards so as to make them conform to metric units. Either horn of the dilemma is bad, but the second one—the changing of gauges—would be calamitous. Some large American manufacturers have estimated that such a change would cost them individually from half a million to three-fourths of a million dollars.

So it is with all of our affairs. Our entire system of manufacturing, of building and of doing things is based on standard units, which cannot be changed, except under conditions that would mean nothing less than calamity. Does anybody imagine that a 2 × 4-in. joist could be anything else but a 2 × 4, although it might be called a 50·8 × 101·6 mm.; and after we were given specifications in metric measures, should we not have to translate them back into English measures, in order to make use of our tables of board measure for easy computation?

Of course, we all know that a 2 × 4 is seldom of those exact dimensions, and we should probably call it a 50 × 100 mm. after we had learned the rules of the new game. But sometimes it is necessary to figure closely in connection with joists S4S, and then we know that the 2 × 4 is reduced to 1⅝ × 3¾ in. How we should conveniently arrive at the exact dimensions of a nominal 50 × 100 mm. joist deponent saith not.

Consider what we do when we get a drawing of a French construction, let us say a metallurgical furnace, to build in this country. The first thing that has to be done is to redraw it, not for the reason that it is expressed in metric measurements, but for the reason that it calls for constituent parts of sizes that are not obtainable here. It is drawn in France so as to dovetail together all sorts of things that are standardised according to metric measures. In America we must use the things that we can get and they are standardised according to inches.

Conversely in drawing something of American practice to be constructed in France, we draw it in our own way and tell them to redraw. It would be easy enough to draw here with metric scales: indeed, in my own practice I put a metric scale on each sheet destined for a metric country; but engineering drawing is something different from the mere use of scales. It is the combination and representation of standard things, and we have to show our own, which we know; not the French, which we do not know; and let it be re-drawn in France according to their standards that are nearest to ours. Any change of standards in either metric or non-metric countries is preposterous, unthinkable. We have all gone too far. Besides the colossal expense of substituting gauges the result could not be anything but a mixture. The man who needed some ½-in. bolts for the repair of his automobile would not relish the information that they were no longer made, but that he could have 10 mm. or 15 mm. bolts.

But, say the metricists, "We do not intend to change the standards. We propose merely to call ½-in. bolts 12·7 mm. bolts, and similarly with other standard manufactures, and this is so that people in Spanish and Portuguese countries, where we hope to expand our export trade, will understand what we are talking about." There is no argument more childish than this. Why not therefore, discard the use of the term bolts and substitute the Spanish equivalent?

The manufacturer who is courting export trade in a Spanish country translates his catalogues into Spanish and converts his English measures into their metric equivalent.

The Argentine or Chileño has no difficulty in being made to understand if the British or American manufacturer wants his business. If it be a question of competing with German manufacturers, they will make special sizes for that purpose, just as do foreign makers of automobile tyres who seek business in this country. Our tyre manufacturers would do the same if they wanted competitive foreign business. Nobody has had the effrontery to propose that the United States should discard its standard inch-sizes and substitute others conforming to foreign practice. The million automobilists would regard such a suggestion as a joke.

* Abstract of a Paper read before the Institution of Mining and Metallurgy.

Digitized by Google

I have referred previously to how some people think metrically of certain things and non-metrically of others. The association of things of observation and experience is indeed the reason why certain of our old English measures, long since discarded generally, linger in special use. Similarly does the chemist sense weights in grammes, while the apothecary does it in ounces. Such habits are not easily altered.

Having pointed out the objections to the compulsory adoption of the metric system, let us consider the arguments that are offered in favour of it.

The prime argument is to have international uniformity. It is stated that a long list of the countries of the world have adopted the metric system, *only* the United States, Great Britain and her *Colonies*, and Russia (of the Indo-European nations) having failed to do so. I have italicised the words *only* and *Colonies*, for therein is concealed the speciousness of this argument. If with "Colonies" we equate Canada, Australia, New Zealand, Tasmania and South Africa, we have a longer list of non-metric countries, and it comprises not only the most populous, but also the most industrial nations of the world. If uniformity be the objective, it would be better to institute a propaganda to induce Germany, France and the Latin countries to adopt the English system.

Another argument on the ground of uniformity relates to the confusion existing in the English system owing to the different kinds of tons, pounds, gallons, &c. That there is such confusion, with its inherent dangers, is true; but it is also true that the confusion is much less now than it was 20 years ago, that it is bound to experience further reduction, and that it may be eliminated entirely in a way far easier than by the introduction of the metric system. But with respect to confusion, the skirts of the metric system are not clean.

The third metric argument is the ease of the calculations, especially the correlation among measures of length, volume and weight. It may freely be admitted that there is some merit in this, but further on I hope to show that the English system is not quite helpless in this respect; and that the superior merit of the metric system is far short of being a determining factor.

We come now to the alleged advantage of the metric system in promoting foreign trade, a matter that I have previously touched upon lightly in this Paper. Listening to the metric advocates, it might be imagined that Great Britain and the United States had no export trade with foreign countries before the war, and that the only way for them to compete with Germany after the war is to adopt the metric system because Germany will offer goods made according to it. We had large trade with them before the war. We hope and expect that after the war it will be greater. But in making it greater, we are encouraged to think that the fundamental ideas are to offer them useful things, excellently made, through well-conducted agencies and by means of models and descriptions in their own languages, also dimensions with metric equivalents if they wish. And having interested them to the point of buying, we must extend to them the banking credits they need, and must pack the goods in such a way as will cause them to be delivered safely and will permit inland transportation by crude methods.

In many of these respects Germany formerly excelled us, largely owing to our indifference in this trade, but successful competition with her in the future is going to be based upon such major points as I have mentioned, and not upon the very minor one of making goods according to metric measurements.

One other argument for the metric system is the alleged simplicity with which it can be acquired by school-children. I do not believe that is so. Without having had any experience in school teaching, it has nevertheless been my good fortune to observe and supervise a number of children during their passage through the grammar school. In mental quality they have been better than the average. Without exception they have had difficulty with the metric system. Vulgar fractions are comprehended more easily. This ought not to be so, but apparently it is. I think it arises from the natural tendency of all of us first to divide an integer into halves.

Both in the use of the metric system and the English there are three well defined tendencies. These are to discard unnecessary units and mulitples, to employ measures of weight instead of those of volume wherever possible; and where not possible to substitute cubic measures for special forms. But there are many cases where weighing cannot be substituted for measuring. Nevertheless, there is a constant tendency to substitute cubic measures for the old ones. Thus our municipalities more and more sell us water by the cubic foot rather than by the gallon. This is because we visualise cubic measures better than anything else. The basis of all measures, using the term in distinction to weights, is the measure of length. Derived from it are the measures of area and of volume.

I trust that I have made it clear that my argument against the metric system is not inspired by blind prejudice against an innovation. On the contrary, I remember the time when I was in favour of its adoption in the United States, and it was not until I had studied the matter more carefully that I changed my mind about that.

I do not claim the English system to be perfect and consequently not to be touched. On the contrary, I have shown previously how it has experienced evolution and certainly it is capable of much further improvement, which undoubtedly will come about. What forms the improvements may take I shall not attempt to indicate more than briefly. It seems to me that we shall see a reduction in the number of units in common use, say to a list comprising the mile, the foot and the inch; the ton, the pound and the ounce; the acre. For all other forms of square measure and for all forms of cubic measure, we may base on the foot. These few measures will be decimalised to a greater and still greater extent. The machinist decimalises the inch. The architect reckons roofing, painting, &c., in "squares" of 100 sq. ft. The water and gas companies provide us with meters reading cubic feet and tenths thereof.

In conclusion, I desire to make it quite clear that my arguments in this Paper are not directed against the metric system, but rather against the propaganda for the *compulsory* adoption of it.

CORRESPONDENCE.

CITY GUILDS EXAMINATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is to be hoped that the invitation to comment on the above, conveyed through one of your editorials in your last issue, has been (or will be) adequately responded to by some responsible people. But in case the response be disappointing, perhaps I may be allowed to make some remarks on the subject.

The examiners would surely feel encouraged by a public display of interest on the part of those for whose students they cater; and they would certainly understand that a little criticism was good for all concerned.

Having had occasion recently, for the purpose of a forthcoming work, to glean (for inclusion amongst others) those C. & G. questions which related to continuous-current motors and control apparatus for other than purely traction work; it has seemed to me that they were rather few and somewhat one-sided.

The subject, it is almost superfluous to say, offers a splendid practical field for examiners. Nevertheless, the results of my search (1912–1917) were somewhat disappointing, and may be expressed as follows:—

1. Elementary theory and general matters concerning motors.—(*Hardly touched upon.*)
2. Motor starters.—(*A few questions, but plenty of scope for more.*)
3. Starters, speed-regulators and controllers.—(*ditto.*)
4. Motor characteristics.—(*Amply dealt with.*)
5. Multiple-switch, contactor, semi-automatic and automatic controls.—(*Practically untouched.*)
6. Efficiency and other tests.—(*Fairly well dealt with.*)
7. General matters regarding applications, installations, troubles, &c.—(*Practically untouched.*)

It will be gathered from the above that the examination questions trend to the motor laboratory and test-room side; and that modern control apparatus, connections and what may be termed every-day matters are neglected.

I was glad to notice that you alluded in your editorial to the usually difficult nature of the questions. The examiners move in such a rarefied atmosphere themselves, that they are apt—one may suppose—to get quite out of touch with their examinees. A few simple questions of a really practical nature that most of the candidates could make an attempt at without much hesitation would encourage them greatly. And the examiners need hardly be told that the answers to such questions would afford plenty of points for sorting out the candidates, and with far less trouble and greater certainty than involved highly theoretical problems.

The statistics given in the annual City Guilds Reports prove that one of the subjects of really fundamental importance has

Digitized by Google

been much neglected by professors and teachers and their students. But now that it has been re-christened and has received an adequate name—"Electrical Installation Work"—perhaps it will receive a little more attention. As it deals with practical electro-technical matters underlying electrical installations of any and every description, it is surely worth the attention of those embryo electrical engineers who find themselves in difficulties with the more theoretical and mathematical branches of electrical engineering. The examination questions are worth perusal by those who have hitherto ignored them.

After all, students at technical colleges, &c., are very much to blame if they do not make known to the authorities the subjects they desire instruction in. My advice to those in the aforementioned difficulties is to write to the Examination Department, C.G.L.I., Exhibition-road, South Kensington, for copies of this year's papers in "Electrical Installation Work." After satisfying themselves as to the value of the subject, let them go to their professor, show him the paper and endeavour to convince him that though the subject was hitherto termed "Electric Wiremen's Work," it really concerns electrical men of every description. Very few wiremen arrive at the Final Examination.

Though it belongs to another story, the A.M.I.E.E. exams. (now temporarily discontinued) and the microscopic results obtained therefrom, afford a glaring proof that those at the top of the electrical mountain range of knowledge are quite out of touch with those who wish to climb a little way up one or other of the various peaks.—I am, &c.,

London, June 2. W. PERREN MAYCOCK.

A SYSTEM OF REMOTE CONTROL FOR AN ELECTRIC TESTING LABORATORY.*

BY P. G. AGNEW, W. H. STANNARD AND J. L. FEARING.

The remote control of electrical apparatus and machinery has an extensive technical application. The apparatus here described is in use in the laboratory of the Bureau of Standards for testing electrical measuring instruments, instrument transformers and similar testing and investigational work.

1. *Scope.*—The range and scope of a remote control system required for such work is well illustrated in testing wattmeters or watt-hour meters on low-power factor, using separate sources for current and voltage. For the best conditions the observer should have both a coarse and a fine control of frequency, current, voltage and power factor. If a test of the standard instrument on direct current is included, two other controls are necessary for the direct current and voltage. To accomplish this without the use of some system of remote control would require the observer to have access to at least 10 rheostats, 5 for fine and 5 for coarse adjustment, as well as to some phase shifting device.

The system described provides the same flexibility of control by the use of a single multiple-lever controller, each lever giving a two-direction two-speed control of voltage, frequency, power factor and current respectively. The purpose of the two speeds is to provide coarse and fine adjustment. The controllers may be used in connection with any one of five motor-generator sets, each of which has three or more machines on the same shaft. Provision has been made to extend the system so as to include additional machines. The machines are all small, the largest having a capacity of but 25 kw.

There are various arrangements which might be used for such a system of remote control:—

1. *Advantages of Using a Single Rheostat.*—Where both a wide range and fine steps are required it is customary to use two rheostats, one for fine and one for coarse adjustment. While this gives a wide range and accuracy of adjustment with relatively small rheostats, the wiring is considerably more complicated than in the case of a single rheostat, and two operating motors are required. It was decided to attempt the use of a single rheostat with a single control handle, rather than one rheostat for coarse and one for fine adjustment.

2. *Methods Available.*—Several different methods suggest themselves for securing the necessary range of resistance in a single rheostat suitable for motor operation. The method selected involves winding resistance wire (or tape) on a long, insulated tube, contact being made by a brush moved lengthwise on the tube, similar to well-known types of commercial rheostats. For short rheostats the brush may be driven by a worm, but for long ones it is practically necessary to operate it by a cord passing over a pulley driven by the motor.

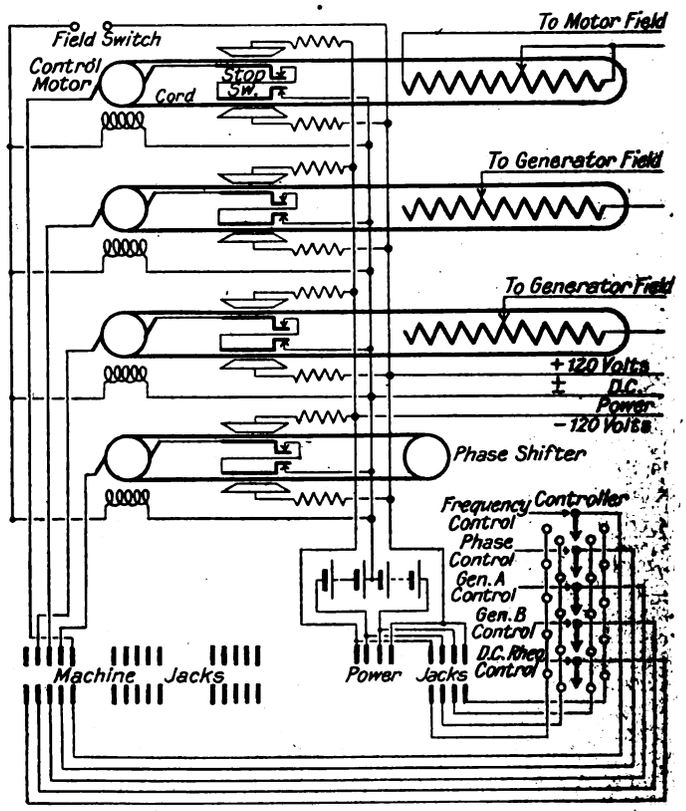
FIELD RHEOSTATS.

The motor field rheostats were 5·5 metres in length, the corresponding overall length of the generator field rheostats being 12 metres.

For the rheostats brass tubes were used, and the lengths were soldered end to end so as to make a perfectly smooth winding surface, a short sleeve being placed inside to make a good mechanical joint.

Several coats of insulating varnish were applied to the tubes and allowed to dry; the results were satisfactory, over 100 megohms being obtained. Enamelled resistance wire was used, the enamel serving for the insulation between turns, which were wound snugly together, so that the rheostat has a smooth rigid surface. The rheostats are mounted horizontally in a single tier, the operating motors being placed on a shelf at one end.

Preliminary experiments had shown that under working conditions settings could be made on a motor-operated slide-wire rheostat of the type described to about 1 mm., about the average diameter of



GENERAL WIRING DIAGRAM SHOWING DETAILS FOR COMPLETE CONTROL OF ONE MOTOR-GENERATOR SET, WITH CONTROLLER, AND JACKS FOR PLUGGING SO AS TO CONTROL OTHER SETS.

the wire which it was found convenient to use in winding the rheostats. It was arbitrarily decided to make the sensitivity of setting on the generator rheostats approximately 0·01 volt per millimetre, or 10 volts per metre of length of rheostat.

With the exception of the No. 22 brass, which was used only in two special rheostats, the wires are so chosen that the resistance per turn increases by a factor of about 2 from step to step, while the total change in diameter of wire is only slightly over 2 to 1.

Settings can be made on the rheostat to an accuracy of about 0·02 per cent. or better, since the mechanism allows the adjustment to be made, when necessary, to a single turn of wire.

The design of the motor field rheostats was much simpler, an untapered winding being found to be sufficient to secure a change of but 0·01 per cent. in speed for a single turn of the wire on the rheostat.

Voltage Rheostats.—These are identical in general construction with field rheostats. They are 7·5 metres long and are wound with about 11 500 turns of No. 22 brass wire, giving a resistance of 254 ohms. Definite voltages from storage batteries (in multiples of 80, up to 320) are connected across the whole resistance and a vari-

* Abstract of a "Bulletin" of the Bureau of Standards (Washington). No. 291, October 12, 1916. Those interested may obtain a copy free on application to the Bureau.

Digitized by Google

able voltage is tapped off by means of the sliding contact for use in testing. The current capacity of the rheostat is sufficient to allow enough current to be drawn from it for all ordinary work in instrument testing.

Current Rheostats.—Satisfactory current rheostats operating on a low voltage source and arranged to fit in with the same system of remote control have so far been worked out only for the larger ranges of current, from 300 up to 10,000 or 12,000 amperes.

This rheostat, which was originally designed for hydraulic operation, was rearranged so as to be operated by four 0·1 kw. motors.

The operation of the motors is precisely the same as for the other parts of the control system, two speeds giving coarse and fine adjustment, &c.

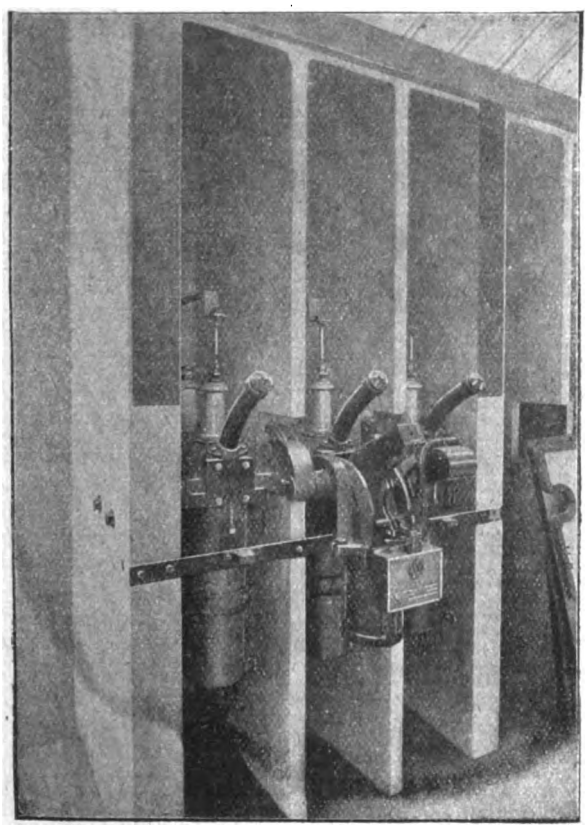
Use is made of two well-known methods of phase control. The more satisfactory one is by the use of two similar alternators on the same shaft, one being used as a source of current and the other as a source of voltage, the phase adjustment being made by shifting the angular position of the stator armature of one alternator. In the other method the adjustment is accomplished by slowly moving the rotor of a phase-shifting transformer. In either case the motion is accomplished by a small motor actuating a compound worm drive.

This arrangement also fits in very nicely with the other parts of the motor-generator control, the two speeds giving coarse and fine adjustment of the phase relation.

In over two years' operation the system has given very little trouble—much less than was anticipated. The simplicity and convenience of the system, both in testing and in investigational work, has greatly increased the efficiency of the work of the laboratory, frequently saving the time of one observer. A general view of the connections is shown in the accompanying diagram.

BRITISH WESTINGHOUSE SWITCHGEAR.

We have received from the British Westinghouse Co. a number of leaflets in a folder giving interesting views of switchgear in various generating stations and sub-stations. These include the new power station of the London & North-Western Railway Co., of which we gave some brief details recently. The leaflets give views of the main boards and also of the cubicle construction which has been adopted in this



VIEW OF CUBICLE WITH DOORS REMOVED.

station. The adjoining figure shows some of these cubicles, with the method of mounting the oil switch Other views in the leaflets show switchgear in some of the London & North-Western sub-stations; also at the works of Det Norske Nitridaktieseskap where the pressure is 35,000 volts. Views in the works of the Singer Manufacturing Co. and sub-station switchgear at Walsall are also incl ded.

THE NERNST VAPOUR LAMP.*

Prof. W. Nernst describes a vapour lamp in recent German patents which is somewhat similar to Darrah's lamp, and is a decided improvement from the point of view of efficiency. The Nernst lamp rests on phenomena which are observed when an arc passes between carbon electrodes in an atmosphere of zinc chloride or zinc bromide. These phenomena are analogous to those observed in the vapour of mercury and other metals. If the pressure of the zinc chloride vapour is too low the light is dull; but at higher pressures—*e.g.*, at atmospheric pressure—the arc is sharp and bright. The chlorides of aluminium and titanium behave similarly to zinc chloride; titanium chloride is specially suitable for the object in view. The efficiency of these chloride lamps is about the same as in the high-pressure mercury vapour lamps.

According to the patent, the lamp includes a spherical bulb, as shown in Fig. 1, which contains the two carbons *a* and *b*. The upper electrode is connected to the iron core of a solenoid, *c*, which is suitably protected against the chemical effects of the vapour. The lower end of the spherical bulb ends in a short closed tubular connection, which contains the salt to be vaporised. The volatilisation is effected by an external source of heat; for this purpose the series resistance, to which the lamp is connected, may be suitably used.

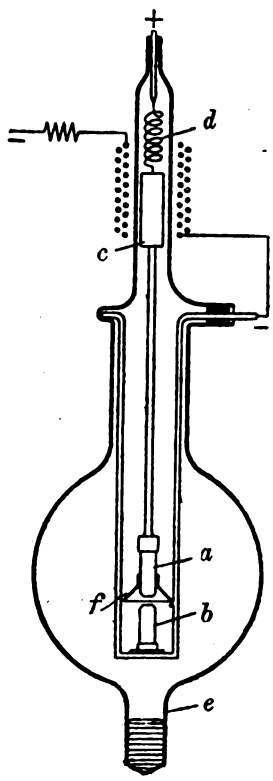


FIG. 1.—ZINC CHLORIDE VAPOUR LAMP.

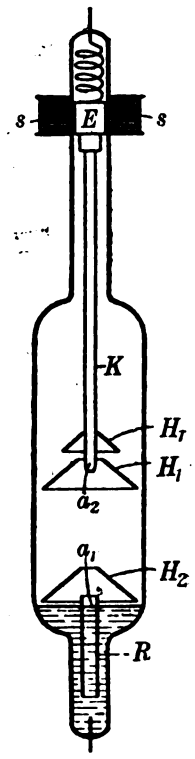


FIG. 2.—LAMP CONTAINING MERCURY AND SALT VAPOURS.

In a second patent Nernst describes a vapour lamp in which the main conducting medium is mercury vapour; a suitable salt is added in order to give a better colour to the light. The principle of the lamp consists in adding a line spectrum to that of the mercury vapour; in this way a white light is produced. Mercury vapour, however, has the property of continually removing any foreign substances. It is, therefore, possible to introduce the colouring substance continuously, if such substances are used as fuse at the temperature of the mercury vapour lamp. The substances thus continuously volatilise with the mercury, subsequently condensing and flowing back into the circuit in order to begin a fresh cycle of operations. In Fig. 2 this lamp is shown, consisting of a glass bulb containing the electrodes. The anode is of mercury, and the kathode consists of a small carbon, *K*, which is connected to the core of a solenoid. It is necessary to prevent the condensed drops of mercury and salt from reaching the arc, and therefore small conical pieces of glass are fused into the vessel, and surround the carbon. The falling drops then volatilise on the surface of the mercury. Another conical glass piece is placed above the mercury in order to lead the vapour to the arc. If a strong current passes, the mercury vapour rises rapidly from the arc, and this causes a sucking movement at the lower ends, which takes a sufficient quantity of the salt vapours with it. A specially suitable salt mixture for these lamps is said to consist of 70 per cent. zinc chloride, 15 per cent. calcium chloride, 5 per cent. thallium chloride, 5 per cent. lithium chloride and 5 per cent. cæsium chloride. A lamp of this kind without a series resistance gives a light of 3,000 hefner c.p. on 120 volts; it takes 4 amperes, and therefore has an efficiency of 0·16 watt per hefner candle-power, which is a considerable improvement on other electric lamps. The numbers of the German patents are 288,228 and 288,229.

*Abstract of an article in the "Electrotechnische Zeitschrift," heft 40, 1916.

Digitized by Google

LEGAL INTELLIGENCE.

Patent Amendment by Alien Enemy.

In the Chancery Division recently Mr. Justice Sargant decided that an alien enemy could amend a patent specification. Letters patent (No. 27,838/12) were granted to the Stahlwerk Becker Co., of Krefeld-Willich, for an alleged invention of "An improved high-speed tool steel." A petition was presented in 1916 by Arthur Balfour & Co. (Ltd.), whose name before the war was Seebohm & Dieckstahl (Ltd.), for revocation of the patent on the grounds of want of novelty (by reason of prior user by Seebohm & Dieckstahl and of prior common general knowledge), and also that the alleged invention was not proper subject matter for letters patent. The petition, which could not be served in the ordinary way, was effected by advertisement. The patentees appeared, and moved for an order that they might be at liberty to amend the specification by way of disclaimer (under sec. 22 of the Patents and Designs Act, 1907). All the parties (including the Crown) were represented, and after legal arguments, Mr. Justice Sargant said that the question raised was an important one. After hearing the Attorney-General he had come to a conclusion which was different from the one which he had previously been disposed to arrive at. The question was whether what the company were proposing to do was setting up a defence or was doing something by way of initiation and not defence. It was well settled that an alien enemy could set up a set-off to a claim inasmuch as that could not result in any payment to the alien enemy. On the other hand, an alien enemy could not counterclaim, because the counterclaim was in its nature an affirmative proceeding which might result in payment to the alien enemy. Under sec. 21 of the Act a patentee might make a substantive application for leave to amend his specification by disclaimer, correction or explanation. It was admitted that a patentee who was an alien enemy could not initiatively apply to amend under sec. 21, but it was obvious that under sec. 22 there was a narrower ambit. It was confined to cases where an action had been brought for infringement or to a petition for revocation. Under that section no amendment could be allowed which would make the invention larger than, or substantially different from, the invention originally claimed. The application to amend under that section was something by way of defence. He had thought that by an application under sec. 22 an alien enemy might gain an advantage against all the world, and that that might be obtained by proceedings on a friendly petition for revocation. But that danger might be guarded against by imposing terms under sec. 22, and the Court could impose the term that proceedings should not be brought after the termination of the war for infringement during it or before its commencement. With the greatest doubt he allowed the proceedings for amendment to go on.

Tramway Transfer Tickets.

At Ystrad Sessions on Monday Gwenllian Jane Ray was summoned for attempting to avoid payment of a fare on a local tramcar.

Defendant purchased a 1d. transfer ticket on Feb. 9, but walked the second half of the journey, there being no connecting car. The ticket was used for that portion of the journey on April 25.

Mr. W. P. NICHOLAS (for the tramway company) said that the conditions printed on the back of transfer tickets stated that passengers should travel by the next available car from the transfer point.

Mr. D. REES (for defendant) said the question was whether the company could create a new offence by the insertion of a new condition on the back of tickets.

The summons was dismissed, the Stipendiary remarking that transfer tickets were an innovation.

London United Tramways (Ltd.)—In the Chancery Division on Tuesday a receiver for the debenture holders was appointed.

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. S. Clay, V.D.

Orders for the week :—

Officer for the Week.—Platoon Commander A. Gerard.

Next for Duty.—Platoon Commander No. 3 Company.

Monday, June 11th.—Technical for No. 3 Company, Right Half Company at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' drill, 6.30.

Tuesday, June 12th.—Lecture 6.30. Sergt.-Instructor Higgs, "Pontooning." Physical drill and bayonet fighting, 7.30.

Wednesday, June 13th.—Drill, No. 1 Company, Right Half Company, 6.15.

Thursday, June 14th.—Drill, No. 2 Company, Right Half Company. Ambulance class, 6.30. Signalling.

Friday, June 15th.—Technical for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' drill at 6.30 to 7.30.

Saturday, June 16th.—Commanding Officer's Parade, 3.0, at Putney Bridge Station for Route March.

Sunday, June 17th.—Parade Clapham Common Station (Tube Railway), 9.45 a.m., for work at Bombing School. Uniform. Rations to be carried.

Armlets.—Members are warned that armlets must be worn at all plain clothes parades.

Musketry.—For all Companies, see Notice at Headquarters.

NOTE.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street, W.)

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

245 MARCONI'S WIRELESS TELEGRAPH CO. & WRIGHT, G. M. Receivers for wireless signals. (6/1/16.) 102,821.
Relates to wireless receivers comprising Fleming valves, and the employment therein of a vacuous tube having two grids between the anode and the filament, a circuit connecting the two grids, a circuit connecting the anode and the inner grid and means for maintaining a fixed potential between the inner grid and the filament.

246 MARCONI'S WIRELESS TELEGRAPH CO. & WRIGHT, G. M. Receivers for wireless signals. (6/1/16.) 102,822.
Relates to wireless receivers comprising Fleming valves, and the employment therein as a limiting detector of a valve containing a filament, a grid and an anode the limitation being obtained by altering the potential between the grid and the filament.

247 MARCONI'S WIRELESS TELEGRAPH CO. & WRIGHT, G. M. Receivers for wireless signals. (6/1/16.) 102,823.
Relates to wireless receivers comprising Fleming valves, and the employment therein as a conductive coupling of a Fleming valve containing only a filament and an anode.

484 FRIED. KRUPP AKT. GES. GRUSONWERK. Magnetic separators. (6/2/15.) 100,062.

2,058 SCHROEDER, G. Dynamo-electric machines. (11/2/16.) 102,406.

3,376 DAVIES, A. & ALLEN & CO., E. Magnetic separators. (7/3/16.) 105,345.

3,566 MCCOLL, A. E. Protective device for alternating current systems. (17/8/16.) 105,356.

3,603 B. T.-H. CO. G. E. Co.). Method of and means for obtaining high vacua. (10/3/16.) 105,357.
Consists in causing a stream of condensible vapour to flow into an exhausted chamber communicating with the vessel to be evacuated and in preventing the vapour from flowing in the direction of the vessel to be evacuated.

4,035 LANE, J. C. & HONEYMAN, D. L. Apparatus for and method of treating articles electrolytically. (18/3/16.) 105,582.

4,775 GRANT, J. E. & MORGAN CRUCIBLE CO. Carbon brushse for dynamo-electric machines. (31/3/16.) 105,361.

4,942 RELAY AUTOMATIC TELEPHONE CO. & BYGRAVE, L. C. Means for connecting electric lines especially suitable for use in telephony. (4/4/16.) (Patent of Addition not granted. Cognate application, 13,029/16.) 105,363.

4,983 BOURNE, L. V. Electrically controlled apparatus for indicating liquid levels, and the rise and fall of gas holders and contents thereof. (5/4/16.) 105,366.

5,054 SUNBEAM MOTOR CAR CO. & COATALEN, L. Means for protecting the ignition apparatus of internal combustion engines. (6/4/16.) 105,374.

5,092 LINCOLN, J. C. Method of and means for electrically bonding rail ends. (6/4/16.) 105,378.

5,194 RATTEY, C. C. Accumulator cells and similar vessels. (8/4/16.) 105,385.

5,341 BRITISH INSULATED & HELSBY CABLES, LTD., & ASTLEY, J. W. Insulators for supporting electricity conductors or appliances. (12/4/16.) 105,586.

5,458 SOC. FRANCAISE RADIO ELECTRIQUE. Telephone receivers. (28/12/14.) 100,281

5,501 BURGE, H. Field or portable telephones. (14/4/16.) 105,592.

5,521 HEDGES, K. W. Tubular earths for electrical conductors. (14/4/16.) 105,411.

5,567 FRANCE, A. G. Means for concentrating or intensifying the light of electric filament lamps. (15/4/16.) (Cognate Application, 5,568/1915.) 105,600.

5,579 WESTERN ELECTRIC CO., MCBERTY, F. R. & POLINKOWSKY, L. Special service system for machine telephone switching exchanges. (15/4/16.) 105,601.

5,933 CAUNTER, L. G. Electrical switches. (25/4/16.) 105,423.

5,945 AUSTIN, N. J. & TAYLOR, G. E. Shields or guards for electric lanterns, electric torches, or similar hand lamps. (25/4/16.) 105,631.

6,039 MORTLEY, G. E. Dynamo-electric generators for aircraft. (27/4/16.) 105,634.

6,104 HALL, J. & KIRK, J. R. Method of automatically taking up shrinkage of coils of electric transformers and other electric apparatus. (28/4/16.) 105,800.

6,476 BROWN, A. C. Vibrating make-and-break devices for use in electric signalling. (5/5/16.) 105,432.

6,745 PRIMROSE, J. S. A. Electrical radiators. (11/5/16.) (Cognate Application, 6,746/16.) 105,809.

7,026 CLAY, J. R. Means for locking electric lamps in their holders. (17/5/16.) 105,440.

7,694 COX, H. W. & THORNE, J. H. Electrical switches. (31/5/16.) 105,820.

7,730 STERLING TELEPHONE & ELECTRIC CO., BELL, F. G. & DAVEY, W. C. Electrical signalling systems. (31/5/16.) (Cognate application, 12,456/16.) 105,659.

7,942 B.T.-H. CO.(G.E. Co.) Systems of turbo-electric propulsion. (5/6/16.) 105,660.

7,963 DECKER, F. J. Controllers or switches for electric motors and the like. (5/6/16.) 105,453.

8,165 B.T.-H. CO. (G.E. Co.) Electric systems of ship propulsion. (9/6/16.) 105,664.
Comprises a propeller and two induction motors adapted to drive said propeller one of the said motors having means for producing primary magnetic fields of two different pole numbers, and the second motor having means for producing primary magnetic fields of two different pole numbers of a smaller ratio of change than the ratio of change of the pole numbers of the other motor, the lower pole numbers of said two motors being the same.

8,303 DIXON, T. B. High-speed telegraphy. (19/7/15.) (Divided application on 2,524/16.) 100,942.
Comprises the provision of capacity, or both capacity and inductance in shunt relation to a second receiving instrument controlled, by a primary receiving instrument, said capacity being adjustable to neutralise the signal distorting effect of the high capacity, or high capacity and inductance, in shunt relation to the primary signal receiving instrument.

8,560 DEAN, H. & CHLORIDE ELECTRICAL STORAGE CO. Secondary electric batteries or accumulators. (16/6/16.) 105,828.

8,625 MORGAN CRUCIBLE CO. & HOLLAND, G. S. Distributors for high-tension magnetos. (19/6/16.) 105,462.

9,036 B. T.-H. CO. (G. E. Co.) Electric welding systems. (27/6/16.) 105,676.

9,921 DUNGEY, J. W. Inter-communication telephone systems. (14/7/16.) 105,536

10,162 HALDEN & CO., J. & HALDEN, J. B. Electric photographic printing or copying frames. (19/7/16.) 105,685.

10,184 HAEFELY ET CIE, E. Insulating sleeves for electrical transformers. (20/10/15.) 101,861.

11,114 FAIRWEATHER, W. C. (Lake Torpedo Boat Co.) Battery cells or tanks. (7/8/16.) 105,849.

12,382 HUMPHREYS, H. Magnetic chucks. (1/9/16.) 105,701.

12,609 TOCCHIO, M. Wireless control systems. (6/9/16.) 105,702.

14,546 WESTERN ELECTRIC CO. Inductances for duplex telephone circuits. (13/10/15.) 101,805.

14,886 MIDGLEY, A. H. & VANDERVELL, & CO., C. A. Dynamo-electric machines. (19/10/16.) 105,714.

15,123 EDWARDS, D. M. Combined electric plug and switch. (21/11/16.) 105,717.

15,269 HOLLANDSCHE ELEMENTENFABRIEK "JULIANA." Batteries for electric pocket lamps. (5/11/16.) 105,721.

16,145 COOKE, G. F. Electric contact breakers or interrupters. (10/11/16.) 105,519.

16,543 JACKSON, W. J. MELLERSH-. (Baruch Electric Controller Corporation.) Protective device for electric circuits. (16/11/16.) 105,871.

17,281 LEOPARD, E. A. & JOHNSON & PHILLIPS. Quick make-and-break switch for electric circuits. (1/12/16.) 105,726.

17,539 GILES, G. Electric condensers. (9/12/15.) 102,619.

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Manufacturing Companies. The reports of the meetings of two typically British manufacturing companies (Callender's Cable & Construction Co. and the Electric Construction Co.) are given in another page. In several respects both are alike. They are controlled establishments; the restrictions and regulations of the Ministry of Munitions have so affected them that practically there is little of the regular business left. However, notwithstanding labour and transport difficulties and the high cost of raw materials the trading profit of both companies was greater than in 1916 and the financial position was improved.

The trading profit of Callender's Co. was £190,087, against £177,157 in 1915 and £162,255 in 1914, and the net profit was £86,860, against £89,178 and £74,827 in 1915 and 1914 respectively. The distribution (dividend and bonus) is 20 per cent. as in 1915 and the provision for depreciation is over £6,500 more than in the previous year. The directors again state that the war has seriously hampered operations; the regular business has continually decreased, while there have been increasing manufacturing difficulties, for shipping facilities have been more stringently curtailed. The general home trade in electric wires and cables, together with the export trade to branches and customers overseas had, therefore, practically come to an end at the close of last year. On the other hand, the special work undertaken has largely increased, so that the workshops were well employed. The operations of the Anchor Cable Co. have become still more closely merged in those of Callender's, and the workshops at Leigh have also been fully employed, running day and night. With more than £500,000 in liquid assets the company's financial position is a sound one and its excellent progress during the period of the war may be taken as an assurance of continued prosperity when peace is happily secured.

The tale of the directors of the Electric Construction Co. is somewhat similar—good progress made under conditions of difficulty and a sounder financial position at the close of the financial year. The trading profit was £103,029 against £88,546 in 1915-16 and £71,999 in 1914-15, the net profit being £51,504 against £43,242 and £35,567 respectively. The ordinary dividend is 7½ per cent. as in the previous year, and although over £5,000 extra was allocated to depreciation a balance of £31,442 is carried forward. The interesting remarks of the chairman (Mr. P. E. Beachcroft) as to the cordial relations which have existed between the company and its employees and as to the efforts made to provide educational and recreation facilities for the younger members of the staff should be noted.

* * * *

Hiring of Apparatus. As an illustration of the great value of a system of hiring-out apparatus to an electric supply undertaking, the case of Barrow-in-Furness may be cited. The accounts of the electricity department for the past year are abstracted in another column, and it will be seen that the power and heating demand is increasing at a very satisfactory rate.

In a great measure this increase is due to the growing popularity of radiators, kettles, flat irons, &c. At present there are 1,250 pieces of apparatus let out to consumers on hire, including 103 motors, 178 radiators (increase of 26 over previous year), 721 flat irons (increase 221), 99 kettles (increase 61), 47 ovens, 99 hot plates, grills, &c. (increase 6) and three arc lamps. It is evident that local authorities and supply companies can do much to develop their heating and cooking load by introducing a scheme for the hiring out of electrical apparatus on reasonable terms. It may not be possible to do much until after the conclusion of the war, but it is a matter which should be carefully considered by all supply authorities.

* * * *

Excess Profits Duty Decision. The Board of Referees have fixed the statutory percentage for companies engaged in supplying electrical and compressed air power in the Transvaal at 9 per cent., while that for private firms is to be 10 per cent.

* * * *

Excess Profits Tax in U.S.A. At the last sitting of the board of governors of Associated Manufacturers of Electrical Supplies (of America), the following resolution was passed:—

Resolved, that without departing in any way from its attitude of co-operation with the Government in its effort to cope with the present situation, and while accepting without demur the decision ultimately reached, the opinion of this board is that the principle upon which the English Government bases the assessment of so-called excess profit taxes is superior to that embodied in present United States legislation from the viewpoint of equity, simplicity and continuing business activity.

Electric Power Development. According to the British Empire Producers' Organisation, which now represents over £700,000,000 of industrial capital, it will tax the entire capacity of electrical manufacturers to modernise the electric power supply plant of the United Kingdom after the war, and if any export trade is also to be sought there must be great extensions of factories and manufacturing facilities.

* * * *

Cheap Power and Industrial Progress. Mr. Robt. Fleming, chairman of the Investment Trust Corpn., delivered an interesting speech at the annual meeting last week, and referred to various industrial problems, including the supply of cheap power. Though we disagree with some of Mr. Fleming's views as to the export of coal, he is an authority on commercial and industrial enterprise, and therefore we give the following abstract of his speech:—

Mr. Fleming pointed out that many committees were at work trying to strengthen or reconstruct our industrial fabric, but the one that to his mind seemed to promise the greatest results was that dealing with coal consumption and power production. The idea was to link up the whole country through central stations placed at the most economical points and near coal, thereby providing the whole industrial country with power and light at a minimum cost. Some of the results would be: (1) A saving in coal consumption (reckoned at 50 million tons per annum) and consequently an equal increase in our available export coal tonnage; (2) an enormous saving in coal transportation; (3) an immense addition could be made to our machinery export trade through the non-use of engines and boilers at home; (4) with our own electric power machinery requirements a home product of sufficient volume we should be able to compete successfully with any other country in overseas electrical business. In that connection he was glad to hear that the British Westinghouse Co.'s thoroughly modern and extensive plant was no longer controlled from America, but by a strong group in the Midlands. The result, he hoped, would be that as our railways were electrified we need not go, as in the case of the Brighton Railway, to the A.E.G. of Berlin. He hoped also that that control would be used to promote the development of the whole country's electrical business, and not for the benefit of any particular financial or manufacturing clique. It was notorious that orders had been lost to this country through combinations of our own manufacturers. With our natural advantages and with a comprehensive system of cheap power—discarding uneconomical plants—the whole industry of Great Britain would receive an impetus. Nor was it a wild idea to suppose that our whole internal transportation system would have its power supplied from the same source, so making available for export to less favourably situated countries the bulk of the coal now used by our own railroads. Taking power production as a base, he was glad to see a general recognition among individual manufacturers of the need for the most modern plant. But even cheap power and the best plants would not avail unless the relations between employer and employee were put on a footing where the mutual aim would be not to restrict, but to expand production. That great problem was having the best thought of the best minds of the nation and would, he hoped, be solved to the satisfaction of masters and men and to the lasting advantage of our country.

* * * *

Commercial Education. The President of the Board of Education (Mr. Fisher) recently received a deputation from the Chambers of Commerce of London, Liverpool, Birmingham, Leeds, Newcastle and Sheffield, and also from Armstrong College, Newcastle-on-Tyne, who laid before the President proposals with reference to commercial and general education.

Mr. Fisher, in his reply, said he was glad to find that the Chambers of Commerce were now alive to the defects of our present system of commercial education, and were anxious to remedy them as speedily and comprehensively as possible. An encouraging sign of the growing interest in educational progress had been the creation of chairs and lectureships in Spanish and Russian in London and in northern universities. It was clear that the world of commerce was now coming to realise that we were seriously behindhand in our national equipment for the teaching of modern languages.

Mr. Fisher said he was in cordial agreement with the deputation's view that a sound growth of commercial education must repose on a basis of a good and thorough system of elementary education, followed by a really good general education. Commercial firms should take more pains to put themselves into connection with educational institutions, so that there might be a free and easy passage from the schools into the firms, and that they might have a wider interchange of knowledge. A promising field was opening out in connection with the constitution of faculties of commerce at the universities. He assured the deputation that the Board of Education valued most highly the supports and sympathy of the Chambers of Commerce, and felt that this was one of the most promising elements in the present situation.

Digitized by Google

ELECTRICITY SUPPLY.

GENERAL.

Belfast.—The strike of 72 skilled and unskilled labourers at the electricity works has terminated.

The men decided to resume work on Monday on the understanding that their claims would be dealt with during the week.

Birmingham.—The award of the arbitrator (Mr. W. W. Mackenzie, K.C.) appointed to consider the application by the manual employés of the Electric supply, tramways, gas and water departments of the Corporation for an additional 5s. 6d. per week has been issued.

A grant of 5s. per week is made for the first full pay day following the award, which is dated May 22. The advance now made is in addition to previous increases, amounting to 6s. 6d. The award is made on account of the increased cost of living, and will affect about 5,000 men.

Board of Trade Electric Power Committee.—Bridlington, Brighton, East Ham, Glasgow, Grimsby, Hackney, Hornsey, Nuneaton, Salford and Stirling Councils have also passed resolutions protesting against the inadequate representation of municipal undertakings on this committee.

At a meeting of the Parliamentary Bill's Committee of the Convention of Burghs at Edinburgh on Monday a letter was read from the Secretary of the Board of Trade Electric Power Committee asking for the appointment of a representative to give evidence before the Committee, and it was unanimously agreed to appoint Councillor Stevenson, of Edinburgh.

Cheltenham.—On Monday the Council decided, in consequence of the award of the Board of Trade arbitrator granting an increase of 6s. 6d. in the wages of most of the employés in the electricity department, to raise the price of electric current by 10 per cent.

Mr. Green said it had been hoped to go through the war period without advancing the charge, and that would have been possible, notwithstanding the higher prices of coal and other materials, but for the fact that £520 per annum more would now have to be paid for wages. He suggested that municipalities and other electricity undertakings would be forced to resort to fresh labour-saving appliances that were now being experimented with in order to meet the situation caused by the workers' demands.

Dublin.—The report of the Special Committee on the administration of the electricity undertaking was before the Corporation on Monday.

Mr. J. J. O'Neill, Chairman of the Electricity Supply Committee, moved that the consideration of the whole subject be referred back to the Committee, with a request that it should report to the next meeting of the Council.

Mr. P. T. Daly said the position of the electricity undertaking was that Col. Dalton was asked to take entire charge. He was called to the Front, and it was suggested now that Mr. Ruddle should take charge, but they wanted to give further consideration to the details.

Dr. Sherlock said after two years' consideration the Committee had produced a report starting from nowhere and leading nowhere. They ought to have an arrangement with Mr. Ruddle before they placed him in full charge.

It was decided to summon a special meeting for the 18th inst. to consider the entire question.

Electric Lighting Orders Extensions.—The Board of Trade has extended for one year from July 8 the periods of two years and 18 months respectively limited by the Yeovil and the Slaithwaite Urban District Electric Lighting Orders (1914).

Folkestone.—The Council have decided to defer the question of exercising their right to purchase the undertaking of the Folkestone Electricity Supply Co.

Hebden Bridge.—The Urban Council are in negotiation with Halifax Corporation for supply of electricity in bulk.

Increased Charges for Electrical Energy.—Increases of rates for the supply of current are being made at the following places:—

Cheltenham and Darwen Councils are increasing their charges by 10 per cent.

Haslingden Council is increasing the charge for current for lighting to 4¾d. (an increase of ¾d.) and power and heating rates (except under special agreement) by 15 per cent.

Loughborough Council has decided to make a charge of 5s. per quarter to consumers whose accounts are under £1, and £2 per annum to all new consumers supplied from existing mains.

At Norwich the charges are being increased 5 per cent.

Keighley.—On the 31st ult. the recently-completed extensions at the electricity works were formally inaugurated by the Mayor (Mr. F. W. L. Butterfield). The new 5,000 kw. set was named the "Butterfield." A 2,000 kw. set was christened the "Brigg," and two 1,000 kw. sets were also christened by the present chairman and a former chairman of the Electricity Committee.

Leek.—Last week it was reported to the Council that during the last two years about £8,000 had been spent on the electricity works, of which they had taken £7,953 from the rates.

The Finance Committee stated that £5,000 or so might have been borrowed, but it could not have been at less than 5½ per cent., and that would have meant a 2d. rate for 15 years. Therefore it was wise to face the expenditure at once. Mr. Frederick Swarbrick, of Minehead, has been appointed chief electrical engineer, at a commencing salary of £250 per annum.

Richmond.—The Council recently agreed to a modification of the agreement scheduled to the Richmond (Surrey) Electric Supply Act of 1913.

At the passing of the Act the price of current to ordinary consumers was 5½d. a unit and this price was to be reduced at stated intervals to 4½d. a unit. The application for the modification was made owing to the losses incurred by the Company on account of the cost of coal, transport and labour, and the Council will support an application to Parliament for a Bill to amend the Act on certain conditions, one of which is that the Company will, at its own cost, provide, maintain and light (until 1951) by electricity three high-power street lamps in the borough.

The relief asked for is not to exceed an addition of 15 per cent. to the consumers' accounts at the present flat rate of 4½d. per unit; the increase of 20 per cent. already in operation as regards electric current used for heating and power and for meter rent not to be further increased, but to be reduced to the pre-war charges after the war.

HYDRO-ELECTRIC NOTES.

French Hydro-Electric Scheme.—The French Government have sanctioned a scheme for the erection of a hydro-electric power plant at Fontpedrouse (Pyrenees Orientales) for utilising the water power of the river Tet and its tributary Riberolle. The electrical energy will be employed for operating the railway between Perpignan and Villefranche.

Hydro-electric Power in Italy.—The Ministry of War has been authorised to advance 20,000,000 lire (about £800,000) to the Ministry of Public Works, which, in agreement with the railways administrations, will undertake the immediate installation of hydro-electric plant for the production of power.

The power generated will be placed at the disposal of factories working under military control, but the installations will eventually pass under the control of the railways administration, and should the railways administration have no immediate use for them the Ministry of Public Works will operate them for account of the railways.

Ontario Power Undertaking.—The business of the Ontario Power Co. has been acquired by the Hydro-Electric Commission of Ontario. The purchase price has been agreed at $23,000,000 (£4,600,000) for 90 per cent. of the stock, and the transfer will take place on Aug. 1. The minority stockholders may sell on the same terms, or exchange their holdings for 4 per cent. debentures of the Hydro-Electric Commission.

LIGHTING AND INDUSTRIAL POWER.

Canal Haulage in New York.—The New York State barge canal is now available for through navigation between tidewater at Troy and Whitehall on Lake Champlain, and the whole canal will be opened in May, 1918, when through navigation will be possible on the new channel between Troy and Tonawanda, where the Niagara River is entered and followed to Buffalo on Lake Erie. According to "The Times" all the locks are of concrete and worked by hydro-electric power or petrol-electric plants. That at Oswego is stated to be the largest in the world, using the siphon principle, and is the first of this type to be constructed in the United States. It has a lift of 25 ft. Both at Seneca Falls and at Lockport there is a flight of two locks, with a combined lift of 48 ft.

Greenock.—The final tests of the new 150-ton electric crane which has been erected for the Harbour Trust by Sir Wm. Arrol & Co. have been successfully carried out and the crane has been taken over from the contractors.

Large Turbine Order.—It is announced that the General Electric Co. (U.S.A.) recently booked an order for turbines totalling 200,000 kw. rating. This is claimed to be the largest single order for turbines ever placed.

Manufacture of Electric Vehicles.—In the House of Commons recently Mr. J. Annan Bryce asked the Minister of Munitions whether he was aware that an active demand existed for electrically-propelled

Digitized by Google

industrial vehicles deriving motor force from existing power stations using home-produced fuel.

Mr. Bryce also asked whether the Edison Accumulators (Ltd.), having taken works for the manufacture of such vehicles in this country, was licensed to produce only a very small number; whether it had been refused certificates to obtain the material necessary to complete even the licensed number; and whether he will now grant priority certificates for such material?

In reply, Mr. Kellaway said he was aware of the demand for vehicles of the character in question, and it was in view of that demand that the company was give a licence to manufacture a limited number of chassis in this country. No promise was, or could be, given that all materials required for such manufacture would be forthcoming, but the necessary priority certificates would be issued in respect of any vehicles ordered from the company in connection with work of national importance.

ELECTRIC TRACTION.

Keighley.—The strike of tramway employés ended on Saturday, when work was resumed on the old terms, but the Industrial Commissioner will investigate the merits of the dispute.

Newport (Mon).—It is proposed to extend the electric tramways from the Pill terminus to the Alexandra Dock gates, and an agreement has been made with the dock company and the Tredegar Estate for protecting their interests.

The Light Railway Commissioners (the Hon. A. E. Gathorne Hardy, Col. G. F. O. Boughey, R.E., C.S.I., and Mr. Alan D. Erskine) recently held an inquiry into the proposal of the Corporation to extend the tramway lines from Pill terminus to the Alexandra Dock gates, at an estimated cost of £13,500.

Mr. A. A. NEWMAN (town clerk) said the Corporation had decided to extend the line at the request of the Government in order to facilitate the transit of workers. There were 1,000 persons engaged at one factory and later 6,000 would be employed there.

Col. BOUGHEY said the Commissioners were prepared to sanction the scheme, and would insert a clause giving protection to the gas company for their mains.

Tramway Workers' Wages.—The dispute between the owners and employés of the Lancashire and Cheshire tramway undertakings has been referred to the Government arbitration committee. The employés claim an extra 10s. a week.

The drivers and conductors of the Dundee tramways department are to get another 5s. per week, and cleaners 2s.

IMPERIAL NOTES.

Australasian Electrical Contracts.—The Adelaide Chamber of Manufactures, having considered a letter from the Secretary of State for the Colonies, regarding the handicaps under which the British electrical industry is at present labouring, have passed a resolution recommending that all contracts be suspended until British manufacturers are again in a position to tender for oversea work.

Canada.—It is announced that a discovery of molybdenite and iron in large quantities in the Laurential Hills (near Quyon, Quebec) has caused a boom in the local mining industry.

In regard to industrial and scientific research in Canada, the Imperial Trade Correspondent at Toronto (Mr. F. W. Field) says he understands that among the problems into which investigation is well advanced is the smelting of iron ores mined in the Dominion, in order to substitute these as far as possible for ores now imported to the extent of 80 per cent.

The Canadian Honorary Advisory Council on Industrial and Scientific Research has also under consideration the question of the uses to which plants built for production of munitions in the Dominion may be put when the war is over, and in this connection committees composed of distinguished representatives of the Dominion in the several branches of technological work are to be consulted. Regulations have been promulgated by the Council in regard to the studentships and fellowships it has instituted. The studentships are each of the value of $600 for the first year and $750 for the second. They are intended to enable students who have passed through a college curriculum and given distinct evidence of capacity for original research to continue their work. The research fellowships are of the value of $1,000 for the first year and $1,200 for the second, and will be awarded only to those who have shown a high capacity for research on some problem of national interest.

India.—At a recent meeting of the Commissioners for the Port of Calcutta a report was submitted showing the saving resulting from the purchase of power from the Calcutta Electric Supply Corpn.

The report stated that when the new arrangement was decided upon, it was estimated, assuming the loss in conversion from a.-c. to d.-c. to be 13 per cent., that the advantage in purchasing instead of generating the power would be a saving of about 33,000 rupees per annum, assuming that about 3,090,000 units were required for the existing docks and 830,000 for the Garden Reach extension. The consumption at the existing docks was actually less than half the estimated amount. Even now, however, the change has resulted in a saving, the cost per unit being now 1·2 annas, against 1·37 annas under the old arrangement.

Messrs. Best & Co. are investigating an electric supply scheme for the town of Madura. It is suggested to provide for about 5,000 private lamps, 1,000 fans and 700 public lamps.

FOREIGN NOTES.

Cuba.—A report has been issued by the Department of Commerce (Washington) on the market for electrical goods in Cuba.

The various classes of electrical work on the island are discussed in detail, and suggestions are made regarding the possibilities of developing the business in the future. The application of electricity for lighting and power plants, and especially in sugar mills, for heating and other industrial purposes have all been studied.

Norwegian Mining Properties.—In a Bill which has been submitted to the Storthing it is proposed to limit mining property concessions to a period of not more than 50 years, and the concessionaire must engage to build workmen's dwellings, schools, &c., and make an annual payment to cover workmen's accident premiums, &c.

Japan.—It is stated that a large extension of equipment is projected by the Mitsubishi Dockyard and Engine Works at Kobé.

To meet the increased demand for vessels two new stocks and a new floating dock of 20,000 tons lifting capacity are to be constructed. The dock will be moored in the new basin as soon as the breakwater of about 1,000 ft. is completed. This breakwater will run nearly parallel with the existing inner breakwater. A new engine shop is now being constructed with the intention of manufacturing Diesel engines for land and marine purposes. It has also been decided to commence the manufacture of the "Stal" type of steam turbine.

The "Japan Gazette" states that the prospecting work carried out in Formosa by a number of firms has resulted in the discovery of several promising copper ore deposits in the Giran and Karenko districts. Experimental work is being carried on in eight localities. It is believed that when all these deposits have been properly developed the copper production of Japan will be increased threefold. A vein or lode of copper ore is said to have been discovered on the left bank of the Dainan river in the Giran Prefecture, in Formosa.

Morocco.—The British Consul at Casablanca says economic development on an unprecedented scale has taken place in the French zone of Morocco during the last 2½ years. Roads have been improved and new railways are projected. Lighthouses have been erected, and others are in course of erection, all along the coast.

The Government has bestowed special attention upon improving the town of Casablanca. The improvements effected, or about to be effected, include the adoption of electric lighting in the streets and most of the dwelling houses in the European quarter. A 50 years' concession for a tramway system has been granted to a French company. British trade increased in volume since the outbreak of hostilities. A British Chamber of Commerce has been formed, and the Bank of British West Africa has opened branches at Tangier, Casablanca and Mazagan. After the war there will, it is anticipated, be a demand for various kinds of machinery and motor cars. It is suggested that British firms wishing to do business in the markets of the French zone of Morocco should be directly represented there.

Taxation of Electrical Energy in U.S.A.—The War Revenue Tax Bill of the U.S.A. imposes certain taxes on electrical industries, including power, light and heating supplies, telephones, &c.

A tax of 5 per cent. for electric power for "domestic" uses and of the amount paid for light or heat; a tax of 5 per cent. of the amount paid for telephone service by subscribers, exclusive of the amounts paid for toll or long-distance calls, provided that any expense incurred by any person, corporation, partnership or association in furnishing such power, light, heat or telephone service for its own use shall not be subject to this tax: a tax of 5 cents upon each dispatch, message or conversation of any telegraph or telephone line for which a charge of 15 cents or more is imposed. The latter provision is that only one tax shall be imposed, no matter how many lines are used.

The electric supplies companies are resisting the tax on the ground that, in view of the low ratio of gross revenue to capital expenditure, it would be especially burdensome upon the industry.

EDUCATIONAL.

Engineering Education in Australia.—At the annual meeting of the Victorian Institute of Engineers in March, Jas. Alex. Smith moved a resolution regretting that students in engineering had been denied admission this year to the Working Men's College (Melbourne) owing to lack of accommodation.

Mr. Smith said that he directed attention to the matter of accommodation in the College eight years ago. Since then something like 1,000 young apprentices and articled pupils in engineering had been denied admittance to the College as a consequence of inadequate accommodation and equipment. £100,000 had been voted by the Government for expenditure on technical school buildings during three years, and it was desirable that a portion of it should be devoted to the provision of equipment and buildings for students at the Working Men's College. The president of the Institute and city electrical engineer (M. H. R. Harper) said the starving of the college was false economy on the part of the Government, and it was no use to talk about building up the prosperity of the nation while young men were unable to study the trades to which they had been apprenticed.

Newcastle School of Wireless Telegraphy.—The recently created Municipal School of Wireless Telegraphy at the Rutherford Technical College, which has been equipped with wireless apparatus out of the subscription of the local shipowners, was opened on June 4.

Digitized by Google

MISCELLANEOUS.

Canadian Industries.—Notwithstanding the war and the absence of over 400,000 men on active service, Canada seems to be making good progress from an industrial point of view.

The Commissioner of Industries for the Grand Trunk Railway estimates that in the past year there have been 75 new plants located on the Grand Trunk lines alone. He calculates that these represent an investment of £2,400,000. Not only are new plants being placed in many railway centres, but the established industries are growing so rapidly that they have been forced to enlarge their plants and equipments. This tendency is general in all branches of manufacture.

Coal Economies.—The Advisory Committee (Ministry of Munitions) is seeking the loan of the services of the managers of certain London municipal electricity undertakings in connection with experiments for the economical use of coal.

Customs Decisions.—A recent appraisers' "Bulletin" issued by the Canadian Customs Dept., states that electric welding furnaces for use in manufacture of boilers for ships are subject to 20, 27½ and 30 per cent. import duty under the British preferential, the intermediate and the general tariff respectively.

According to recent decisions, the following duties are leviable under the Australian preferential and general import tariffs respectively:—

Bodies for railway or tramway vehicles propelled by petrol, steam, electricity, oil or alcohol, 35 and 45 per cent. ad val.; chassis for railway or tramway vehicles propelled by petrol, steam, electricity, oil or alcohol, 25 and 30 per cent.; bodies for vehicles with self-contained power, propelled by petrol, steam, electricity, oil or alcohol, n.e.i., including dashboards, footboards and mudguards, single-seated bodies, £15 and £17 each; double-seated bodies, £21 and £24. 10s. each; bodies with fixed or moveable canopy tops, £36 and £42 each; chassis for vehicles with self-contained power propelled by petrol, steam, electricity, oil or alcohol (but not including rubber tyres), free and 10 per cent.

Electro-Medical Treatment.—At the recent annual meeting of the Nottingham Electro-Medical Hospital, Dr. Bolton, the hon. medical superintendent, stated that 202 patients presented themselves for advice, and were carefully examined free of charge.

All but 36 were accepted for treatment, the remainder being instructed either to go to special hospitals or surgeons, according to their maladies. The electrical treatment was particularly effective in cases of stiff joints following injury, and of that type 21 had been treated. Sciatica furnished 12 cases, chiefly coal miners, and the patients generally were drawn from a very wide area.

Enemy Businesses in Egypt.—The Foreign Trade Department of the Foreign Office has recently issued lists of persons and firms in Egypt with enemy interests, which have been licensed by the Egyptian Government to carry on business for the purpose of liquidation only, or to which a receiver has been appointed for the purpose of liquidation.

No new transactions should be entered into with any person or firm mentioned in the lists, and claims against persons or firms in the lists should be at once made to such person or firm, or, in cases where a controller or receiver has already been appointed, to the controller or receiver.

Amongst the licensed firms to carry on business are: Colloid Wolfram Lamp Co. (controller: F. H. Russell, Gresham House, Cairo) and Siemens-Schuckert (controller: R. E. Moore, Savoy-chambers, Cairo).

Receivers for liquidation have been appointed in the cases of the Deutz Gosmotoren-Fabrik, Cairo (Receiver: R. E. Moore, Savoy-chambers, Cairo); Soc. anon. d'Electricité Ganz, Cairo (Receiver: F. H. Russell, Gresham House, Cairo); Orenstein & Koppel (Receiver: F. H. Russell, Gresham House, Cairo).

Enemy Firms Wound Up.—The controllers of the British Phosphor Metal Co. G.m.b.H. and of Isaria (Ltd.) have applied for release. Objections to the Board of Trade before June 9.

The total number of businesses controlled by alien enemies and ordered by the Board of Trade to be wound up is now 454. The latest list includes H. &. F. Bonten (Ltd.), 8, Elder-street, Bishopsgate-street Without, London, E.C., iron and hardware merchants and agents.

Engineering Wages.—Some misapprehension has arisen with regard to the award of the Committee of Production in respect to the wages of employees in the engineering and foundry trades.

The award, which began to operate on April 1 last, was limited to the members of the societies included in the Engineering Employers' Federation, who are engaged in the federated shops and foundries, and its general effect has been to increase the wages of men 5s. per week, and the wages of boys and youths 2s. 6d. per week.

There is no foundation for the statement that the Minister of Munitions has authorised an advance of 5s. per week to munition workers irrespective of the trades in which they are employed. But the Minister has undertaken to extend the award of the Committee of Production so as to make it applicable to the employees of all unfederated firms in the engineering and foundry trades under his control, and a clause has been inserted in the Munitions of War Bill to empower this extension.

Exports to China.—The "London Gazette" contains a further list of firms and persons in China to whom goods may be exported from the United Kingdom. These include the Western Electric Co.

Exports to Switzerland.—The Foreign Office has issued a list, corrected to May 19, of articles (including those set out below) in respect of which licences for export to Switzerland are only granted if the goods are consigned to the Société Suisse de Surveillance Economique (S.S.S.).

Accumulators and accumulator plates, aeroplanes and airships and engines for same and parts, aluminium in all forms (except jewellery), anti-friction metal, antimony, asbestos, automobiles, belting, bitumen, boiler compositions and packings, bronze, aluminium bronze, insulated cable, cadmium, carbons and carbon electrodes, &c., copper and copper wares (including carbons containing copper, copper cables and wires, &c., dynamos, electrical appliances adapted for use in war and parts of same, electric fire lighters, insulated electric wires and cables, marine and aerial engines and parts, galvanised iron, fur metal, gutta percha, insulating materials, lead, lubricants, machine oils, machine tools and parts, machinery and parts in special steel, electrical machinery, dynamos and electric motors, metal working machinery, magnetos and parts, manganese, mica, molybdenum, nickel, phosphor-bronze, platinum, rubber, ebonite, selenium, signalling lamps, telegraph and telephone materials, titanium, tungsten, vanadium, varnishes and wolfram.

Carbons for electricity (except electrodes) and carbon brushes for dynamos can be sent by the small parcel system under which the War Trade Dept. may license the export without insisting on the production of an acceptance certificate from the S.S.S., electric batteries and parts and parts of telegraph and telephone apparatus may be sent under the small parcel system.

Munition Tribunal Case.—At Stoke-on-Trent on Monday application was made for a leaving certificate by a charge engineer employed at the central power house of the Stoke-on-Trent Corporation.

The applicant's case was that his present salary of £140 a year was insufficient to maintain himself in the Potteries and his wife and five children at Sheffield, and that he had been offered a position with a large firm at nearly double his salary.

The application was opposed by Mr. C. H. Yeaman, borough electrical engineer, who claimed that the salary paid to the applicant was a reasonable one, and the salary offered to him in his new position was an inflated one created by war conditions and owing to the great scarcity of skilled men. If their skilled men were to be allowed to leave them in that manner the efficiency of the electricity undertaking would be greatly imperilled.

Applicant contended that a man was already in training to do his work, and produced sheets signed by the man as a charge engineer.

The chairman said the whole point they had to consider was whether applicant could be better employed in the national service than in his present position. It was evident he was an engineer of skill and experience, because a firm employed on work of the greatest national importance had offered him a position at almost double his present salary. Taking both the importance of the work and the salary into consideration, and also the fact that a man was in training to replace him, the Court decided that a leaving certificate would be granted.

Postage of Documents in Duplicate.—The Postmaster-General notifies that henceforth he will accept the duplicates of documents at the same time as the originals for transmission abroad, and will retain the duplicates for despatch by a ship other than that conveying the originals.

For the present the system will apply only to correspondence for Australia, Ceylon, Egypt, India, New Zealand, South Africa (British, including Bechuanaland, Basutoland, Rhodesia, and Swaziland), Aden, Bismarck Archipelago, British agencies in China, British East Africa, British New Guinea, British Somaliland, Hong Kong, Malay States, Marshall Islands, Mauritius, Norfolk Island, North Borneo, Sarawak, Seychelles, Straits Settlements, Sudan, Tonga and Zanzibar.

Further particulars may be obtained from Post Offices.

Prohibited and Restricted Exports.—The Director of the War Trade Dept. announces that zinc N.P. is deleted from the list.

Resuscitation After Electric Shock.—In a recent report Mr. W. P. Strickland, inspector of the New York & Queen's Electric Light & Power Co., gives particulars of the recovery of one of his men from the effects of an electric shock.

The man, when about to erect primary wires, was apparently killed by accidentally touching a wire carrying current at 2,300 volts. A lineman immediately took hold of the ankles of the limp body, lifting it until the whole weight rested on the neck, and letting it fall. He then took a pair of connectors and hammered the soles of the injured man's feet without removing his shoes. Another lineman opened the man's mouth, pulled forward the swallowed tongue (which occurs in electric shock), and was about to begin the Schaefer prone method of resuscitation, when the man returned to life. He was removed to the hospital, and is now well, though suffering severely from his burns. Similar cases of recovery are mentioned in connection with the plan of striking the feet without removing the boots or shoes in case of electric shock.

Telegraphic Addresses.—It is stated that only about two-thirds of the telegrams reaching London for registered telegraphic addresses contain the "indicator" as part of the address, and, as this causes delay, the Postmaster-General advises that firms should have their registered address with the "indicator" printed on their stationery, and to notify their correspondents that it should be used. THE ELECTRICIAN telegraphic address is "Benbrotric, Fleet, London."

The Engineering Industry After the War.—We have received from the London Association of Foremen Engineers a copy of the report of the debate which took place at meetings in October, November and January last on the position of the engineering industry after the war.

X-Ray Hospital Equipment.—The Ealing Chamber of Commerce is raising £750 for providing the King Edward Memorial Hospital, Ealing, with an X-ray equipment.

Digitized by Google

TENDERS INVITED AND ACCEPTED.

Laying Cable Ducts, &c.

KEIGHLEY Corporation require tenders by June 18 for laying porcelain cable ducts and building manholes in connection with a new h.-t. feeder. Particulars from Borough Electrical Engineer.

CARDIFF.—The Corporation has accepted the tender of the British Insulated & Helsby Cables for the supply of 2,815 yds. of three-core cable, at £1,400 per mile; 90 yds. armoured cable, £99; 465 yds. l.t. four-core pilot cable, at £159 per mile.

The Asylums Committee has also placed an order with the General Electric Co. for electric light sundries, at £135. 8s.

GILLINGHAM.—The Council has placed an order with the British Electric Transformer Co. for a transformer, at £137.

METROPOLITAN WATER BOARD.—The Board has accepted the tender of Pope's Electric Lamp Co. for electric lamps for six months from April 1.

SALFORD.—The Council has accepted the following tenders:—

Albion Clay Co., stoneware conduits for supply to Irwell Park Wharf, £418. 18s. 2d.; British Westinghouse Electric & Mfg. Co., switchgear, £410; and h.t. switchgear for Trafford sub-station, £363; ditto at Blackfriars sub-station, £378; W. T. Glover & Co., lead-covered feeder cable, £2,474; Bertram Thomas, l.t. switchgear at Blackfriars, £492. 10s.

BIRMINGHAM.—The Corporation has accepted the tender of the Vaughan Crane Co. for an electric hoist at £3,095, also the tender of the British Thomson-Houston Co., at £1,695. 16s., for a turbo-exhauster.

MANCHESTER.—The Electricity Dept. has accepted the following tenders:—

Callender's Cable & Construction Co. and W. T. Glover & Co., cable; G. & J. Weir, turbine driven feed pump.

HOMERTON (LONDON).—The City of London Guardians have instructed Messrs. Pinching and Walton to put in a new installation of domestic telephones at their Homerton institution at £332. 6s.

GLASGOW.—The Council has accepted the following tenders for 12 months' supplies to the electricity department:—

Callender's Cable & Construction Co., e.h.t. concentric and triple concentric and single v.b. sheathed and insulated cables; W. T. Glover & Co., h.t. cables; Craigpark Electric Cable Co., rubber-covered cables and flex; Ferranti (Ltd.) and Chamberlain & Hookham, meters; Carran Co., Falkirk Iron Co. and Lion Foundry Co., c.i. boxes, section pillars, &c.

The tenders of P. R. Jackson & Co. for commutators and the Carron Co. for chilled iron and scrap iron brake blocks for the tramways dept. have also been accepted.

JOHANNESBURG (TRANSVAAL).—The Council has accepted the following tenders for cable:—

Telegraph Mfg. Co. 0·013 twin £250 and 0·004 twin, £150; Rice, Wilson & Herd, 0·013 twin, £200, 0·022 twin, £375, 7/18 concentric £181 and 7/16 concentric £231.

SYDNEY (N.S.W.)—The Metropolitan Board of Water Supply and Sewerage has accepted the tender of Ferrier & Dickinson (at £1,950) for the supply of four electrically-driven induced-draught fans at Ryde pumping station.

Messrs. H. P. Gregory & Co. tendered at £1,480, Noyes Bros. at £1,730 and £2,040, and R. Wildridge & Co. at £4,895.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments:—

Postmaster-General's Department, Tasmania.—Callender's Cable & Construction Co., 6 miles wire, £33. 10s. per mile; W. T. Henley's Telegraph Works Co., 433 yards cable, £1,370 per mile; 1,253 yards ditto, £900 per mile; 260 yards ditto, £705 per mile; 820 yards ditto, £435 per mile; 500 yards ditto, £205 per mile.

Postmaster-General's Department, New South Wales.—Western Electric Co., 2,000 jointing sleeves, 10s. 8d. per 100; 1,000 ditto, 12s. 6d. per 100; 2,000 ditto, 13s. 3d. per 100, A. J. Todd & Co., 1,500 jointing sleeves, £5. 2s. 8d. per 1,000; 2,000 ditto, £6. 15s. 10d.; per 1,000; Lawrence & Hansen Electric Co., 3,500 cords, 1s. 10d. each; Automatic Telephones (Australasia) (Ltd.), 100 automatic telephones, £3. 14s. 3d. each.

Postmaster-General's Department, Queensland.—50 fuses, 1s. 3d. each; 1,190 ditto, 10½d. each; 7,000 micas for protectors, 9s. per 100; 1,500 mouthpieces, 4d. each; 2 lb. shot carbon, £16. 16s. per lb.; 6 repeating coils, 17s. 6d. each; 80 ditto, £2. 2s. 6d. each; 25 translators, £2. 2s. 6d.; Jas. Paton & Co., 100 chambers for microphone, 2s. 4d. each; 8,000 pairs fuse clips, 6s. 6d. per 100; 10 retardation coils, 4s. each; 36 dozen nuts, 10s. 3d. per 100; 24 dozen mica washers, 16s. 8d. per 100; 12 only spur wheels, 3s. 6d. each; Dunlop Rubber Co., 50 receiver cases, 1s. 7½d. each; 250 earpieces, 11d. each; 250 ditto, 11½d. each; 250 ditto, 1s. each.

Postmaster-General's Department, South Australia.—Western Electric Co., 100 foiled paper condensers, 3s. 6d. each; 1,100 yards cable, 2s. 3d. per yard; 750 opal caps, 13s. per 100; 900 line lamps, 6½d. each; 720 relays, 8s. 6d. each; British General Electric Co., 2,000 protectors, 7s. 1d. each; 92 jacks, 8s. each; 92 line lamp sockets, in strips of 10, 6s. 6d. each.

Postmaster-General's Department, Victoria.—British Insulated & Helsby Cables, 500 jacks, 9½d. each.

N.S.W. Public Works Dept.—Sydney Electric Light Dept., 39 miles copper cable, £55. 12s. 6d. per mile.

Victorian Railway Commissioners.—Siemens Bros. Dynamo Works, cable, vulcanised rubber-braided, at rates.

N.S.W. Railway Dept.—Standard Waygood Hercules (Ltd.), 48 3-ton electric cranes for goods sheds, Darling Harbour; Price, Martyn & Co., 50-ton electric overhead travelling crane for Zara-street power house, Newcastle.

APPOINTMENTS VACANT AND FILLED.

The Governors of the Central School of Science and Technology, Stoke-on-Trent, invite applications for the post of principal of the department of mechanical and electrical engineering. Salary £500 to £750 per annum. Forms of application, which must be returned by June 23, can be obtained from the clerk to the Governors, Dr. W. Ludford Freeman, Education Offices, Town Hall, Hanley. *See advertisement.*

An assistant telegraph engineer is required for the Posts & Telegraph Department, Federated Malay States. Salary £360, rising to £480 per annum, by annual increments of £15, with duty allowance of £75. Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, S.W. 1. *See an advertisement.*

A teacher of engineering subjects is required by the Bristol Education Committee for the Temple Junior Technical School (Engineering). Salary £170, rising to £200. Forms of application from the Secretary for Education, Guildhall, Bristol. Applications by June 16.

Reigate Corporation require a shift engineer for their generating station. Applications to Borough Electrical Engineer by noon, June 12.

Stepney (London) Guardians require an engineer (temporary) for their children's homes, Stifford, to take charge of electric lighting and other machinery. Salary £3 per week. Forms of application from the Clerk, Barnes-street, Stepney, E. 14. Applications by June 9.

Mr. Frederick Swarbrick, of Minehead, has been appointed electrical engineer to Leek Urban District Council.

Col. A. S. Cooper, C.M.G., has been appointed Director of Inland Waterways and Docks.

Mr. J. R. Davison, of Manchester, has been appointed mechanical engineer at Belfast electricity works. The Committee recommended Mr. W. G. Moffat, but was not accepted by the Corporation.

BUSINESS ITEMS.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of July 12. *Further particulars are set out in an advertisement.*

BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 8s. is payable at 4, Queen-street, Carmarthen, to creditors of Fredk. Brown (formerly partner in Hugh Bros. & Brown), electrician, 8, Stafford-street, Llanelly.

In consequence of the railway having been sold to the Barbados Government, the Barbados Light Railway (Ltd.) is being wound up, and Mr. J. W. Woodthorpe, 1, Leadenhall-street, London, E.C., has been appointed liquidator.

CATALOGUES, &c.

Terminal Boxes.—We have received from Messrs. W. T. Henley's Telegraph Works Co., Ltd., Blomfield House, Blomfield-street, London, E.C., a copy of their new catalogue of about 110 pages relating to terminal boxes, terminal ends, &c. The book, which is well illustrated and neatly got up, will be dealt with more fully in our next issue.

Portable Electric Tools.—From the Light Electric Motor Co., Baltic-street, Dundee, we have received a set of leaflets which give particulars and prices of the portable electric drilling machines, the "Dundee" electric grinders, grinding and polishing machines, motor-driven pumps, &c., manufactured by them. The drilling machines can be supplied for any voltage up to 250 and for either continuous or alternating current. In consequence of the small current consumption the electric grinders can be connected to an ordinary lighting circuit lamp-holder. The whole of the tools and machines are British made.

India and Enemy Trading.—At the recent conference of Indian Chambers of Commerce a resolution was carried that for a period of 12 months after the war no enemy subject should be allowed to enter India, and no enemy shipping should be permitted to use Indian ports.

After this preliminary period there should be a reconstruction period—which might terminate with complete reparation and the restitution ton for ton of British shipping sunk illegally—and during this period enemy shipping should be subject to special taxation and be excluded from coastal trade. Severe restrictions should be imposed permanently upon hostile aliens, both individuals and firms, who should only be allowed to resume their trading activities under licence. Aliens who are not enemies should be treated on the principle of reciprocity.

Digitized by Google

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Aberdeen.—The financial year, which ended on Thursday last, was a record one.

For the first time the revenue exceeded six figures, being £100,069, an increase of £5,741 over 1915-16, and the passengers carried numbered 27,141,275, an increase of 1,851,406.

Barrow-in-Furness.—The capital expenditure of the electricity department at March 31 was £179,231, against £171,348 in 1916.

The net revenue from electricity supply was £62.555 (against £58,663), and with meter rents, &c., total was £63,114 (£59,208); total working costs were £39,824 (£34,808), and gross profit was £23,290 (£24,400), Interest required £4,891, and sinking fund £7,175, leaving net profit of £11.223 (£12,804). Combined maximum load was 3,625 kw. (3,905 kw.) and load factor 42·3 per cent. (40·36 per cent.). 296,856 equivalent 30-watt lamps are connected (against 253,714); units sold were 13,429,260 (13,806,254). Total working costs were 0·712d. per unit sold (against 0·605d.), the increase being mainly due to coal (0·045d.) and repairs (0·02d.).

In his report the borough electrical engineer (Mr. H. R. Burnett) states that during the year a 960 kw. B.T.-H. rotary converter was installed of a 150 kw. machine. Considerable repairs, particularly in the boiler house, were carried out, and a turbo-alternator was overhauled by Messrs. Jas. Howden & Co. Plans have bene prepared for a further extension of the plant, and a large boiler and mechanical stokers have been ordered. About 3·7 miles of new mains were laid; an e.h.t. cable was laid across Walney Bridge and e.h.t. supply was also connected to Messrs. Vickers' new shell shop and to the new gasworks. In South Vickerstown about 100 additional workmen's houses were erected and connected to the l.t. mains. Including 61 consumers taken over from the Isle of Walney Estates Co. there were 300 new connections to the mains, but it was not possible to accept all applications. A sub-station in Walney (with one 150 kw. Westinghouse rotary converter) was completed in March, and another is nearing completion. A 250 kw. B.T.-H. rotary converter is on order for the Michaelson-road sub-station. The demand for apparatus continues to increase, and at March 31 last 1,250 pieces of apparatus were in use. This number would have been further increased had it been possible to obtain all the apparatus for which a demand had arisen. The use of this apparatus is to a considerable extent responsible for the large increase in the output for private lighting and domestic purposes (from 1,085,676 to 1,290,360 units). There are 420 motors of 3,118 H.P. connected. The revenue from private supply increased from £14,350 to £16,238, and from power and heating from £38,929 to £41,384. Owing to Messrs. Vickers having put their new power house into operation in August the firm's consumption dropped by over a million units, but this was loss counterbalanced by increased supply to other consumers.

Birmingham.—The receipts of the tramways department for year ended March 31 were £838,725, or £67,608 over 1915-16.

In the first six months of the year, when the services were carried on without interruption, the traffics increased by £71,000; but during the second half of the year there was a decrease of £4,000, as compared with the corresponding period of the previous year. The Committee consider that the loss to the department caused by the failure in the supply of electric current amounted to £50,000. The total expenditure was £98,085 in excess of the previous year, an increase of 18·4 per cent. Of this increase the cost of current represented £31,242, traffic expenses (chiefly due to war bonuses, wages, &c.) £29,860, general expenses £10,877, general repairs and maintenance (due to wages and bonus and high price of materials used in maintenance of rolling stock and permanent way) £27,420. Thus, while the receipts increased only by 1·075d. per car-mile, the expenses increased by 1·610d. After paying interest and sinking fund charges the year's surplus is £76,291, of which £66,206 has been carried to reserve and £10,085 to suspense account. The further extraordinary increase in the cost of the operation of tramways renders it imperative that the income of the department shall be augmented. In order to attain this result, the Committee are of opinion that the time has arrived when a revision of the tramway fares is necessary, and they recommend that all existing stages be increased so as to allow passengers to ride approximately 2 miles for 1d.; that all return tickets be abolished, excepting those on the 2d. and 2½d. stages, &c.

With regard to the suggested provision of trailer cars, the Committee say that in order to obtain accurate information as to their value in Birmingham it will be necessary fully to equip one of the tramway routes with these vehicles. Unfortunately, owing to the extreme difficulty of obtaining the necessary materials and equipments, it has so far been impossible to make much progress in this direction. A trailer car is being run on some of the routes, and the Committee will proceed with further experiments as soon as circumstances permit.

The report of the Electric Supply Committee states that the total number of units sold during the year was 149,724,637, compared with 117,016,321 in the previous year, and the receipts were £717,831, against £498,962. The increase in units sold of over 32,000,000 is principally accounted for by the increase in the sales of e.h.t. current (over 29,000,000), the increase under this heading alone being over 55 per cent. The output for lighting and power (exclusive of traction) shows an increase of 35 per cent., and the money value of this supply shows an increase of 50 per cent. The cost of fuel has been considerably higher than during the preceding year. Part is due to the increased output, part to the increased cost of coal per ton, and part to the deterioration in the quality of fuel, which has led to more coal being used per unit generated. Wages have also risen materially, the number of men employed having increased as well as the rates of pay. The cost of repairs has been much larger, the plant has been greatly overworked and considerable repairs and replacements have been necessary. After meeting all charges for interest and sinking fund, the balance is £67,794. 12s. 6d. Of this sum the Committee have carried £40,000 to renewals and special expenditure account, leaving £27,794. 12s. 6d., which it is proposed to pay to the credit of the borough rate. In order to facilitate the handling of coal, the Committee recommend the purchase of 3½ acres of additional land at Nechells, to permit of an increase of the railway siding accommodation.

The accounts and recommendations of both Committees were adopted by the Council on Tuesday.

Coventry.—The gross capital expenditure of the electricity department at March 31 was £571,294 (increase of £110,139 over 1916), of which £31,213 has been repaid.

Revenue was £169,787 (compared with £108,543) and working and general expenses were £104,179 (£63,232), leaving gross profit £65,607 (£45,311). Interest required £1,0191 (£8,800), instalments of principal £1,472, stock redemption funds £1,847 (£1,847), sinking fund £11,102 (£9,506), property tax £3,054 (£3,798), reserve fund £12,000 (£17,148) and bank interest and charges £3,919 (£1,240), and the net result is that £6,000 (as in previous year) has been applied to relief of rates and £27,814 (£18,058) carried forward.

Glasgow.—The year ended May 31 was a record one for the Corporation tramways department.

The receipts were £1,245,507, an increase of over £96,000 compared with 1915-16. The passengers carried were 388,250,000, an increase of nearly 26,000,000. About 248,000,000 passengers bought halfpenny tickets.

At a public meeting last week the Lord Provost, referring to the Glasgow Tramway comforts scheme, said that Mr. Dalrymple had conceived a brilliant scheme which, he was creditably informed, the whole nation wanted to copy. They had been assailed with suggestions that they were committing a terrible crime; they were teaching the nation to be gamblers, but he saw no evil in it. The funds were going to a great and good object. It was well known that the nation or the man who had not got the sporting instinct in his nature was not worth being called either a nation or a man. For the benefit of those people of tender conscience who would not accept a prize, they had put on again the little red boxes, but while in one week the boxes had realised the marvellous sum of £37, the war tickets in the same week had brought in £1,700.

Manchester.—The accounts of the tramways department for the year ended March 31 have been issued.

The gross capital expenditure was £2,237,827 (increase £6,279), of which £660,264 has been redeemed. Annual revenue was £978,677 (against £939,469 in 1916), working expenses were £598,743 (£561,438), and war service allowances required £91,023 (£92,808), leaving gross profit £288,910 (£285,222) or £303,939 (£299,740) after adding bank interest, &c. Interest on capital absorbed £61,091 (£59,736), redemption of debt £63,358 (£61,236), interest and sinking fund for street improvements £6,560 (£6,128), rent of tramways £27,426 (£26,773), and proportion of outlay on leaseholds £630 (£684), leaving a balance of £144,932 (£145,182), of which £39,525 (£21,181) has been placed to renewals fund, £5,406 (£24,600) paid as income tax and £100,000 (as in previous year) contributed in aid of rates.

Passengers carried were 219,151,984 (209,877,667), including motor 'buses 1,416,760 (758,034), car-miles run 18,388,302 (18,486,440) and units used 28,684,389 (28,713,922)=1·56 (1·55) per car-mile. Average total revenue per car-mile was 12·773d. (12·197d.), and working expenses, including power, were 7·814d. (7·289d.). The total amount provided for reduction of rates by the undertaking since its inception in 1902 is £1,115,090. There are 685 cars in stock, and the total length of (equivalent) single track is 203 miles. The net receipts of the parcels department were £2,880 (£3,405) and parcels carried were 1,112,180 (1,225,718).

The receipts of the motor omnibuses were £7 296=9·677d. (11·840d.) per 'bus-mile, and, after provision for traffic and general expenses, repairs and maintenance, power expenses and depreciation, the net revenue was £158=0·211d. (3·143d.) per 'bus-mile.

Nottingham.—The accounts of the electric supply department were approved by the Corporation on Monday.

Sir JOHN TURNEY, who submitted the report of the department, said it was not so bad as appeared on the face of it. They had had to pay £10,400 more in income tax, and for wages and coal than in 1916, so that had it not been for that they would have earned £15,732, instead of £5,332. The committee had raised £485,989, of which they had redeemed £207,507, and had put aside £44,282.

Digitized by Google

COMPANIES' MEETINGS AND REPORTS.

Callender's Cable & Construction Co. (Ltd.)

The twenty-first ordinary general meeting was held on May 31, Sir J. FORTESCUE FLANNERY, Bart., M.P., M.Inst.C.E. (chairman of the company), presiding.

The SECRETARY (Mr. Walter Allnutt, F.S.A.A.) having read the notice convening the meeting and the report of the auditors,

The CHAIRMAN said that the tempest of cruelty which had burst upon the world through the unfettered ambition of an inhuman and intolerable military despotism had uprooted commerce, and the course of all manufacture had been changed, much of it from the making of goods for the benefit of man to the making of implements for his destruction. The company's manufactures had followed this unhappy downward course in an increasing degree since the war began, but, while sparing no effort to serve the State, they had struggled hard to keep together the company's old and valuable business connection at home, in the Dominions and in neutral foreign countries by every means possible under the restraint arising out of the war. They had had some success, and every precaution had been taken to enable them to open out again in their commercial connections when the war was over. In the meantime the Ministry of Munitions had imposed such restrictions as completely to change the ordinary course of the business, and the Ministry of Shipping had restrained the export even of goods already made, so that large foreign and colonial orders, the satisfactory execution of which would have redounded to the credit of the company, were now in a state of indefinite suspense. The variety of the work which they had taken in hand for the Government had been very great, and formed a monument to the mechanical ingenuity and business adaptability of the managing director and his highly competent staff. After referring to the increasing employment of women and the measures taken by the board to enable them to work under healthy and comfortable conditions, the chairman said the increase in the wear and tear of plant had been very considerable, for it was working at high pressure all the time, the output having enormously increased; and such provision had been made as seemed reasonable, and not more than reasonable for the depreciation thereby incurred. A large quantity of new and improved machinery had been installed and the buildings very considerably increased, and they were now constructing practically a new works upon freehold land purchased with foresight years ago, in excess of the actual requirements of the time.

The year's profits were £190,000, as compared with £177,000 for 1915, or an increase of £13,000, which was a very moderate increase in profit when consideration was given to the extra output and the trouble and labour required to earn it. The board recommended a dividend which, with bonus and special bonus, amounted to 20 per cent. per annum, and if the recommendation were acted upon there would remain a balance of £249,000 to be carried forward. The sum to be distributed was £35,000, or just one-seventh of the amount carried forward. In other words, the latter was equivalent to a 20 per cent. dividend for seven succeeding years. They did not promise such a distribution; the future was very doubtful in regard to every commercial enterprise, but it was a very fair and very satisfactory opening for the accounts for the new year. He thought it would be agreed that the results were encouraging, and they had not been attained by any "profiteering." They had not been paid excessive rices; they h d made no unfair market out of the needs of the nation. They had changed their form af manufacture at the bidding of the State, which they had served for a reasonable and moderate remuneration. The profits exhibited no sensational increase. They were honest profits, largely based upon the accumulated savings of past years. To anyone who said that 20 per cent. seemed a high return, the answer was that it had been earned not alone in the year just closed, but as the result of the thrift, the savings and the accumulations of many past years.

Mr. T. O. CALLENDER, J.P. (m naging director), who seconded the motion, said that no company, he believed, in this country—certainly no company in the electrical industry—had had more confidential work or more important work entrusted to it than Callender's, which they had done their best, he believed, successfully, to carry through. The ordinary business of making cables and work in connection therewith had practically ceased. It was impossible to obtain the necessary materials, and even if they could make the cables, in most cases it would be almost out of the question to get them to their destination. They recognised that when the war ended a great deal of work would be required to win back to this country the trade which had been lost through the necessary closing down of many old connections. Although the success of the company in the past had been considerable, it was probable that they would have much larger and greater work to do in the future, when the new England which would arise after the war began its business life. It was unquestionable that electricity would play a greater part in the daily life of man and a much greater part in the manufacturing life of the country than hitherto, and Callender's would not be behind in obtaining a share of the orders that would result.

The resolution was unanimously adopted. Mr. A. W. Tait was re-elected to the board and Messrs. Worley & Sons were reappointed auditors.

Electric Construction Co. (Ltd.)

The twenty-fourth annual general meeting was held on May 31, Mr. P. E. BEACHCROFT (chairman of the company) presiding. In moving the adoption of the report and accounts, he said that the gross profit from manufacturing and contracting was £103,000, compared with £88,500 in 1915-16, and the net profit £51,500 against £43,200. The increase in net profit was about 20 per cent., which, having regard to constantly increasing prices of all materials and higher rates of wages, must be regarded as very satisfactory. Increases in wages were regulated by the Ministry of Munitions, and were generally put into operation with only short notice, but under existing conditions, he supposed that was unavoidable. As no corresponding increase, however, could be obtained on current contracts, they would realise how difficult it was nowadays to frame accurate estimates. For example, on April 1 an increase of 5s. per week was granted to all workmen and a war bonus of 10 per cent. to the weekly staff. The work in progress on March 31 (which was greatly in excess of any previous year) would have to bear the full increase, and the estimated profit accruing for the new financial year would be somewhat reduced. It was to be hoped, therefore, that if and when further increases were granted, some opportunity would be afforded employers of completing current contracts on the old basis or of being granted an increase in prices by Government departments on such contracts. For their improved results they were again indebted to a larger turnover. That having been obtained from substantially the same equipment as in pre-war times, they would realise that very special exertions had been made by both their staff and workmen, for which they could not be too highly commended. He was proud to say that the recent unrest in the engineering trade was non-existent in their shops, and that their interest in the welfare of the men had been reciprocated by loyal and unremitting efforts on their part. The directors recommended payment of the final dividend on the preference shares, and a dividend at the rate of 7½ per cent. per annum on the ordinary shares, the transfer to general reserve fund of £12,389, leaving to be carried forward £31,442, subject to liabilities under the Finance Acts for two years. He concurred in the views expressed by many chairmen of public companies on the danger of appropriating so large a proportion of excess profits. The simplicity of the tax was of itself, of course, a great temptation, and to get as much as possible out of the taxpayer was presumed to be the duty of those who administered the Acts. Moreover, no corresponding duty had been imposed by Germany, where large sums were being accumulated by manufacturers which would be utilised in capturing neutral markets. It was apparent that if any great expansion was to be made in the trade of this country there must be a corresponding accumulation of capital, but how that was to be accomplished with so large a proportion of profits taxed at the source it was difficult to see. After explaining the various items in the balance-sheet, the chairman said their position gathered strength year by year, and he saw no reason why that should not continue. Much of their success was due to the amicable relations which had existed between the workpeople and themselves. They had endeavoured in every reasonable way to do what they could to contribute to their well-being and comfort, and many of the recommendations made by the Ministry had been in operation at Bushbury for some years. They had provided up-to-date recreation rooms and ground for tennis and bowls, and such facilities, he considered, were essential for the health and well-being of employees of all industrial concerns. Their clubs were managed and controlled by the employees themselves, and were almost entirely self-supporting. The future of our industrial development after the war was occupying the minds of all who had the welfare of the country at heart, and legislation must take account of future generations. The proper education and training of the young to take their part in that development were all important, and technical school training should be compulsory. Wolverhampton, where their works were situated, had recognised its duty in that matter, and had provided excellent classes. The company had for many years encouraged its boys to attend those technical classes, and successful students had been awarded prizes and had been given promotion in the workshops. They had reintroduced the system of indentures, under which they hoped to turn out journeymen possessed of a greater degree of skill and knowledge of their trade, and in other respects the directors were doing what they could to encourage and help the boys. He would like to see it made compulsory for factory boys to attend classes until 18 years of age, and compulsory upon employers to give boys those facilities during business hours. That might somewhat disarrange the routine of workshops, but it would only be temporary. Their improved position was due, as he had stated, to the unremitting efforts of the staff and all employees of the company. Their managing director (Mr. Gray) and their joint director and secretary (Mr. Willock) knew well their appreciation of their efforts, and the past year had strained them to the utmost limit. Mr. Furniss, their manager at the works, had more than justified his appointment, and all those under him had loyally co-operated.

Mr. JAMES GRAY seconded the motion, which was carried unanimously. Sir Jas. Pender, Bart., was re-elected a director, and Messrs. Jas. Meston & Co. re-appointed auditors.

ANCHOR CABLE CO. (LTD.)—The accounts for 1916 show that the profit, after providing for excess-profits control taxation, and including £44,023 brought forward, amounted to £105,158, compared with £79,380 in 1915. After writing £23,000 off for depreciation on buildings, plant, &c., the directors recommend a dividend of 20 per cent., the same as for the previous year, leaving £66,908 to be carried forward.

BANBURY & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The report for 1916 states that the total capital expenditure is £33,219. The total revenue was £4,863, and working expenses were £3,290, leaving £1,573. After providing £324 for interest on debenture stock, and adding interest received (£73) and £303 brought forward from 1915, the balance is £1,624. A sum of £600 has been added to renewals fund, and £114 to sinking fund for redemption of debentures and dividend of 2½ per cent. on the ordinary shares absorbs £625, leaving £285 to be carried forward.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO. (LTD.).—The dividend received from the Brisbane Tramways Co. in 1916 amounted to

Digitized by Google

£94,936, and with sundry receipts and amount brought forward (£12,081), less charges in London and Brisbane, the total available is £101,792. The directors recommend that a balance dividend of 4s. per share (tax free) be paid on the ordinary shares, making a total dividend for the year of 8 per cent. (tax free), and that £23,567 be carried forward.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The gross profit for year ended March 31 amounts to £226,744. 15s. 11d., compared with £244,064. 19s. 9d. for 1915-16. After deducting general expenses and amount written off sundry assets (£26,772. 16s. 11d.) there remains £199,971. 19s., which added to amount brought forward (£86,428. 4s. 5d.) gives a total of £286,400. 3s. 5d.; deducting debenture stock interest (£91,249. 5s. 4d.), there remains a balance of £191,150. 18s. 1d. The directors recommend that £15,000 be placed to reserve, that a dividend of 6 per cent. be paid for the year upon the cumulative participating preference stock (on account of which £21,382. 6s. 7d. has already been paid), amounting to £42,764. 13s. 1d. and a dividend of 3 per cent. for the year upon the ordinary stock (£39,787. 18s. 1d.), leaving to be carried forward £97,598 6s. 11d. The aggregate receipts of the tramway, omnibus and electricity supply companies in which the company is interested showed an increase which was largely counterbalanced by the continued increase in the wages paid and the cost of all material. Many of the companies have increased the amounts placed to their renewal accounts and reserves, and while their financial position has been thereby improved, the dividends distributed have been less than they would otherwise have been. The increase in the receipts has consequently not been reflected in the company's revenue from investments, and the net profit shows a reduction of £9,197. 5s. 11d. compared with the previous year. The amount standing to the credit of reserve account at March 31, 1916, was £410,000 and it is proposed to increase this amount by £15,000. The investments now stand at £4,285,578. 17s. 9d., and yielded a revenue of £205,258, representing an average of 4·79 per cent. for the last year.

DELHI ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The gross receipts from the tramway undertaking during 1916 were £11,135 and from the electric supply undertaking (including £2,853. 12s. 5d. current sold to tramways) £22,934, these figures representing increases of 16 and 13½ per cent. respectively over the figures for 1915. The combined undertakings show a net revenue of £11,593, against £10,300 in 1915 and £8,163 in 1914. After charging general expenditure in London and Delhi, debenture and loan interest, Indian income tax and depreciation of plant, &c., the profit was £3,194 and with £895 brought forward, the total available is £4,089, of which there has been transferred to renewals reserve account £1,000, and the directors recommend payment of a dividend upon the preferred share capital at the rate of 2 per cent. (less tax), leaving to be carried forward £1,089. The whole of the plant and equipment has been overhauled during the year, and the expenditure under this head (except special renewals, amounting to £668. 5s. 11d.) has been charged to revenue. Additions to plant made during the year amount to £1,855. 17s. The load upon the station and the lack of adequate spare plant to ensure proper overhaul rendered the installation of further plant imperative. A contract for a third Diesel engine has been entered into, but as it was impossible to obtain the necessary priority classification for a new dynamo, arrangements have been made locally for the temporary use of an old machine.

DOULTON & CO. (LTD.)—The report for 1916 states that after providing for debenture interest and including balance brought forward, there remains at credit of revenue account £61,052. The directors have already paid the preference share dividend, leaving £43,552, which the directors recommend should be carried forward.

ELECTRO-BLEACH & BY-PRODUCTS (LTD.)—Mr. E. G. Cubitt, who presided over the annual meeting on Friday last, said that the accounts had been audited and were believed to be entirely in order, but the company had been unable to secure the necessary sanction of the Ministry of Munitions to deal with them. It was, therefore, impossible to present their balance-sheet, and therefore the meeting would have to be adjourned. There was one thing, however, which he was sure the shareholders would like to know, and that was they were quite warranted in paying the interim dividend which the shareholders had already received.

GREAT NORTHERN TELEGRAPH CO.—At the recent general meeting at Copenhagen it was stated that 10 of the company's European cables had been broken 15 times, while the East Asiatic cables had been broken 29 times. Owing to the war it had been found impossible to restore the connection between Russia and Denmark. The war had caused great difficulties for the company, as most of the cables ran through the blockade zones and the minefield, and for that reason it was impossible to repair a number of the cables. A dividend of 24 per cent. was declared.

LONDON & SUBURBAN TRACTION CO. (LTD.)—The revenue for 1916 consisting almost entirely of dividends and interest receivable from the subsidiary companies, amounted to £120,586, compared with £122,430 for the previous year. After deducting all expenses chargeable to revenue, including debenture and loan interest, and providing for sinking fund charges upon the 5 per cent. debenture stock, there remains £81,374, making, with £3,483 brought forward, a total of £84,857 available for dividends. There has already been paid the full dividend upon the 5 per cent. cumulative preference shares, leaving £4,684, which the directors propose to carry forward. During the year £12,385 5 per cent. debenture stock was purchased and cancelled. The continuance of the war has adversely affected all the subsidiary companies, owing to the large increase in the cost of labour and materials, but in the case of some of the companies the increased cost of operation has been largely met by an expansion of revenue. The directors regret that the working profits of the London United Tramways (Ltd.) for the past year, after allowing for the balance brought forward from 1915, were insufficient by £2,583. 9s. 3d. to meet its revenue liabilities, and since the commencement of 1917 it has become evident that the net results for the current period will be even less favourable. In these circumstances, and in view of the fact that a large sum will be required to put the undertaking into a proper condition of repair, a re-organisation of the capital of the company appears unavoidable. Pending the formulation of a scheme for this purpose proceedings have been commenced by a debenture stockholder for the appointment of a receiver of that company's undertaking.

LONDON UNITED TRAMWAYS (LTD.)—The gross receipts for 1916 amounted to £336,335, an increase of £2,190 compared with 1915, but the directors regret that, owing to increase in cost of material and labour, the expenses have increased by £34,010. After adding balance brought forward and deducting interest and all expenses chargeable to revenue, there is an adverse balance of £2,583 to be carried forward. It has now become evident that the net results of operation in the current year will be even less favourable. In these circumstances and in view of the fact that a large sum of money will be required for placing the undertaking in a proper condition of repair, proceedings have been commenced by a debenture stockholder for the appiontment of a receiver pending the preparation of a scheme for the re-organisation of the company's capital. As a result of further negotiations between the directors and the London County Council, the litigation arising out of the arbitrator's award in the matter of the purchase of the company's tramways in Hammersmith, which form part of the security for the 4 per cent. first mortgage debenture stock, has been settled (the terms of settlement have already appeared in these columns). In consequence of his appointment as President of the Board of Trade, Sir Albert H. Stanley has resigned his position as a director of the company and Mr. W. C. Burton has been appointed to the vacancy on the Board, while Mr. H. A. Vernet has been appointed an additional director.

METROPOLITAN ELECTRIC TRAMWAYS (LTD.)—The revenue for 1916 amounted to £558,866. After adding balance from 1915 and deducting expenses chargeable to revenue, including £22,158 for future reconstruction and renewals, the available balance is £37,796. The directors recommend that £10,015 be placed to reserve account and £25,000 be appropriated to dividend on preference shares, leaving to be carried forward £1,781. During the year the company purchased and cancelled £12,264 4½ per cent. and £4,404 5 per cent. debenture stock. The traffic receipts, after adjustment of accounts with the London County Council in regard to through running services, amounted to £504,338. 3s. 5d., an increase of £43,515 over 1915, but the directors regret that this increase is more than swallowed up by the increase in working expenses due to the higher cost of both labour and materials. The number of units sold by the North Metropolitan Electric Power Supply Co. amounted to 53,352,819, compared with 39,457,712 in the previous year, the increased output being mainly due to the larger supply given to power users. As a result of the abnormal cost of fuel, the gross profits of the Power Co. show a decrease of £4,080. 12s. 9d., compared with 1915.

NORTHERN COUNTIES ELECTRICITY CO. (LTD.)—The accounts for 1916 show that after providing for interest charges the profit is £837, reducing the debit balance brought forward to £5,815.

RHONDDA TRAMWAYS CO. (LTD.)—Mr. L. B. Schlesinger, who presided over the annual meeting last week, said that the balance to credit of the revenue account for 1916 was £26,883. After deducting rent to Rhondda Council, debenture interest, war bonus, &c., the balance was £8,305. The directors recommended that £2,500 be placed to reserve and renewals account, and that £3,804 be carried forward.

SOUTH WALES TRANSPORT CO. (LTD.)—The capital expenditure during 1916 amounted to £4,712, of which £2,024 was on vehicles and general account. Net receipts were £9,106, and after deducting expenses, £1,029 for mortgage and other interest, and providing £5,000 for renewals and depreciation, the balance was £389, making, with £1,319 brought forward, £1,709, which has been carried forward. The company's operation suffered from the increasing cost and shortage of materials and services of all kinds, and the directors regret that they are unable to recommend a dividend for the year.

STRATFORD-ON-AVON ELECTRICITY CO. (LTD.)—At the recent meeting the chairman (Mr. W. H. Jackson) said that they had made some progress during the past year, the units sold having increased by 8,238. The lighting units showed a decrease of 13,000, but power units increased by 13,000 and heating by 8,000. They regretted they could not recommend a dividend, as they had had to put money to depreciation. They must be prepared for heavy expenditure in the early future for mains renewals and battery extension.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—The gross earnings of the company for the year 1916 amounted to £709,226, whilst the gross maintenance and other charges in Argentina and London were £477,371, leaving a profit of £231,855. Deducting interest on debenture stock and dividend on the preference shares to Dec. 31, 1916, and the interim dividend on the ordinary shares (£72,100) and adding amount brought forward from previous year (£6,234), there remains an available balance of £165,990. The directors recommend payment of a final dividend of 5s. per share on the ordinary share capital, making, with the interim dividend paid on Nov. 1 last, a return of 8 per cent. for the year, tax free (£81,000), the appropriation of £2,000 to staff provident fund, £50,000 to reserve fund and £26,000 to reserve (War contingencies) fund, leaving to be carried forward £6,990. To fill the vacancies created by the death of Sir Geo. Franklin and of Mr. Geo. Keith the board announce that Sir John Gavey has accepted the position of chairman of the company, and that Mr. J. E. Kingsbury and Mr. Albert Anns have been elected as directors.

Digitized by Google

THE ROUND TABLE.

By "KVA."

THIS WEEK'S CHESTNUT.—A representative of a firm of electrical accessories manufacturers called on a clerk of the works, who was also advising on the wiring installation. "Now, sir," said he, "about lamp-holders. What do you think? Some of our cord-grip B.C. type——" "B.C. type? Certainly not," cried the C.O.W. "I've had enough antiquated stuff put up to me on this job. I'll have an A.D. type or nothing!"

* * * *

Mr. A. Joseph, who rejoices in the occupation of scrap metal merchant, has sent me a copy of the adjoining sketch, which is cleverly fashioned out of the numerous scrap articles in which he deals. I think the lady looks too formidable to

"scrap" with, but it is noticeable that there is nothing electrical about her except wire. I wonder what a figure "gotten up" out of, say, scrap installation material or scrap turbines would look like. There's room here for artistic ingenuity. An ELECTRICAN Hot Plate for the best attempt.

* * * *

At the starting of a new 5,000 kw. set at Keighley Corporation electricity works the units in the works were "christened" by various members of the Electricity Committee. (I see that the ceremony included breaking a bottle of wine over each baby, I am sure much to the chagrin of the drivers and stokers.) The proceedings are reported in the "Yorkshire Post," but the item which takes my fancy is the following :—

"Mr. W. A. Brigg expressed his satisfaction that the name of his uncle, Mr. B. S. Brigg, would also go down to posterity through the medium of the set bearing the name of 'Brigg,' because he was for many years a member of the Gas Committee."

I congratulate Mr. B. S. Brigg upon this happy method of recording his "conversion."

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, June 5, 1880.]

ACCIDENT AT LYONS.—A workman met with an extraordinary death at Lyons last week. Having to unfix a wire conducting the electric current for a lighting apparatus he incautiously handled it without non-conducting india rubber gloves. The current knocked him down insensible, and notwithstanding every medical help he never recovered consciousness.

WAS IT WIND OR LIGHTNING?—A suit has been brought in the Circuit Court at Madison, Wisconsin, to collect from an insurance company for damages done by the great storm of 1878. The property was insured against lightning, and the company resist payment on the ground that it was destroyed by wind. The plaintiff hopes to prove by the evidence of members of the Signal Corps that the whirlwind which destroyed his house was of electrical origin. A vast amount of insurance is likely to be effected by the decision of this case, owing to the heavy losses of property during the recent whirlwinds.

POLO BY THE ELECTRIC LIGHT.—A polo match was played at the Ranelagh Club Grounds, Fulham, between members of the Hurlingham and Ranelagh clubs on Saturday night, when the ground was illuminated by the electric light. Three high stands had been erected, and operators with concave reflectors turned the rays of light upon the players as they galloped about the field. The effect as a spectacle was exceedingly picturesque. Hurlingham took the ball through their opponents' goal three times, and lost but one goal on their side. After the match there was an illumination of the grounds and a display of fireworks by Messrs. C. T. Brock & Co. Serrins light was used.

Postal and Telegraph Services.—In the House of Commons on Tuesday, the Postmaster-General (Mr. A. Illingworth) made his annual statement on the postal and telegraph services.

He said that up to the end of last month 75,000 men had passed from the service of the Post Office into the Army. Some telegraphists and engineers could not be released because their work in this country was necessary in order to maintain communication with the Forces. He regretted that 3,829 of the men had been killed.

During the year the gross revenue of the Post Office was £34,100,000, an increase of £440,000 over the preceding year. The expenditure was £31,780,000, or £1,545,000 more than in 1915-16, and £7,500,000 more than in 1913-14. The net revenue was £2,320,0000, compared with £4,430,000 in 1915-16 and £6,655,000 in 1913-14. An enormous amount of work was done for other departments for which the Post Office had not been paid. As to the telephones, the estimated additional revenue from the alteration of the flat rate was £280,000. The actual additional revenue for 1916-17 only amounted, however, to £120,000. He thought it likely that by the end of this year the revenue from that source would amount to £230,000. The actual additional revenue from increased trunk fees for 1916-17 had reached the much more satisfactory total of £220,000. Capital expenditure had been kept down as much as possible. The London capital expenditure for 1915-16 was £370,000, and for 1916-17 £93,000. In the provinces in 1915-16 the expenditure was £882,000, and in 1916-17 £196,000. The number of paid telegrams was still declining. They were 16 per cent. lower in number in 1916-17 than in 1913-14, and 13 per cent. lower than in 1915-16. The ordinary traffic had fallen from 72,199,000 in 1914-15 to 54,249,000 in 1916-17. The number of Government telegrams dispatched free in 1913-14, before the war, was 617,000, and in 1916-17 8,012,000. The net receipts, however, were only £50,000 less than last year, and more than £300,000 over the receipts of 1913, as an increase had been made in charges for telegrams.

After giving interesting particulars of the interesting work done by the Department for the Army, prisoners of war and interned civilians, Mr. Illingworth said that not many innovations had been made during the year, but a very important one was the alteration in the form of the London address by the addition of a number to the letters denoting the postal district. At present 40 per cent. of the letters were addressed in this way, resulting in a saving of £4,000 per annum. He hoped the public would address their letters in the new way, and so simplify the work for the Post Office staff and ensure a much better delivery of letters. A large addition had been made to the work of the Post Office during the war by the payment of Army and Navy allowances and pensions. Owing to the increased cost of living, a revised scale of increased wages, including the existing bonuses, had been granted.

"IGRANIC"

SELF-ACTING STARTERS

No. 110.

"Z" type Starter for small motors. Butt contacts are self cleaning.

are amply rated and thoroughly reliable.

Self-Starter with interlocked magnetic circuit breaker.

No. 115.

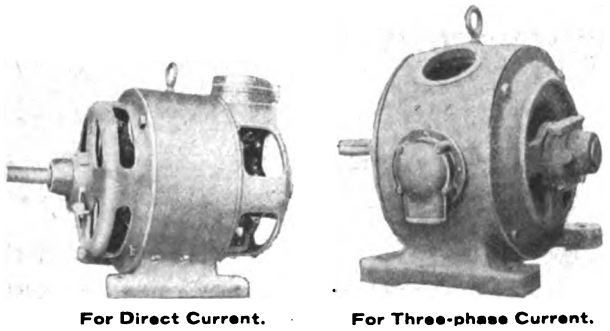
IGRANIC ELECTRIC Co LTD 147, Queen Victoria Street, London.

Digitized by Google

SIEMENS

STANDARD

ELECTRIC MOTORS



For Direct Current. For Three-phase Current.

for

ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."

HOME BRANCH ADDRESSES:

BIRMINGHAM—Central Ho., New St.
BRISTOL—30, Bridge Street.
CARDIFF—99, St. Mary Street.
GLASGOW—66, Waterloo Street.
MANCHESTER—196, Deansgate.
NEWCASTLE—64-68, Collingwood
SHEFFIELD—22, High St. [Bldgs.
SOUTHAMPTON—46, High Street.

Branches in Principal Towns Abroad.

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite—Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1912 to 1917.

ATTWATER & SONS,

Telegrams: Attwaters, Preston.
Telephone No. 1048 (2 lines).

Hopwood St. Mills, PRESTON.

Established 1868.
Codes: 5th Edition A B C & Western Union.

AUTOMATIC TRAIN CONTROL.

The report of the Inter-State Commerce Commission (U.S.A.) for the year ended June 30 last includes the report of the Division of Safety, and is abstracted in the "Railway Gazette" for May 25.

During the year three automatic train control devices were tested. The B. F. Wooding system was installed on the Delaware, Lackawanna & Western Railroad. The tests disclosed certain defects in the apparatus, and parts of the system were rebuilt, but a conclusive report could not be made until tests had been conducted under winter conditions.

The tests of the Gollos system (on the Chicago, Burlington & Quincy Railroad) disclosed defects of construction and arrangement; certain portions were rebuilt, but the system cannot be recommended in its revised form. The tests made under ice and snow conditions were not conclusive and no opinion could be expressed of the method employed of making electrical contact between the track and engine apparatus.

Preliminary trials were made of the system of the National Safety Appliance Co., which is of the electromagnetic inductive type. The apparatus comprises electro-magnets located on the track, with corresponding secondary or receiving coils on the engine, one each for "clear," "caution" and "danger" cab-signal indications and one for the control of an air brake valve magnet. There are from one to four of these track coils at each place; they are momentarily energised, as a train passes over them, for the display of the proper cab-signal indication or the operation of the brake valve, being controlled by a system of track and line circuits. The brake valve magnet is normally energised by a local engine circuit, the effect of which is counteracted by the induced current picked up from an energised stop-track coil. Special circuits are provided to protect against trouble from certain causes. An installation was made on the Western Pacific Railroad near Oroville, and demonstrations in May, 1916 disclosed that the apparatus was not then entirely suitable for testing the principles embodied in the system, and the proprietors undertook some further development work which was in progress at the close of the year.

Other devices were submitted, but have not yet been tested. The automatic train-control system of the Julian-Beggs Signal Co., which is of the intermittent electric control type, will be tested this year. The roadside apparatus consists of circuit controllers operated by the signals, a battery and a ramp or contact rail. The engine apparatus consists of contact shoes adapted to be raised vertically, upon making contact with the ramp, for breaking a normally closed circuit on the locomotive for energising a locking coil of a three-position instrument. This instrument is a special form of relay, having a field coil which is constantly energised from the engine battery, and an armature coil which is energised only by current from the ramps, the direction of flow of current from the ramp being controlled by the position of the signals. The locking coil holds the armature in any position in which it is set. The armature carries contacts controlling the circuits for a brake valve and cab-signal lamps. The system also includes a speed recorder supplied with sliding electric contacts in the speed control circuits.

An automatic train-control system by the Sprague Safety Control & Signal Co. of the induction type employs a permanent electro-magnet for transmitting an impulse to a passing train. The effect of this permanent magnet is counteracted or neutralised by an electro-magnet, the circuit for energising which is controlled by the signals. Speed control features and cab-signals are provided.

An automatic train-control device submitted by Mr. A. Y. Dodge is of the intermittent electrical contact type, consisting of an automatic train-stopping device, speed control features and cab-signals.

An automatic train control device presented by the Macfarlane Train-Control & Signal Co. depends for its operation upon a track circuit of comparatively high amperage, and an electromagnetic receiving device of low resistance, mounted on the engine cab-signals and speed control apparatus are provided.

The report states that the past year has been marked by some practical development in automatic train-control systems. A device of this character is being installed on the lines of the Brooklyn Rapid Transit Co. Regarding the newer devices which have been considered, however, while the plans of several of them have been designed upon theoretically correct principles, in only a few cases has the apparatus actually been built, and in the tests which have been made the construction employed has not been such as to result in entirely successful operation. A considerable number of the devices of the intermittent electrical contact type, which have been presented, are substantially identical in the fundamental arrangement of circuits and apparatus. In addition to the experiments of the National Safety Appliance Co., other train-control systems of the wireless and induction types are being developed.

TEES STEEL WORKS DEVELOPMENT.

The Tees Conservancy Commissioners have sanctioned the transfer of 21 acres of land at Portrack, Stockton, to the East Coast Steel Corporation for the erection of blast furnaces, steelworks and an extensive shipyard. The company is a new one, and it proposes to commence work on their project this year. It is said that it will involve the expenditure of about $3,000,000. A syndicate of northern ironmasters is promoting the new undertaking.

Digitized by Google

The Senior Service

NAVAL MEN are proud that theirs is the Senior Service; and we are proud that Simplex Service is the Senior Service in the Conduit and Fittings World.

Simplex Service has an honourable tradition, the outcome of early engineering initiative and constant vigilance. War conditions have not found us wanting, but have confirmed our prestige.

Every War Department: Admiralty, War Office, and Ministry of Munitions purchase Simplex Conduits, Fittings and Accessories when the best is required.

Simplex Conduits, Limited,

Works: Garrison Lane, Birmingham.

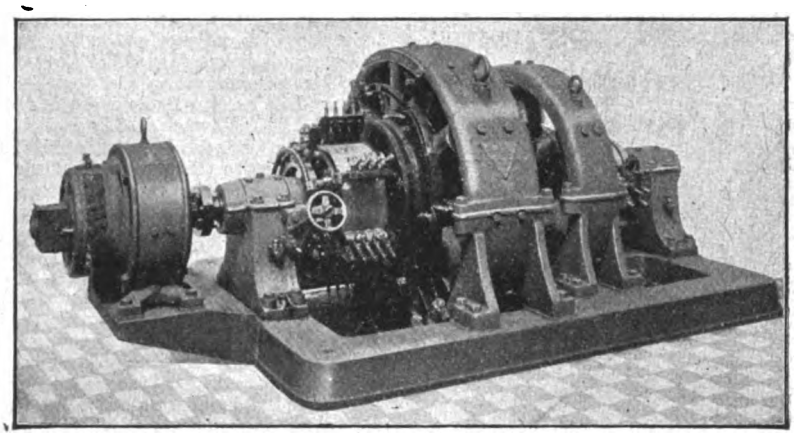
LONDON—113-7, Charing Cross Road.
NEWCASTLE—61-5, High Bridge.
LEEDS—6, White Horse Street.
MANCHESTER—16, Corporation Street.
SWANSEA—14, Heathfield Street.
BRISTOL—10-11, Denmark Street.
GLASGOW—72A, Waterloo Street.
CARDIFF—4, Westgate Street.
LIVERPOOL—96, Whitechapel.
SHEFFIELD—281-3, Attercliffe Common.

VICKERS LIMITED.

Motors and Generators of all types.

Rotary Converters.

Complete equipment for the electrical lighting and driving of Machine Shops, Factories, Mills, etc.



Patent Automatic Reversing Drive for Machine Tools.

250 K.V.A. Rotary Converter. 6 phase, 50 periods, 480/560 Volts. 1,000 r.p.m. Inverted type.

River Don Works, SHEFFIELD.

Digitized by Google

In consequence of our main attention being devoted to war requirements, we have for disposal, at greatly reduced prices, several pieces of

X-RAY & ELECTRO-MEDICAL APPARATUS

also

ELECTRIC HEATING AND COOKING APPLIANCES

including

HOT PLATES FOR LABORATORY USE

Full particulars on application.

ISENTHAL & CO., LTD.

(Department 4),

Denzil Works, Willesden, London, N.W.10.

Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, &c.

— THE —

ARORA

ELECTRIC

FIRE

Has given Universal satisfaction.

LOW PRICE, ROBUST, CHEERY, ECONOMICAL

NO ADVANCE IN PRICES.

DELIVERY FROM STOCK.

Write for LIST G (Fires and Cookers).

to Sole Manufacturers—

THE ARORA CO., LOUGHBOROUGH.

THE BRITISH TRADE CORPORATION.

The proposal for the creation of the British Trade Corporation has been submitted to considerable criticism, especially by financiers, merchants and exporters. Among recent critics is Mr. Robert Fleming, chairman of the Investment Trust Corporation.

At the recent meeting of the Corporation, Mr. Fleming said that a careful perusal of the report of Lord Faringdon's Committee did not leave on his mind a clear impression of certain benefit, and nothing but benefit, to result from the operations of the Corporation. Its scope seemed almost impossibly comprehensive, but the suggestion that "British Embassies and Legations abroad, all commercial attachés, consuls, trade commissioners in the Dominions, &c.," should be placed at the exclusive disposal of a concern that had only two manufacturers on its Board, could hardly have been intended. It was contended that our deposit banks do not provide sufficiently long credits for their customers to enable sales to be made in competition with Germany. That was a question for bankers. Many of those who were better informed maintained that in all cases where advances could be made on sound business principles no difficulty existed in obtaining them through accepting houses and other channels outside deposit banks. But if such was not the case he saw nothing illegitimate or even difficult in establishing an institution for the sole purpose of making such advances. But quite apart from granting longer credits in the way of regular business to help the sale of British goods, the committee were also appointed to enquire "particularly with reference to the financing of large overseas contracts by British firms." Clause 19 dealt with the formation of large foreign enterprises. The clause said that "foreign banks" formed syndicates to carry out big public works, or any business of considerable magnitude, and suggested that "some such procedure should be followed here." But the same end was accomplished if the means employed here were somewhat different. A recent republication of articles appearing in the "Frankfurter Zeitung," under the heading of "England's Financial Supremacy," pointed out that, "since 1895 some 95 per cent. of the available German capital had been invested in home industry and in particular in agriculture," while in England it had mostly gone abroad. In other words, in many cases the Germans sold the goods and we paid for them by taking the securities. Excluding political adventures in the Near East, such as the Bagdad Railway and the lighting system of Buenos Ayres, which we delivered into their hands by a sale to them of the British-owned tramway systems of that city, he could recall no large public enterprise in a foreign country during the last 20 years financed by Germany, except the case of the first issue of the bonds of the Victoria Falls and Transvaal Power Co. In that case, in 1908 to 1910, the A. E. G. of Berlin did the work and took pay in £3,000,000 5 per cent. first mortgage bonds. Subsequent issues of securities of the same company were placed in London, but the bulk of the engineering work, as before, went to Berlin. On the other hand, during those 20 years the immense system of railways all over the world belonging to British companies was added to and equipped to a great extent. It was through the possession of those big public concerns that our home trade received continued support. In the East, the electric tramways, light and power undertakings of Calcutta, Shanghai, Hong Kong and Singapore had been built or electrified. Anglo-African financiers had done the same with Cape Town, Lisbon and Santiago. Lord Cowdrays firm's enterprise had been multiform. Lord Faringdon's firm had headed the work of tramway, light, power, telephone and gas construction in Pernambuco. Various trust company groups had done the same in the colonies and South America, mainly through Anglo-American engineers. He referred to Montevideo, Buenos Ayres, Cordoba, Santa Fé, Para, Caracas, Manaos, Bombay, Fremantle and Melbourne. Probably the investment trust companies, with their aggregate paid-up capital of over £100,000,000, had done more than any other to help those new formations, and the suggestion of Sir George Touche, made the other day, for some unity of action by them was worth consideration. The elements of construction of all those were mostly obtained in this country. The Dr. Pearson group had done similar big construction in Mexico, Rio de Janeiro, San Paulo and other places. Of those securities no less than £51,000,000 was publicly dealt in on the London Stock Exchange, and England provided probably half the money, but the amount of trade they brought to this country in their construction was paltry. If we could make these things as well and as cheaply as others, and he believed we could—and that was really the vital thing that would control the destination of oversea contracts—why could not we enact a simple law which required that any industrial concern to have its shares and bonds publicly issued here or quoted on our Stock Exchanges must give its orders for construction and maintenance, if they could be placed as advantageously, to British manufacturers? Partly with the view of testing the all-important question of comparative cheapness, some of them in 1904 bought up the principal tramways of Montevideo. In acquiring control—thanks to local influence—they just got ahead of the Germans. The antiquated and worn-out mule tramways were reconstructed into a really first-class electric system, then of 80 miles, and now extended to 90 miles. They said: "We will buy in the lowest market, but, on equal terms, give a preference to British goods." On the 80 miles they spent about £800,000. Except the rails, which they bought cheaper from the United States, and a trifling item or two from Belgium and Germany, all the materials were British. The engines came from Birmingham, the boilers and power-house piping from Glasgow, the economiser from Wakefield, the generators from Edinburgh, the condensers from Bradford, the power-station crane from Manchester, the power-house and car shed steel work from Liverpool and the rolling stock from Preston. The

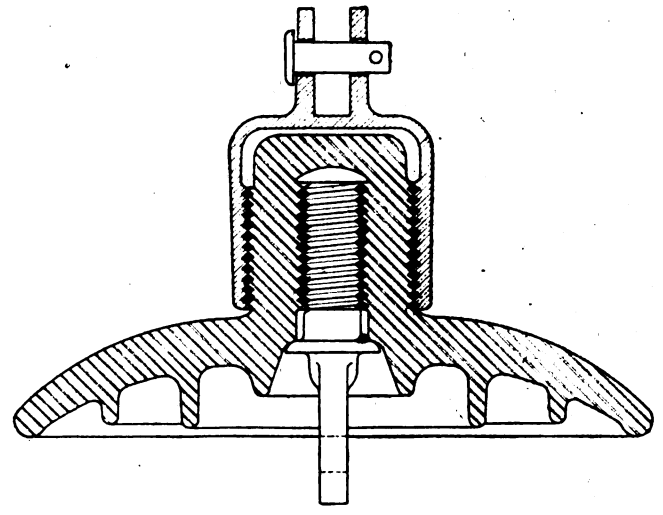
Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

PRESCOT

HIGH-TENSION INSULATORS.



No more troubles due to unequal co-efficients of expansion.

A wide-spread difficulty cleared away by our patent method of attachment (Patent No. 5341/16) without in any way sacrificing mechanical or electrical efficiency.

We show the method as applied to a suspension insulator, but it is equally applicable to stalk insulators.

We welcome enquiries from those interested.

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED **SECOND HAND**

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.

Phone: Victoria 4026 Grams: Vicmaster, Sowest London

For Effective Impregnation use "LACWATT"

Black or Golden Brown.

JENSON & NICHOLSON, Ltd., Insulating Varnish Department, Goswell Works, Stratford, E.15.

Digitized by Google

MASTER

BATTERIES FLASHLIGHTS

MASTER
Tungsten - Light Batteries:
Guaranteed to satisfy.
Give brightest light and longest life.
Will not corrode or leak on shelf.

PERFECTION
Best describes MASTER Flashlights:
Novel and unique in design.
Handsomely finished.
Carefully constructed of durable materials.

Investigate the MASTER line of Batteries and Flashlights—a Product with a Profit. Direct importations from the U.S. or deliveries from our complete London stock.

Request catalogue and quotations for full business, with guaranteed deliveries.

THE RIVER PLATE COMMERCIAL COMPANY
EXPORT ORDER DEPARTMENT,
UNITED BATTERY CORPORATION,
MANSION HOUSE — 15, GEORGE ST. — LONDON, E.C.

FOR
High and Low Tension
SWITCHGEAR
THE
NEW SWITCHGEAR CONSTRUCTION CO., Ltd.
SUTTON, SURREY, ENGLAND.
ABC Code 5th Edition. Telephone: Sutton 773.

E. SHOWELL & SONS, LTD.
STIRCHLEY, BIRMINGHAM.
Cast
Cable Sockets.
Suite K74. Made in all Sizes.
Type A.—Straight.
„ B.—Offset.
„ C.—Right angle.
Illustrated Dimensioned Showcard for Drawing Office use supplied free on application.
Sole Agent for the Electrical Trade:—
LIONEL ROBINSON, 3, Staple Inn, London, W.C.
TELEPHONE: Holborn 6323.

Germans bought some less important lines in Montevideo and the materials were, of course, made in Germany. He was safe in saying that to-day in point of construction of track, power-house and rolling stock, and popularity with the Montevideans, the British lines were much ahead of the German, and the investment had been a very satisfactory one, though at present they suffered from dear coal. The other clauses of the report of Lord Faringdon's Committee were also criticised.

ELECTRICITY IN COLLIERIES.

The Niddrie & Benhar Coal Co., Ltd., Niddrie, Scotland, have recently been compelled to carry out extensions of their electric power installation at their Newcraighall collieries. The extensions were rendered necessary in consequence of the large quantity of water to be pumped and the necessity for making additional provision for colliery power requirements. A 1,000 kw. mixed pressure turbo-generator equipment is to be put down.

The turbine will be made by Messrs. Willans & Robinson, of Rugby, and the alternator by the General Electric Co., of Witton. The condensing and cooling plant will be of the multijet ejector type by Messrs. S. Bullock & Co., of London, and the circulating water is re-cooled by means of spray nozzles manufactured by this firm. The main switchboard will be made by Messrs. Brash & Russell (Glasgow), who are also contractors for an overhead power line equipment which will connect Newcraighall colliery with the Niddrie and Woolmet collieries. The electrical system is alternating-current at a pressure of 3,000 volts, 50 cycles, and the exhaust steam from the main winding and other surface engines is used in the low-pressure part of the mixed-pressure turbine for generating purposes. This is supplemented by "live" steam as required. The consulting engineers are Messrs. D. Selby Bigge & Co.

FRENCH BAUXITE.

In the last issue of "The Times" Trade Supplement there is a short article on French bauxite mines. Several sales have recently been effected to a Norwegian company.

Previous to the war the Germans were practically masters of the industry, having an intimate knowledge of the extent and value of every deposit throughout the district. The contributor thinks it would be better to treat the ore on the spot, as a great economy would be experienced in cartage. Sites abound suitable for the erection of works, and there exists in the neighbourhood an abundance of water, still unharnessed, capable of providing the necessary power required by the electrolytic plant for refining the ore. Cables already supply current for lighting the outlying villages. The question of labour would be more readily solved there than elsewhere, as, owing to its vicinity to Italy, plenty of Italian labourers would be available.

PATENTS IN INDIA.

The Government of India has issued a memorandum to the local governments and administrations, dealing with proposed changes in the trade policy of the country after the war.

Under the Indian Patents and Designs (Temporary Rules) Act of 1915 the Controller of Patents and Designs has full power to avoid or suspend patents or designs held or registered by or for the benefit of enemy subjects, to grant licenses to persons other than such subjects to make, sell or use the patented invention or registered design so avoided or suspended and to extend the times prescribed by the main Act (Act II. of 1911). The temporary Rules will be in force for six months after the war is over, and when these Rules cease to be applicable there will be a reversion to the conditions under the main Act. If a patentee has been unable to work his patent he may ask for a special concession by way of (*a*) reduced, or remitted renewal fees and (*b*) extension of the term of his patent. As regards both these cases sufficient powers exist under sections 57, 77 and 15 of the main Act.

Electrical Engineers and Manufacturers
The House for Electric Heating.
Telephone: Gerrard 7601 (2 lines)
Special Offer of "Quead" and "Ensign" Fires from Stock.
Be Patriotic and Save Coal.
Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.

Petrol-Engine Sets.
F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON
Manufactured in sizes from 2 kw. to 20 kw.
Quotation for larger sizes on application.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,039. [Vol. LXXIX. No. 11.] FRIDAY, JUNE 15, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 417
Arrangements for the Week 419
Fuel and Power Supply. By E. W. L. Nicol, Assoc.I.E.E. Illus. 420
Some Tests on Coke Firing. Illustrated 422
Some Personal Experiences With Hand Firing of Coke. By J. A. Crowther 423
Grates for Coke Firing. Illustrated 424
Gas-Fired Boilers. By William B. Woodhouse 427
Coal Concreted from Ashes or Dusts. By R. Goulburn Lovell, A.R.I.B.A. 428
Association of Consulting Engineers 429
SOME FUEL PROBLEMS 430
Gas Burners for the Firing of Boilers. Illustrated 433
A Dual Method of Machine Firing by Coal and Gas. Illustrated .. 436
Coal Economy. By George Wilkinson 438
Volunteer Notices 438
COMMERCIAL AND INDUSTRIAL SECTION 441
Electricity Supply 442
Tenders Invited and Accepted 444
Financial Matters 444

NOTES.

The Concreting of Coal.

THE utilisation of waste coal has a certain fascination, which is due, no doubt, to the popular idea that a very great deal of coal is at present wasted and might be usefully employed. In this connection, however, it must be remembered that the advent of the mechanical stoker has altered the aspect of affairs very materially. Slack, and even coke breeze, can now be used for steam raising to an extent which at one time seemed quite improbable, and, therefore, the waste is reduced to coal dust and to certain low grades of coal which at present may not repay the cost of handling. Such coal dust and slack as is available is already used to some extent for briquetting. The usual methods, however, require special plant, and no doubt there is an opening for other simpler methods for this class of work. From this point of view the process outlined by Mr. R. G. LOVELL in his Paper before the Society of Architects may be welcomed. But we feel that Mr. LOVELL is not on very safe ground when he deals with the utilisation of ashes, except, perhaps, in so far as these may be obtained from the domestic grate. In that case, however, there is the difficulty of collection. In steam-raising plant the calorific value of the ashes is, no doubt, in many cases undesirably high, but we think this merely indicates defective methods. The percentage of combustible in the ash should not exceed 20 per cent., and may be considerably less. This view is borne out by tests which were published in THE ELECTRICIAN of January 19th last. It appears to us that steam raisers should improve their methods in preference to attempting to make an inferior fuel from ash. It is no doubt possible to make ash into a comparatively good fuel by mixing a considerable proportion of good coal dust therewith; but this method may be looked upon equally as the transformation of good coal dust into comparatively poor material by mixing with it a large proportion of incombustible material in the form of ash and a binder of some kind. So far as we can judge by the very meagre details given by Mr. LOVELL, there may be a future for this process if it is run on the right lines; but we fear that he is inclined to allow his enthusiasm to run away with his discretion. For example, to state that "all industrial concerns consuming more than 10 tons of coal per day can reduce their bill by at least one-third and also use up their accumulating waste products" is to invite distinct scepticism. Any such claim is altogether improbable, and would lead to the conclusion that such industrial concerns are at present guilty of extraordinary inefficiency.

Training in Technical Optics.

IT will be recalled that a few months ago we referred to the Report of the Committee appointed by the Board of Scientific Societies to inquire into the subject of Training in Optical Technology. The report was intended to meet the most urgent aspects of the problem, reserving more complete plans for later consideration. It, therefore, aimed at co-ordinating and extending the efforts that are already being made, a distinction being drawn between the requirements of a technical school for optical work and glass manufacture, and the more advanced courses at colleges and universities. We are interested to observe in "La Nature" particulars of a scheme in France. The proposal comprises (1) a college of optical training, (2) a central optical laboratory and (3) a special trade school. It is pointed out that optical technology enters into almost all fields of scientific work, and has an interest for engineers, photographers, medical men and many others, besides the manufacturers of optical goods. It is also suggested that a journal should be started to deal specifically with the subject. This is also much needed in the United Kingdom. Before any substantial progress can be expected the facilities for the dissemination of knowledge on optics must be extended, so as to resemble those instituted in the field of illumination. It is interesting to note how closely the necessities of the situation, as summarised in France, resemble those recognised to exist in this country. We hope that there will be constant interchange of experience, and that co-operation between optical enthusiasts, both in France and in England, will be initiated at an early stage.

Electricity v. Gas.

IT is not often that we find such a frank avowal as that made by Mr. J. D. KEILLOR in a Presidential Address to the Waverley Association of Gas Managers. Mr. KEILLOR admitted quite frankly that the competition of electricity at the present time is a serious matter for the gas industry, and he called upon his fellow members to apply such a driving force to the industry that their position would be "for ever assured." That, we fear, is an ideal which can never be reached. There is no such thing as an assured position for any industrial undertaking. The position can only be maintained if the steps that are taken are sufficiently progressive to maintain progress and to prevent stagnation. From this point of view there is no question that gas has been beneficial to electricity and electricity to gas, because each industry has provided a very necessary stimulus to the other. Mr. KEILLOR is evidently afraid that the action taken by the Board of Trade in regard to linking-up will place the electric supply industry in a much stronger position than hitherto—in fact, in a sort of national position, which will cause it to be a grave menace to the gas

Digitized by Google

industry; but he goes on to express the view that if such a scheme is possible with electricity it should not be impossible to attain similar results with gas, and that centralisation of gas production should not be preceded by centralisation of electric supply. The practicability of such measures from the point of view of gas we must leave to gas engineers; but we think we may be allowed to point out that the transmission of electricity is a far simpler operation than the transmission of gas, and as such it necessarily has far greater commercial possibilities. Be that as it may, electric supply engineers must not take it for granted that gas engineers will do nothing to meet their competition. They might, in fact, do worse than take occasional glances at the technical gas journals.

War Bonuses for Workmen.

DURING the past two and a half years war bonuses have been granted to the working man to enable him to meet the increased cost of living. In one case that we have in mind three bonuses, each of 5s. per week, have been awarded to the men, and a like number of half-crown bonuses have been awarded to the apprentices. This is one way to meet a somewhat complicated position, and it is no doubt the simplest; but we believe it is by no means the best. It should be clear that so long as there is no control of the prices of the necessities of life, this granting of war bonuses leads to a vicious circle. The bonuses are granted because the cost of living is high, and in due course the cost of living becomes still higher on account of the granting of bonuses. The Government should long ago have taken strong steps to stop the undue rise in the price of necessary commodities. It is to be hoped that some such step will be taken as the result of the recent appointment of Commissioners to inquire into the causes of labour unrest. In his address to these Commissioners last Wednesday the Prime Minister brought forward many points of importance. It appears to us that a real attempt is to be made to get at the bottom of the causes of such unrest, and any such inquiry properly conducted can only be beneficial. We are glad to note that "profiteering" is to be one of the matters to be investigated. We do not doubt that a great deal of unpatriotic money-making of this kind is being carried on at the present time, and if it is permitted to continue it must lead, and quite rightly, to a great deal of discontent. The sooner it is well understood that no section of the community may prey upon the remainder of the nation the better.

War Bonuses for Teachers.

REFERRING again to the question of bonuses, it is a distinct hardship that these should be granted to some classes and not to others. As an example, take the case of the teacher. Irrespective of grade, even in normal times, the teacher is badly paid. At the present time, owing partly to the parsimony of his employer, partly to the *laissez-faire* policy of the Board of Education, and partly to the peaceable nature of the teacher himself, his position is bordering on pauperism. It is no uncommon thing to find that after prolonged deliberation an education committee decides to grant a war bonus of 3s. per week, with a further allowance of a few coppers per week (9d. is a usual figure) for each child, if the teacher is a parent. This scheme applies only to those who, in normal times, are miserably underpaid. To those in receipt of more than three pounds per week, the bonus is not granted as a rule. In view of the important work which the teacher should perform, and which he would perform were he properly controlled, it is deplorable to find him absolutely at the mercy of local education committees, and trying to do his work with the millstone of financial worry around his neck.

Tramways & Light Railways Association.—The annual congress of this Association will be held on Friday, the 29th inst., at the Institution of Civil Engineers.

Royal Society of Edinburgh.—The Council have awarded the Makdougall-Brisbane prize to Dr. R. A. Houston for his series of Papers on "The Absorption of Light by Inorganic Salts."

Edison Medal Awarded to Nikola Tesla.—At the American Institution of Electrical Engineers on May 18, the Edison Medal was awarded to Mr. Nikola Tesla for "early original work in polyphase and high-frequency electric currents." Dr. A. E. Kenelly, chairman of the Edison Medal Committee, summarised the origin and purpose of this honour, referring to various past awards, and Mr. Charles A. Terry contributed an account of Tesla's researches.

The Diminishing Output of Platinum.—It is remarked in the "Engineer" that, notwithstanding present high prices of platinum, production in the Urals during 1916 showed a further decrease. The total output amounted to 86,508 oz., as compared with 118,709 oz. in 1915; the production in 1913 and 1914 was 158,084 oz. and 156,755 oz. respectively, whilst in 1909 the output amounted to 214,042 oz. The chief causes of this decline in the production of platinum are the shortage of labour.

Drying Generators.—In moist atmospheric conditions the periodical drying out of generator-windings is desirable, and, according to the "Electrical World," the Redondo plant of the Pacific Light & Power Corpn. is habitually treated in this way. Three 18,000kw. generators are dried out simultaneously, about 500 kw.-hours per day per generator being required. Arrangements are made to balance the load approximately. The temperature of the winding ranges between 35°C. and 46°C., according to the atmospheric conditions.

Research at American Universities.—We notice that the National Research Council, established by the National Academy of Sciences (U.S.A.), at President Wilson's request, has asked all the important colleges and institutions in the United States to appoint boards of trustees to consider and report on methods by which research can best be provided in their respective institutions. Such boards have already been appointed by the University of Pittsburg, the Massachusetts Institute of Technology, and other institutions.

Heating of Underground Cables.—The Incorporated Municipal Electrical Association have sent out a circular letter enclosing copy of communication from the Secretary of the Institution of Electrical Engineers to the I.M.E.A., referring to research into the heating of underground electric cables, pointing out that the results will serve as the guide to every undertaking in future in deciding the limits to which underground cables can with safety be loaded, and suggesting that each municipal electric supply undertaking should subscribe a sum from one guinea to five guineas, according to the size of their undertaking, towards the current expenditure.

Electric Vehicle Committee.—A meeting of this committee was held in London on May 4, 1917, Mr. R. A. Chattock presiding. The officers of the committee were re-elected for the current year, and the annual report and accounts submitted and approved.

The question of marking upon the batteries of electric vehicles the working limits for specific gravity was again under consideration, and, in view of a report received from the accumulator makers' section of the B.E.A.M.A., wherein objections were set forth to the proposal, it was decided to drop the matter for the present.

The secretary (Mr. F. Ayton) submitted the letters he had received from automobile manufacturers and electrical engineering firms in reply to the recent circular letters sent out to these firm setting out the desirability of undertaking the manufacture of electric vehicles and equipments so soon as normal conditions return. Several firms had written stating that they were giving the question serious consideration.

A Census of Mining Engineers and Metallurgists.—We observe that the Bureau of Mines, in co-operation with the American Institute of Mining Engineers and the American Chemical Society, is preparing a census of mining engineers, metallurgists and chemists, with a view to ascertaining how

Digitized by Google

their services can best be placed at the disposal of the United States Government. The classification will embrace 27 specific groups of industrial chemists, 16 groups of engineering specialists, and 15 groups in the metallurgical field. In this way the Bureau hopes to be in a position to supply detailed information on short notice regarding the names of specialists in various fields. European experience throughout the war has shown the vital necessity of such machinery at an early stage.

Memorial to Prof. Berthelot.—The unveiling of the monument to Prof. Berthelot, which was retarded by the outbreak of war, took place in the theatre of the Sorbonne, Paris, on May 21st. The President, Mr. Raymond Poincaré, presided, and addresses were delivered by various professors associated with the college. Prof. F. G. Donnan, who was present on behalf of the University of London, paid a tribute to Berthelot's work, and M. Painlevé, Minister of War, recalled the immense services he had rendered since the tragic year of 1870.

Optical Research.—As already announced, arrangements have been completed for the establishment of a new department of technical optics at the Imperial College of Science and Technology.

The new department is under the management of a Technical Optics Committee, of which Mr. Arthur H. D. Acland is chairman, and which consists of 13 members representing the Admiralty, the Army Council, the Ministry of Munitions, the Royal Society, the National Physical Laboratory, employers in the optical trades, glass manufacturers, and the Imperial College; while two further members have to be elected representative of glass and metal workers. Mr. Frederic J. Cheshire has recently been appointed head of the new department for a period of five years, with the title of Director of Technical Optics and Professor of Technical Optics at the Imperial College. Mr. Cheshire has been Deputy Director-General of the Ministry and Technical Director of the Optical Department of the Ministry and is president of the Optical Society. It is anticipated that the organisation of the department will be rapdily completed, and that training will begin at an early date.

Royal Society.—A special general meeting of the Royal Society was held on the 7th inst. in order to discuss certain changes made by the Council last year in Statute XII. relating to the election of Fellows.

The changes empower the Council to recommend for election (A) Privy Councillors "whose election would assist the work of the Society" and (B) "men distinguished in the scientific or educational services of the State or by their services to science and its applications." At the meeting the following resolution, moved by Sir David Bruce, and seconded by Sir E. Ray Lankester, was carried: "That this meeting is of opinion that the Council will serve the best interests of the Society by restoring Statute XII. to the form it had before the change made in it by the Council on November 2, 1916, and by postponing further consideration of the statute relating to the election of Fellows until after the termination of the war."

Among the Papers read at the meeting held yesterday, we notice one by Mr. J. W. T. Walsh on "The Theory of Decay in Radio-active Luminous Compounds."

Scientific Investigation in Canada.—The Canadian Advisory Council on scientific and industrial research has just concluded a session at Ottawa. Among the problems discussed were the manufacture of nitrogenous fertilisers, the production of potash from certain raw materials, the utilisation of the "tar sands" of the Athabasca region, the manufacture of oil and other products from oil shales and the smelting of iron ores mined in the Dominion in order to substitute these as far as possible for ores now imported. The Council had also under consideration the question of the uses to which plants built for the production of munitions in Canada may be put when the war is over. Committees composed of the most distinguished representatives in the Dominion of the several branches of technical work will be constituted within the next few weeks. Regulations have been promulgated by the Council in regard to studentships and research fellowships, which will be awarded to those who have shown a high capacity for research in some problem of national importance.

Science in Warfare.—The Rede Lecture was delivered at Cambridge on Saturday by Sir R. T. Glazebrook, F.R.S., the subject being "Science and Industry: the place of Cambridge in any scheme for their combination." Referring to the part played by science in the war, he said that with a few exceptions all the gauges for munitions passed through the National Physical Laboratory and about 400,000 had been dealt with in the last 18 or 20 months. The standard of manufacture had been gradually improved, and results at first thought unattainable had been realised.

The lecturer said that the war had brought home to us the dependence of the modern world on science and the need there was that when peace came we should use her great power to repair the ravages of war. Cambridge could supply the men who would do this work. The universities and technical schools must provide and train the staffs of physical laboratories. No doubt the number of men engaged in the application of science to industry must increase, but if we were to reap the full advantages science could give, steps must be taken to ensure a wider appreciation of the value of her gifts. Some knowledge of the meaning of ordinary scientific terms, of the usual everyday processes of Nature—both chemical and biological—of the cause of the simple natural phenomena, and of the general scope and methods of scientific inquiry should be the possession of every undergraduate before he left Cambridge to take up his life-work elsewhere. To insist on the retention of Greek in the Previous Examination would close Cambridge to many who would carry the places where at present they never penetrated the rich benefits three years' residence at Cambridge gave. The study of Greek was not advanced by its compulsory character. Cambridge must open her doors wide to every son of our great Empire who could show that he would reap benefits from studying within her walls any branch of knowledge for which she offered opportunities, and the University must train men to be leaders in all walks of life, and not least in industrial pursuits.

OBITUARY.

SIR WM. C. MACDONALD.—The death is announced of Sir William Christopher Macdonald, Chancellor and President of McGill University.

Among his many gifts to the university were a fully-equipped engineering building, which cost over £70,000, besides endowment; a physics building, costing £60,000; a building for the departments of chemistry, mining and architecture, costing £100,000; £30,000 to endow the Faculty of Law; £18,000 for two Chairs of Physics; at least £42,000 for the endowment of engineering; £10,000 for a pension fund, and other endowments.

HENRI BAZIN.—The death is also announced of M. Henri Bazin, the eminent French hydraulic engineer, in his 88th year.

DEATH ON ACTIVE SERVICE.—Capt. R. C. Johnson (R.F.A.) has been killed. Capt. Johnson was appointed chairman of Richard Johnson, Clapham & Morris (Ltd.) after his brother, Capt. W. Morton Johnson (Manchester Regt.) was killed in July, 1916.

PERSONAL.

It was announced at the meeting of the Grimsby Electric Lighting Committee on Monday that the borough electrical engineer, Mr. W. A. Vignoles, who is on active service, has received the Distinguished Service Order.

Capt. Rupert Stanley (R.E.), who was professor of electrical engineering at the Belfast Municipal Technical Institute, has been awarded the decoration of the Legion of Honour for his work at the front in connection with wireless telegraphy.

We regret to learn that Lieut. Francis Arthur Ellis (Welsh Regt.), son of Mr. Arthur Ellis (city electrical engineer of Cardiff), has been severely wounded by a gas shell.

Mr. Arthur J. Cridge, of the British Westinghouse Electric & Mfg. Co., Trafford Park, Manchester, was married on Tuesday to Miss Grace Gertrude Heath at St. Stephens Church, East Putney (London), and Mr. and Mrs. Cridge afterwards left for Cornwall.

Our readers will, doubtless, join us in tendering our condolences to Mr. George Tough, the engineer and manager of Coventry Corporation electricity department, on the death of his wife, which occurred suddenly on Sunday last.

ARRANGEMENTS FOR THE WEEK.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

Thursday, June 21st.

10 a.m. Annual Convention at the Institution of Civil Engineers, Great George-street, S.W. Presidential Address by Mr. F. M. Long, city electrical engineer of Norwich. Paper on "Individual Interest in Municipal Enterprise," by Mr. J. Horace Bowden.

2.30 p.m. Paper on "Fuel Economy," by Mr. J. A. Robertson.

Friday, June 22nd.

10 a.m. Annual General Meeting. To reassemble if necessary to complete any adjourned business.

Digitized by Google

FUEL AND POWER SUPPLY.

BY E. W. L. NICOL, ASSOC.I.E.E.
(Fuel Expert to the London Coke Committee.)

"Having regard to the experience obtained in the present War, this Conference records its opinion that the safety of the Empire and the necessary development of its component parts require prompt and attentive consideration, as well as concerted action, with regard to the following matters :—

"1. The production of an adequate food supply and arrangements for its transportation when and where required, under any conditions that may reasonably be anticipated.

"2. The control of natural resources available within the Empire, especially those that are of an essential character for necessary national purposes, whether in peace or in war.

"3. The economical utilisation of such natural resources through processes of manufacture carried on within the Empire.

"The Conference commends to the consideration of the Governments summoned thereto the enactment of such legislation as may assist this purpose."—Resolution passed by the Imperial War Conference, April 25, 1917.

Amongst the many resolutions passed by the Imperial War Conference, one or two are of peculiar and immediate interest to engineers responsible for the production of power on a large scale. The proposed State control of essential national resources, with the view to their economical utilisation, and the development within the Empire of adequate capacity for the production of food and munitions, will not only involve radical reorganisation in the use of coal generally, but particularly in that of the bituminous coal from which the chemical fertilisers and other materials essentially necessary for national purposes are derived.

Under these changed conditions, in order to combine the economy of the coal carbonising process and the operation of electrical generation, so that the highest degree of the economical use of bituminous coal may be fully realised, the co-ordination and pro rata development of the basic industries of fuel and power supply may ultimately become necessary in view of the vital industrial and defensive importance of adequate and cheap supplies both of fuel and power.

The use of coke (and other surplus combustible residuals) as fuel for steam raising, and the consequent necessary changes in steam boiler design, rating and firing methods will, in the event of the recommendations of the Conference being adopted, provide new engineering problems of the most interesting and immediately practical character.

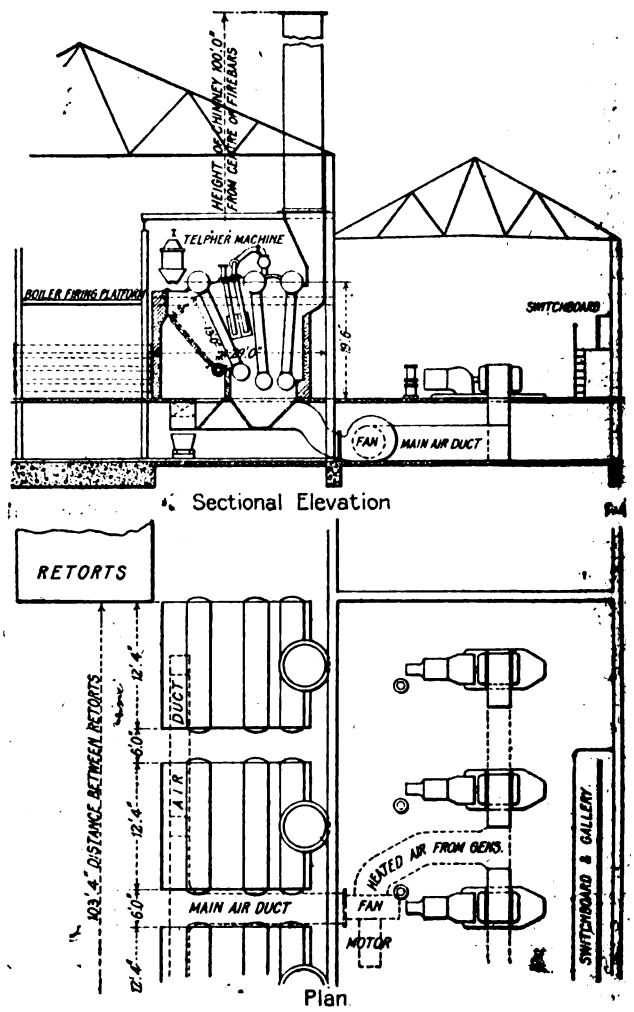
In the present article it is proposed to consider, *inter alia*, the mechanical stoking of large capacity steam boilers exclusively with gas coke as fuel, and to indicate, if possible, the lines upon which, in the light of present experience, experiment and research may be directed with the view to improving and standardising steam generating appliances used, as well as to elucidating factors advantageous to the efficient combustion of non-volatile coke as fuel under steam boilers.

In modern coal carbonising practice, both horizontal (or inclined) and vertical retorts are used for the destructive distillation of bituminous coal, and to those unacquainted with their working a brief description may be interesting. Both types of retorts usually are heated by means of regenerative gas producers, and both are charged and discharged by mechanical power. From horizontal (or inclined) retorts the coke is discharged at the working temperature—viz., 1,500°F. to 1,800°F.—into conveyors, where it is immediately quenched with water; or into skips, which are conveyed by "telpher" and lowered into a tank of water placed outside the retort house. The producer furnaces are, generally, fed with incandescent coke direct from the retorts.

An essential difference in the working of the vertical retort is that the coke, before being allowed to gravitate from the retort, is cooled in a cooling chamber and is discharged practically cold.

For the purpose of steam raising there are thus available two kinds of gas coke—viz., "vertical" coke, relatively light and porous; and "horizontal" coke, of various degrees of hardness and density, either incandescent, for immediate local use, or quenched for storage and distribution. From either kind there is also a certain amount of small residuum, called coke breeze.

The sensible heat unavoidably wasted by the quenching of "horizontal" gas coke represents a considerable proportion of the total heat used for carbonising the coal, which, if it could be used for the purpose of steam raising, would appear to offer attractive possibilities in a combined fuel and power supply centre, laid out with this end in view as indicated in the diagram. By thus utilising the sensible heat as well as the combustion heat of surplus gas coke in a suitably constructed boiler furnace a considerable saving in fuel would be effected, as well as economy in transport and in many other directions.



ARRANGEMENT OF HORIZONTAL RETORT SETTING WITH WOODESON'S WATER TUBE BOILERS.

Consideration of these features might form a starting point for the development on a working scale of an experimental boiler and furnace for use with coke as fuel. One type of furnace suggested by the writer has an inclined grate, and is indicated on the drawing, for which he is indebted to Messrs. Clarke, Chapman & Co. (Ltd.), of Gateshead-on-Tyne. The furnace as shown is intended for use with coke exclusively, incandescent or otherwise, so that the boiler tubes, so far as possible, are exposed to the direct radiant effect of the burning fuel, no intervening baffle, arch or secondary combustion space being considered necessary or desirable.

Digitized by Google

Whatever the merits or demerits of any such scheme may be, more immediate interest will be centred upon adapting existing steam generating plant to the use of coke as fuel. So far as hand-fired boilers are concerned, experience has shown that, with few exceptions, existing types are more or less easily adaptable, any necessary conditions essential to the attainment of satisfactory results being readily applied. Positive control of the draught pressure, under as well as over the fire, is in all cases a desirable, although not an absolutely essential, feature.

Experience in mechanically stoking relatively large capacity boilers with gas coke or coke breeze as fuel, although necessarily more limited, would appear to be no less definitely established. For internally-fired boilers, and to some extent externally fired water-tube boilers, various forms of forced draught "sprinkler" stokers have been applied, apparently with satisfactory results. For firing coke and breeze on a larger scale, the Babcock & Wilcox Co. have adapted their well-known chain grate stoker by applying forced draught under the grate. The test results obtained with the first experimental installation, which has been working practically continuously night and day since January, 1916, are to some extent qualified by the fact that the insulation of the boilers had not been completed at the time the test was made. Data collected over a more extended period are available in connection with the mechanical coke burning installations made by the Underfeed Stoker Company. Their forced draught over-feed travelling grate stoker has now been in use with coke breeze exclusively as fuel over a period of some six years, with results that are considered satisfactory, both as regards relative cost of maintenance and efficiency, in circumstances which necessitate continuous operation at maximum loads over long periods. Records of one such installation are available, showing an interruption of only four days since going into commission some 18 months ago. In other boilers, in similar circumstances, the ignition arches have lasted for 14 months. A contributory beneficial effect to this very satisfactory performance of both mechanical stokers and brickwork is no doubt the prior elimination, in the process of carbonisation, of the volatile sulphur, which is one of the destructive elements in all natural coal fuels.

In general principle the Underfeed Company's travelling grate stoker is similar to the familiar chain grate stoker, in that the grate travels over two drums or sprockets situated at either end of the grate. The coking arch, as used for bituminous coal, is retained in a somewhat modified form, and this feature, combined with impelled draught, has the effect of largely extending the range of choice of fuels which may be used—an important consideration from both the commercial and national view points. With the ordinary natural draught mechanical coking stoker the user is limited to a considerable extent, whatever his geographical position or the character of local fuel supplies, to more or less uniform grades of bituminous coal, a disadvantage which has been sharply revealed by the present conditions of coal shortage and transport difficulties.

Amongst the various fuels which the makers claim to be satisfactorily dealt with by the travelling grate stoker are gas coke (suitably graded), gas coke breeze, furnace and foundry coke breeze, anthracite grains, duff and rubbly culm, anthracitic Welsh coal and bituminous coal. This, no doubt, is a very sanguine achievement for any one type of stoker; but, from the point of view of both the fuel user and the fuel producer, it is doubtful whether with any set of fixed conditions of use the best results are obtainable from such a variety of fuels differing widely in chemical composition, and volatilising and ignition temperatures. For instance, the large primary coking and secondary combustion spaces necessary for the complete combustion of a "two-stage" fuel like bituminous coal are neither desirable nor necessary for a "single-stage" fuel like gas coke, which, preferably, should be burned directly to CO_2 in contact so far as possible with the heating surfaces of the boiler. In dealing with the latter fuel, the function of the coking arch, which to a considerable extent screens the most effective heating surfaces from the direct radiant heat of the fire, is reduced merely to a convenient means of maintaining a sufficient temperature at the furnace door to ensure the ignition of the coke as it enters the furnace; and it would appear to be in this regard that experiment on a working scale is most required, with the view to improving the design and efficiency of both boiler and furnace, and also the methods of mechanically stoking and clinkering coke-fired boiler furnaces.

An important feature of the travelling grate stoker is the provision made for the relative regulation of draught in varying degrees of intensity from the front to the back end of the grate. The depth of fuel usually admitted in using average coke breeze and graded coke is varied between 8 in. and 12½ in., according to grade and resistance of the fuel bed.

This adjustment, which is made as required in the usual way by regulating the height of opening for the admission of the fuel under the furnace door, and also that of relative draught intensity, requires no more than ordinary supervision; but failure to recognise and adjust these elementary factors has resulted in "sulphurous" fumes being blown back into the boiler room, when either coke or coal is used, the fumes in the latter case probably being considered less "sulphurous" by reason of the disguising effect of other gases more or less malodorous.

In power plants where normal conditions necessitate the continuous working of boilers at or over their full capacity, as rated on a volatile coal fuel basis, the cutting and grading of coke to the most advantageous sizes will be an important feature. The resistance of coke to rapid oxidation varies considerably, and this factor would appear to have some definite relation to its hardness and density. The ratio of surface exposed to the oxidising process to weight also has an important influence upon the economic rate at which coke may be consumed; and the desirability of grading to approximately uniform size will be obvious.

The various standard grades adopted three years ago by the London Coke Committee—viz., 0 to ⅜ in., ⅜ in. to ¾ in., ¾ in. to 2 in.—have been so far sufficient to meet the special requirements of steam users for both mechanical and hand firing; but here, again, arise factors having an important bearing on the efficient utilisation and stoking of coke by mechanical means, and also upon the economical rating of coke-fired boilers, which can be determined only by organised and systematic experiment and research conducted on a working scale under competent supervision.

The comparative evaporative values of coke and coal as fired under various conditions, and also the relative evaporative capacity of coal and coke fired boilers, will be of interest. Where appliances for the positive control of the furnace atmosphere are installed, coke has a decided inherent advantage over bituminous coal, in that it contains practically only one combustible constituent—fixed carbon. Under the best conditions of mechanical stoking, bituminous coal has a relatively low efficiency, as it requires for the complete combustion of its

——	Coal.	Coke.		Breeze.		
System of draught.....	Natural	Impelled.		Impelled.		
System of stoking	Mech.	Hand.		Hand.	Mechanical.	
Type of boiler.....	W.-tube	Lanc.	Cornish	B.&W.	Stirling	B.&W.
Grate surface, sq. ft. ...	87·88	36·0	29·0	81·0	60·75	50·0
Fuel per grate-ft.-hour lb.	26·9	15·0	16·1	25·2	37·1	28·28
CO_2, per cent.....	8·0	14·0	16·0	14·5	14·5	11·7
Excess air, per cent. ...	159·0	48·0	28·0	43·0	43·0	75·0
Fuel loss, per cent.	23·0	13·0	11·0	12·5	12·5	...
Calorific power, B.T.U.	12,000	12,000	12,000	10,083	9,590	9,018
Evaporation from and at 212°F. per lb. of fuel as fired.....lb.	7·5	9·8	9·8	7·84	5·8	6·59
Plant efficiency, per cent.	60·3	78·8	78·8	75·1*	69·6*	71·01*
Current rates quoted f.a.s. London, pr.tn.	28/0	28/0	28/0	10/6	10/6	10/6
Fuel cost per 1,000 galls. evaporated ...	16/8	12/10	12/10	6/0	8/0	7/1

* No economiser or superheater.

Digitized by Google

numerous and ever-varying fixed and volatile constituents, which include hydrogen, at least 50 per cent. excess of air. This figure corresponds to some 13 to 14 per cent. CO_2 in the flue gases—a desirable result which is, in the writer's experience, very rarely obtained in ordinary practice. With all due deference to those in charge of well-conducted steam plants, it is now suggested that 5 to 8 per cent. CO_2, indicating 300 to 150 per cent. excess of air, would probably cover the higher limits of working where highly bituminous coal is used at high rates per grate-foot-hour under ordinary conditions of draught and supervision. Compared with bituminous coal of equal gross calorific power, coke—which is relatively uniform in character and composition, requires a minimum excess of air and no secondary air supply in order to complete its combustion—will have a higher net evaporative value.

The table on p. 421 shows typical results obtained with bituminous small coal, gas coke and coke breeze of good average quality under various conditions of mechanical and hand firing.

SOME TESTS ON COKE FIRING.

Owing to the interest which is now being taken in the question of coke firing, we think it desirable to publish the detailed results of some tests which we give below, and for which we are indebted to Messrs. Babcock & Wilcox (Ltd.).

It is pointed out by Messrs. Babcock & Wilcox that coke and coke breeze have been used as boiler fuel for a number of years, but until recently their use has been confined mainly to boilers at gas works. The arrangement of furnace ordinarily employed has been a hand-fired grate with under grate forced draught, supplied either by fans or steam blowers.

Table I. gives details of a test on a Babcock & Wilcox boiler equipped with a furnace of this pattern, the forced draught being supplied by a fan.

Table I.—*Details of Test made at a London Gas Works.*

GENERAL DATA—	
Boiler heating surface	4,020 sq. ft.
Type of furnace	Hand fired with forced draught.
Grate area	81 sq. ft.
Ratio of H.S. to G.A.	50/1.
Duration of test	8 hours.
Fuel—	
Description	Coke breeze.
Analysis of dried fuel—Volatile matter	4·50%
Fixed carbon	75·25%
Absolute ash	20·25%
	100·00%
Percentage of moisture as received	10·05%
Calorific value of fuel as received	10,083 B.T.U.'s per lb.
Total quantity of fuel fired	16,326 lb.
Consumed per hour	2,041 lb.
Consumption per sq. ft. of grate area per hour	25·2 lb.
Steam—	
Average Gauge pressure	110 lb.
Water—	
Feed temperature	48°F.
Total quantity evaporated	105,610 lb.
Evaporation per hour, actual	13,201 lb.
Equivalent evap. from and at 212°F.	16,000 lb.
Evap. per sq. ft. of H.S. from and at 212°F.	3·98 lb.
Evaporation per lb. of fuel as fired, actual	6·47 lb.
Evap. per lb. of fuel as fired, from and at 212°F.	7·84 lb.
Factor of evaporation	1·212
Flue Gases—	
Average temperature at boiler damper	520°F.
Average CO_2 at boiler damper	14·5%
Draught—	
Suction at boiler damper	0·45"
Pressure at fan	1·2"
Efficiency—	
Boiler only, with forced draught furnace	75·10%

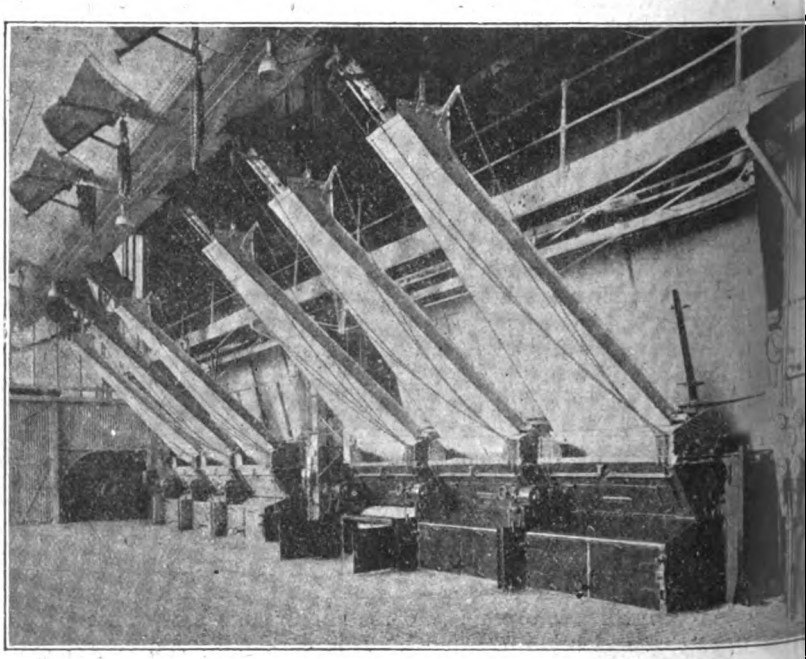
It will be seen that when burning 25·2 lbs. of coke breeze per square foot of grate area per hour an efficiency was obtained of 75·1 per cent. on a boiler without either a superheater or economiser. Similar arrangements of furnace have been in use in a number of gas works for years.

To meet more recent requirements for burning this fuel on automatic stokers, experiments were carried out some little time ago, and as a result a special furnace setting for the chain grate stoker has been designed, on which coke breeze is now being successfully burnt with the assistance of under grate draught. Particulars of four tests carried out at a Scotch gas works are given in Table II. It will be noted that the efficiency is somewhat lower than that referred to above, but the conditions under which these tests were carried out were not favourable for obtaining the maximum efficiency, in that the boiler-house roof at that time had not been erected, and the lagging of the boiler was not completed. Further, during the tests it was raining. All these conditions would increase the radiation losses.

On the first three tests shown the fuel used was unscreened breeze of a size differing on each occasion; on the fourth test screened breeze was used. It will be seen that in each case a good duty was obtained from the boiler.

This installation consists of a pair of boilers, both of which have been working practically continuously night and day since January, 1916. It should be noted that these boilers are not fitted with a superheater, and no economiser has been installed. With these accessories a higher efficiency would, of course, be obtained.

A typical arrangement of these forced draught, or more correctly, balanced draught, stokers is shown in the adjoining illustration.



INSTALLATION OF BALANCED DRAUGHT BABCOCK & WILCOX STOKERS FOR COKE-FIRI

Although the chain grate stoker has only recently been used for burning coke breeze alone, for many years it has been the practice in some parts to burn this fuel mixed with a certain proportion of bituminous coal. This mixture can be burned with natural or induced draught, and no modification is required to the standard arrangement of the chain grate stoker; the proportion of breeze varies according to its quality and that of the coal, and in some cases as much as 50 per cent. is burnt successfully. Where overhead bunkers are in use it has been found difficult to ensure a uniform mixture of the two fuels, and for this reason the burning of the mixture has usually been only considered satisfactory with a small proportion of breeze; but where the stoker hoppers are fed by hand and care can be taken in mixing, a greater percentage of breeze can be burned successfully.

Digitized by Google

Table II.—*Tests with Coke Breeze.*

Boiler—							
Construction	Babcock & Wilcox hand type standard without superheater.						
Heating surface	2,010 square feet.						
Stoker—							
Type	Babcock & Wilcox chain grate drop link with special arch setting and forced draught.						
Grate area	50 square feet.						
Ratio of H.S. to G.A.	40·2/1.						
GENERAL DATA—							
Duration of test	7 hours	...	8 hours	...	6 hours	...	4 hours
Fuel—							
Kind used	Unscreened breeze	...	Unscreened breeze	...	Unscreened breeze	...	Screened breeze
Size—1¼ in. to ½ in.	26·72%	...	13·85%	...	12·07%	...	100·00%
½ in. to ¼ in.	35·62%	...	43·21%	...	31·03%	...	—
¼ in. to ⅛ in.	24·43%	...	27·42%	...	24·14%	...	—
⅛ in. to 0 in.	13·23%	...	15·52%	...	32·76%	...	—
	100·00%	...	100·00%	...	100·00%	...	100·00%
Analysis of Fuel as Received—							
Moisture	23·80%	...	16·99%	...	9·26%	...	7·64%
Volatile matter	3·15%	...	3·18%	...	8·58%	...	4·62%
Fixed carbon	56·29%	...	62·81%	...	67·19%	...	72·96%
Absolute ash	16·76%	...	17·02%	...	14·97%	...	14·78%
	100·00%		100·00%		100·00%		100·00%
Calorific value of fuel as fired	8,070 B.T.U.'s	...	9,018 B.T.U.'s	...	10,519 B.T.U.'s	...	10,845 B.T.U.'s
Total quantity fired	10,528 lb.	...	11,312 lb.	...	8,498 lb.	...	4,200 lb.
Consumed per hour	1,504 lb.	...	1,414 lb.	...	1,416 lb.	...	1,050 lb.
Consumed per hour per sq. ft. grate area	30·08 lb.	...	28·28 lb.	...	28·32 lb.	...	21·00 lb.
Riddlings (percentage of fuel fired)	3·1%	...	2·8%	...	3·9%	...	—
Steam —							
Quality	Saturated	...	Saturated	...	Saturated	...	Saturated
Average gauge pressure	88 lb.	...	97 lb.	...	99 lb.	...	92 lb.
Water—							
Feed temperature	41°F.	...	41°F.	...	41°F.	...	41°F.
Total quantity evaporated	48,700 lb.	...	61,400 lb.	...	52,200 lb.	...	27,000 lb.
Average evaporation per hour, actual	6,957 lb.	...	7,675 lb.	...	8,700 lb.	...	6,750 lb.
Equiv. evaporation per hour from and at 212°F.	8,446 lb.	...	9,325 lb.	...	10,579 lb.	...	8,194 lb.
Evaporation per sq. ft. H.S. from and at 212°F.	4·20 lb.	...	4·64 lb.	...	5·26 lb.	...	4·08 lb.
Maximum evaporation for one hour, actual	8,500 lb.	...	9,600 lb.	...	10,200 lb.	...	7,400 lb.
Evaporation per lb. of fuel, actual	4·63 lb.	...	5·43 lb.	...	6·14 lb.	...	6·43 lb.
Evaporation per lb. of fuel from and at 212°F.	5·62 lb.	...	6·59 lb.	...	7·47 lb.	...	7·80 lb.
Factor of evaporation	1·214	...	1·215	...	1·216	...	1·214
Flue Gases—							
Temperature at boiler damper	478°F.	...	486°F.	...	480°F.	...	520°F.
Average CO_2 at boiler damper	10·4%	...	11·7%	...	11·9%	...	9·9%
Temperature of air	45°F.	...	55°F.	...	58°F.	...	53°F.
Efficiency—							
Heat utilised in boiler	67·57%	...	71·01%	...	68·85%	...	69·87%
Heat lost in flue gases	14·57%	...	12·89%	...	12·41%	...	16·51%
Heat lost in radiation and unaccounted for	17·86%	...	16·10%	...	18·74%	...	13·62%
	100·00%	...	100·00%	...	100·00%	...	100·00%

REMARKS.—The tests were carried out on a boiler (without superheater or economiser) before the boiler house roof was erected, and before the lagging was completed. Further, it was raining during the tests, and these facts would increase the radiation losses. The maximum suction draught available at the boiler damper (0·41") was on the low side, and with a higher suction draught better results should be obtained.

SOME PERSONAL EXPERIENCES WITH HAND FIRING OF COKE.

BY J. A. CROWTHER.
(Borough Electrical Engineer, Wallasey.)

Although gas-works coke has been used for firing in steam boilers for at least 30 years to my knowledge, its use has not become at all general, and the object of this short article is to give some information as to its good and bad qualities.

The analysis of gas coke shows a large percentage of fixed carbon, as high as 83 per cent. in a good sample, and a calorific value of about 12,000 B.Th.U., with ash 6·5 per cent. It is, of course, low in volatile matter. This compares very favourably with a fair sample of slack, an analysis of which from Welsh pits gives :—

Fixed carbon	46·75 per cent.
Calorific value	10,769 B.Th.U.
Ash	13·27 per cent.

The amount of water evaporated per lb. of coke in a Babcock & Wilcox boiler has averaged over a considerable period, 6·75 lb., the temperature of the feed being 85°F. ; with a clean boiler 8·15 lb. was recorded on short test. The flue gas analysis gives 18 per cent. CO_2, which can under proper conditions be well maintained. The amount of ash as one would judge from the analysis, is smaller than with slack.

With hand firing, the effect on the brickwork of a Babcock & Wilcox boiler—that is, the arch, side walls and the bridge or back wall—is very severe, the intense local heat destroying the firebrick very rapidly, probably assisted by the sharp gritty nature of the coke.

I have usually found that in two months a considerable amount of patching is necessary, with probably the renewal of the two courses on the side walls nearest the grate level, and that after six months the greater portion of the furnace brickwork will require renewal. After many experiments I find that firebrick blocks, say, 9 in. by 9 in. by 18 in., commencing from grate level on the side walls, give best results, and that silica bricks or "Glenboig," are well worth the extra cost for the arch and bridge.

There is no deleterious action on the plates of "Lancashire" or the tubes of water-tube boilers, some tubes in the latter type having been in use 17 years without renewal.

Some of the disadvantages of coke fuel are its great bulk in proportion to weight, which considerably limits the quantity that can be stored in the space at disposal. The greatly

Digitized by Google

varying size, from lumps of 14 lb. weight to breeze, unless it is first put through the breaker which necessarily produces a greater quantity of breeze, rather difficult to utilise, and makes mechanical handling almost impossible, thereby increasing labour costs.

The percentage of volatile matter being low, coke gives a very short flame, thus making the heating action very intense in the firebox. To overcome this trouble it is customary to use steam jet blowers under the furnace; the steam is converted into water gas in passing through the incandescent coke, and, on ignition, burns with a moderate length of blue flame.

Gas coke is troublesome to ignite, even after a good fire has been obtained, and within certain limits it cannot be forced, so that for emergency work it is somewhat unsatisfactory.

I do not know of a satisfactory automatic furnace that can be used for its combustion, and until this is accomplished the labour costs must be higher than with one of the numerous mechanical stokers now on the market for the combustion of slack or small coal. This is to some extent neutralised by the small amount of ash to be handled and the reduced cost of removal, which, in many places, is becoming a serious item.

The greatest advantage of coke, particularly in populous neighbourhoods, is the absence of smoke. If the gasworks are near the generating station a saving in cartage may be effected, and in towns where no great demand exists for coke, reasonable or low prices may be arranged.

Where the price per ton approximates to that of slack of a similar calorific value, after many years' experience, I should plump for slack, unless considerations other than £. s. d. overbalanced the scale, and until the satisfactory automatic stoker makes its appearance.

GRATES FOR COKE FIRING.

In the design of mechanical stokers for coke firing certain difficulties arise, notably in the ignition of the coke as it is fed on to the fire. Moreover, the combustion of coke differs from that of coal in that it is practically devoid of volatile matter; this not merely gives rise to the ignition difficulty, but burning of gases is practically absent, and reliance must be placed more on radiation. Thus, it is necessary to modify designs which have been found satisfactory for coal firing, and to adopt forced draught. We have already referred to the results obtained by Messrs. Babcock & Wilcox, and in what follows we describe what is being done by certain other makers, either in mechanical stoking or hand firing. The way in which the conditions above mentioned may be met are well illustrated by the mechanical stoker of the Underfeed Stoker Co.

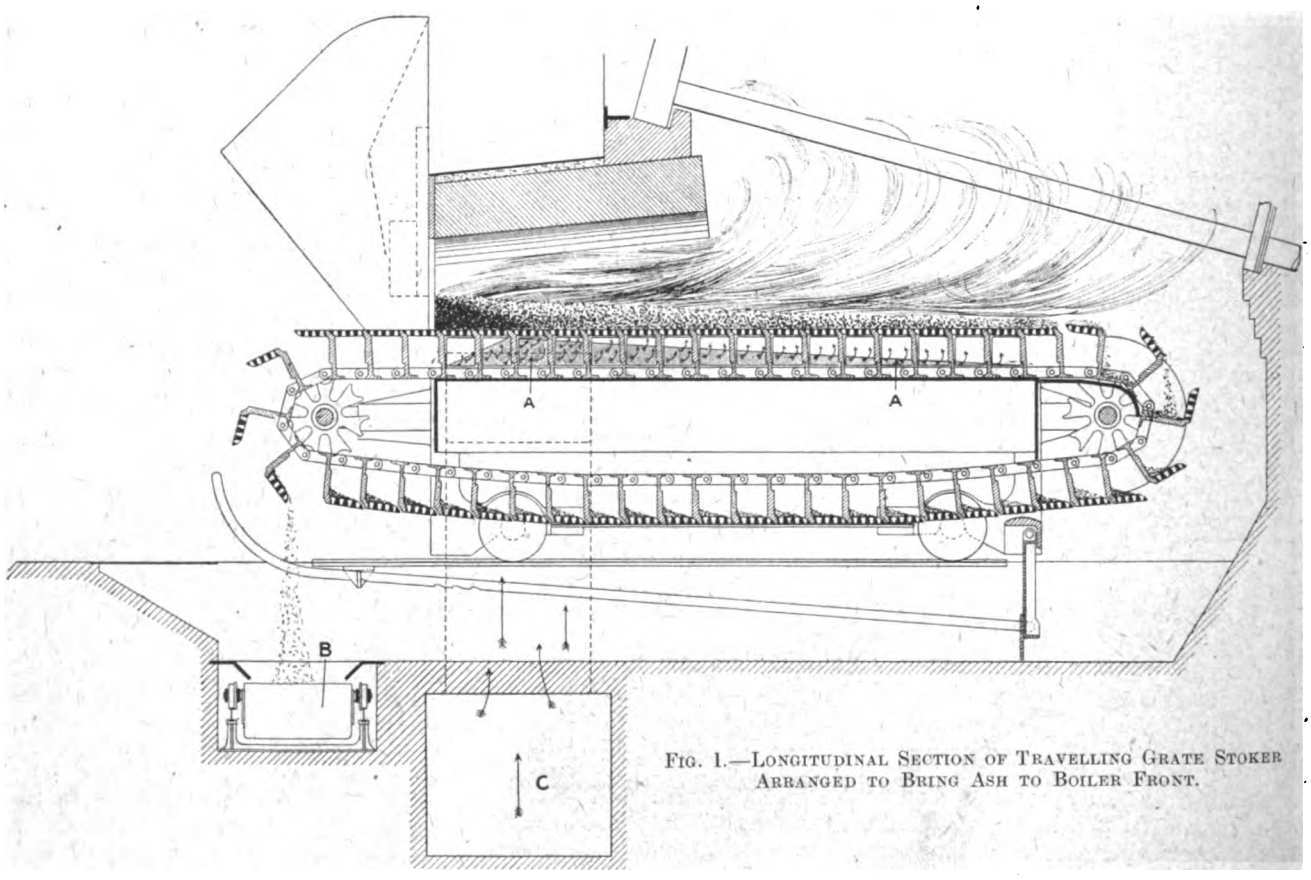


FIG. 1.—LONGITUDINAL SECTION OF TRAVELLING GRATE STOKER ARRANGED TO BRING ASH TO BOILER FRONT.

UNDERFEED STOKER CO.'S GRATE.

This stoker consists of an endless moving grate of box-shaped firebars, mounted upon chains, the links of which engage sprocket wheels which are rotated by a mechanism receiving power from a suitably placed driving shaft. The caps of the firebars are perforated or slotted for the delivery of air into the fuel. The grate, as will be seen, is composed of a plurality of moving box-shaped sections, which gradually open as they pass around the rear sprocket wheel, close again underneath, open again at the front as shown, and finally close when passing under the feeding hopper.

The air supply for the maintenance of combustion enters through the rectangular boxes at the sides of the stokers, and flows respectively into the longitudinal chambers, one on either side of the stoker. These chambers, as will be seen from the illustrations, have their upper surfaces sloping at an angle of approximately 30° and are provided with longitudinal openings *A* for the delivery of air into the open ends of the box-shaped firebars, which register with the top opening *A* of the air chambers *E* (Fig. 2). The course of the air is through *D* into *E*, and thence into the interior of the box-shaped firebars, escaping finally through the perforations or slots in their upper surfaces, into the fire.

There is thus produced a travelling grate of strictly cellular construction, presenting the opportunity of progressively varying the quantity of air admitted to different parts of the fuel bed, so that at the front where the fresh coal is being fed and the resistance to the admission of air is greatest, the maximum quantity can be supplied;

Digitized by Google

while at the back, where the fire is thin and open, the minimum may be admitted. This control of the supply of air to the fire is accomplished by the movement of the hinged triangular-shaped dampers shown immediately under *A*, of the air chambers *E* in Fig. 2 These dampers can be placed in any position by the movement of handles, with the result that the quantity of air delivered is under perfect regulation, and can thus be progressively admitted from the front to the rear of the stoker.

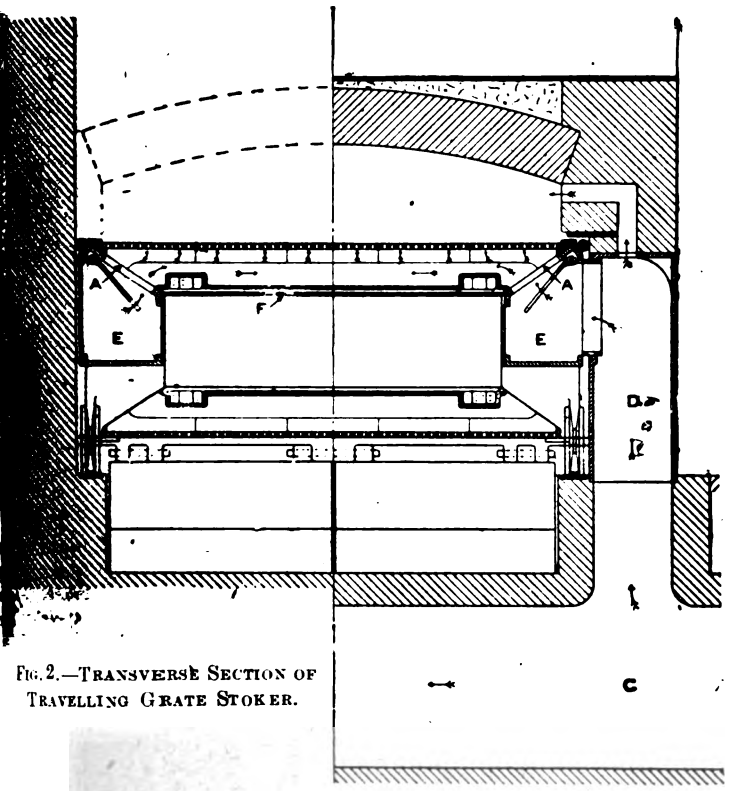


FIG. 2.—TRANSVERSE SECTION OF TRAVELLING GRATE STOKER.

The fuel is delivered in the ordinary way into the hopper from which the quantity fed upon the grate is regulated by a sliding shutter adapted to be raised or lowered by a rack or pinion. A longitudinal section is shown in Fig. 1. Here the box-shaped sections face so that they carry the ashes under the grate and deposit them at the front. By reversing the sections the ashes are deposited at the back, which is the more usual arrangement. The machine is mounted upon four wheels, two of which are shown, so that it can, if required, be withdrawn from the furnace in the same manner as the chain grate. This arrangement is further illustrated in Fig. 3.

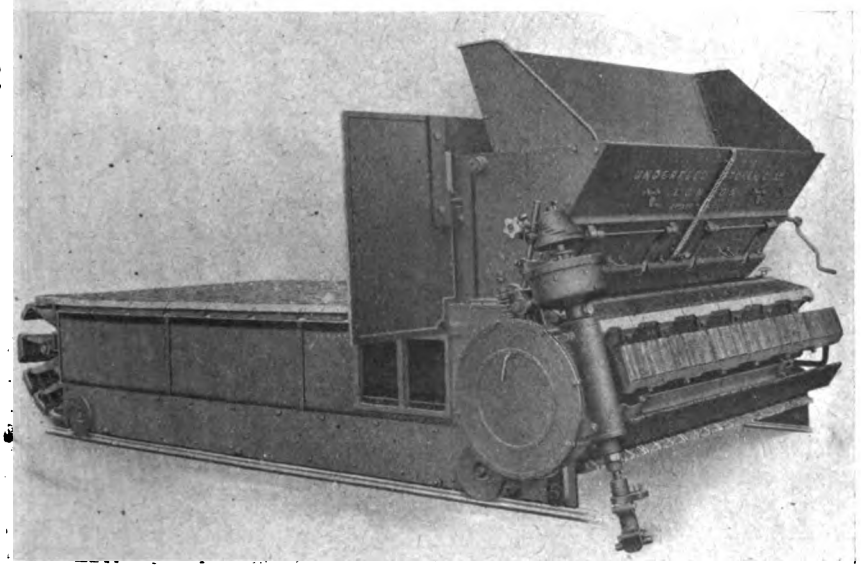


FIG. 3.—UNDERFEED STOKER CO.'S TRAVELLING GRATE STOKER.

The means for bringing the air into contact with the coal form a most important feature, enabling the stoker to be operated by impelled draught, though it may also be worked by natural or induced draught if desired. Impelled is preferred to induced draught because less power is required, there is less trouble with the fan and the thermal loss by infiltration of air through the interstices of the boiler setting is reduced to a minimum. With impelled draught there is great flexibility in the rate of combustion, which can in a very short time be increased to the maximum, and can, of course, be as quickly reduced should the load demanded from the boiler sud denly cease.

A further point of great importance is that when two stokers are installed under one boiler, as is frequently the case, each being self-contained with respect to its air supply, one may be shut down quite independently of the other.

One of the difficulties in coke firing is that coke is not so easily ignited as coal and, therefore, special methods must be adopted to ensure that the fuel as fed on to the grate ignites properly. This is secured in the present arrangement by the extended arch, seen in Fig. 1. This arrangement provides a hot chamber, and the radiation from the roof of the arch is sufficient to ensure the required ignition.

Fig. 4 shows the general arrangement of such a stoker used with a Stirling boiler. Here it will be noticed that the arch is still longer than that in Fig. 1. This longer arch is required partly by the necessity to deflect the gas into the tubes and partly by the peculiar quality of the fuel, which in this case is very small coke-breeze. It will be realised that the greater part of the heat from a coke fire is obtained by radiation, there being practically no burning gases, and this radiant heat is only obtained from the open part of the grate.

The arrangement shown in Fig. 4 has been at work at the Priestman Collieries, near Newcastle, for some 18 to 20 months, running 24 hours a day and 7 days a week.

We understand that a number of these Underfeed stokers are being used by the Compagnie du Gaz de Lyon. The company

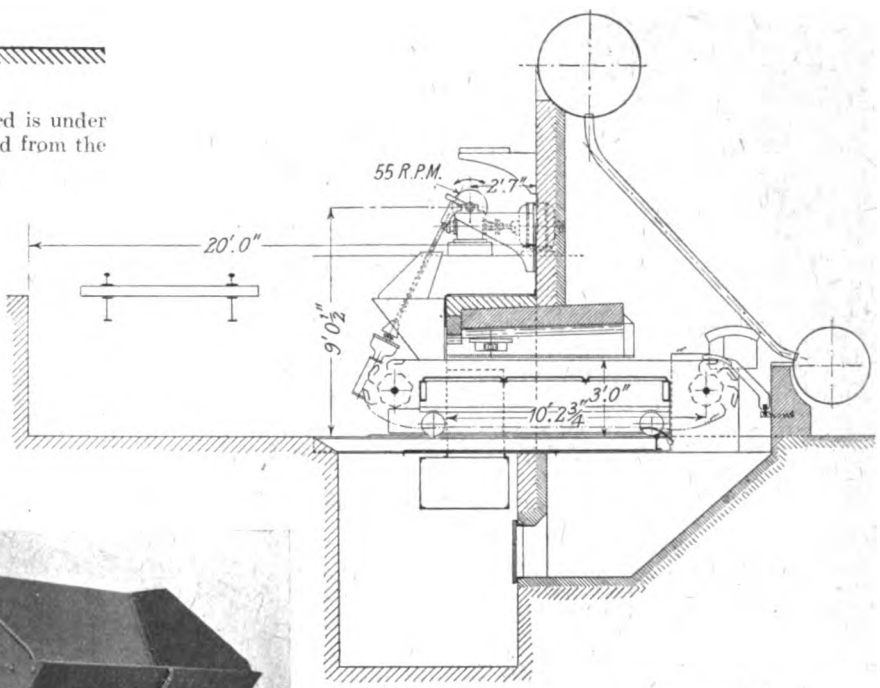


FIG. 4.—GENERAL ARRANGEMENT OF UNDERFEED STOKER WITH STIRLING BOILER.

supplies gas and electricity to the city of Lyons, and they burn in their generating station coke and coke-breeze from the gas works, and also burn coal when the supplies of coke and coke-breeze are insufficient. The first installation of the stokers was made some seven years ago and has been greatly expanded from time to time until there are now 40 grates at work with another eight on order, making a total of 48. This affords a very satisfactory indication that the problem of coke firing by mechanical stokers has been solved, and we think that station engineers will do well to see for themselves this stoker in operation.

Digitized by Google

THE "FENNIS" PATENT SELF-CLEANING COMPRESSED AIR FURNACE.

The makers claim that this furnace will burn any class of fuel, large or small, and that it burns with special advantage poor quality and refuse fuels, such as pond settlings, coal pickings, large lumps and small, coke dust, shale or material which contains a large percentage of ash or clinker. With such refuse steam may be generated as quickly as in furnaces fitted with stationary bars, burning a higher-grade coal.

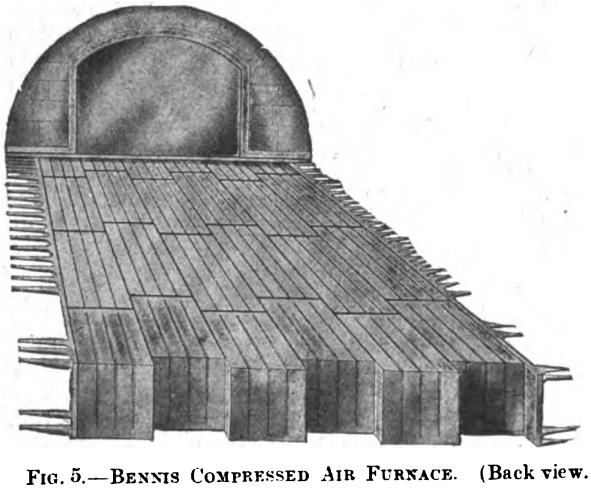


FIG. 5.—BENNIS COMPRESSED AIR FURNACE. (Back view.)

The furnace consists of a strong cast-iron front, lined with fire-brick and fitted with a door for hand-firing (Fig. 5). The fire-bars are of the Bennis self-cleaning trough type. The furnace consists of tubular fire troughs of the length of the grate. The tubular bars are placed close together, and are protected from direct contact with the fire by being covered with short interlocking grate bars *A*, about 2 ft. in length (Fig. 6).

The back of the tubular fire trough is protected by a solid block *B*. In the event of any of these interlocking grate bars or blocks being injured or damaged, it can be replaced without interference with the rest of the fire surface.

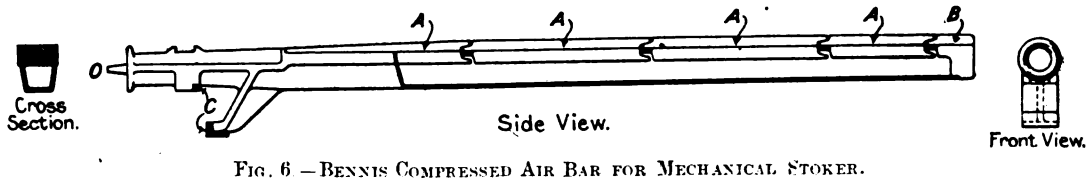


FIG. 6.—BENNIS COMPRESSED AIR BAR FOR MECHANICAL STOKER.

Each trough is provided with an independent steam jet blower, and fitted with grids having graduated air spaces. The air spaces between the bars are always free and open, and each tubular fire trough has its own supply of air, fed by a minute steam jet, so that the draught is evenly distributed over the whole fire-grate, and the boiler continues to do its work even while the operation of cleaning out the clinker from the chamber proceeds. The fire is thus always clean and ready should sudden calls for steam be made upon it. By turning the blowers full on, the rate of combustion can be greatly increased.

The bars are constructed with extremely fine air spaces, so that coke breeze or dust fuel can be burned with advantage. A steel shaft, carrying a cam for each bar, is placed immediately beneath the front to operate the bars, compelling them to stir up the fire and convey it slowly to the back of the grate where the clinker is deposited in a pit arranged for its reception. The cam-shaft is operated by strong gearing, supported by a bracket fixed to the furnace front. A swing door connected by a chain to the front is situated beneath the back bearer, for facilitating the cleaning out of the ashes.

The makers state that the furnace is particularly useful in collieries and gas works, being specially adapted to their requirements. During the process of cleaning out the ashes there is no fall in the steam pressure as there is with ordinary hand-firing.

Fig. 5 shows a back view of the furnace, with fire bars and toothed side bars. The side bars are made with teeth, so that they can be chipped to suit the irregularity or corrugations in the flues. Inside protection plates are used for protecting the rivets and mouth of the furnaces from the heat.

MELDRUM GRATES AND STOKERS.

For the purpose of coke-firing Meldrums Limited supply the type of firebar shown in Figs. 7 and 8 in the case of hand-firing. The bars are very thin, and consequently, the air spaces are numerous. This form of grate is used with forced draught, and the spaces being narrow tend to prevent holes being blown in the fire and to equalise the combustion over the whole grate. In conjunction with forced draught, Meldrums Limited supply their sprinkler stoker for firing coke, the coke being broken to a suitable size. The stokers may be either fitted with the fixed bars above described or with moving grates. In the latter case the bars consist of a light framework into which are fitted small falling bars as shown in Fig. 9. These are interlocked so that they cannot be accidently displaced. The bars are operated by means of cams. The Meldrum sprinkler stoker is no doubt well known to our readers, so that a brief reference to this device will be sufficient.

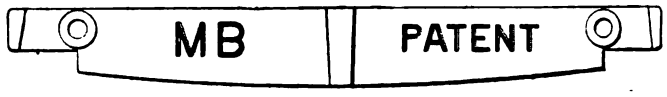


FIG. 7.—ELEVATION OF FIRE-BAR.

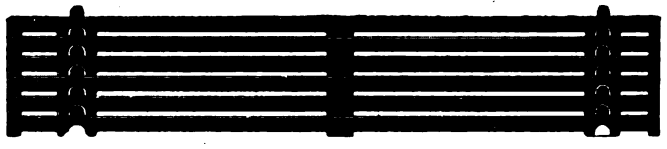


FIG. 8.—PLAN OF MELDRUM FIXED FIRE-BARS.

There are but two moving parts, the upper one being a measuring valve, and the lower one a "beater" or distributor. The speed of rotation of the measuring valve is controlled by a ratchet gear, which can be easily regulated. A hinged deflector is fitted above the beater so that the fuel can be directed exactly where required on the grate. With moving bars the fuel is thrown more to the front end, but with fixed bars it is evenly distributed over the whole grate.

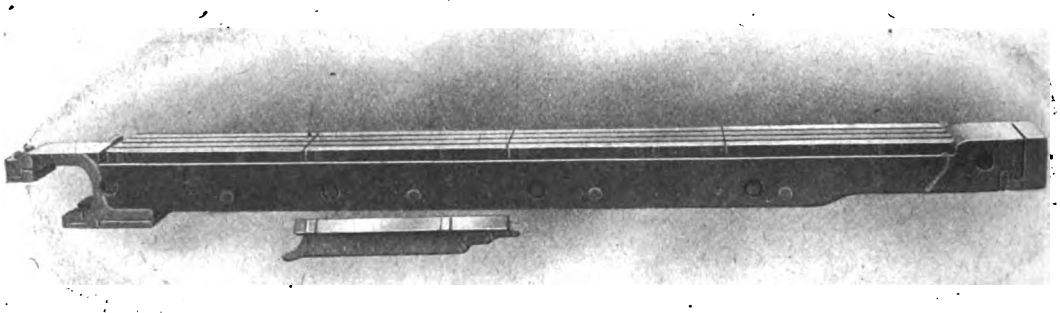


FIG. 9.—MELDRUM GRATE BARS FOR MECHANICAL STOKING.

Digitized by Google

GAS-FIRED BOILERS.

BY WILLIAM B. WOODHOUSE.
(Engineer of the Yorkshire Power Co.)

Many interesting figures have been published of coal-fired boiler efficiencies which reflect great credit on the makers of boilers and automatic stokers, but which give little or no indication of the average boiler efficiency obtained under working conditions day by day. Generally speaking it seems safe to say that this working efficiency does not exceed 60 per cent., which, as test conditions show, must be regarded as a low figure. This low figure is due to several causes, of which the first and most important has nothing to do with the stoker or the boiler, but depends on the fact that bituminous coal is not the most suitable fuel for firing.

Every furnace or fuel bed is, in its nature, a gas producer, and may be considered as divided into layers in the following order: At the bottom, unburnt coal evolving gas rich in hydrocarbons; next, the ash and clinker, entraining some unburnt coal; and at the top, burning coal. For a complete combustion the gases produced should pass through a final stratum of incandescent coke or coal with a low percentage of volatiles, so that the carbon monoxide meets with the top or secondary air at a high temperature, and in the presence of a radiant surface where its combustion can be completed rapidly.

Actually under working conditions, this is only partially the case, with the result that either smoke is produced or a large excess of air is used, either condition resulting in low efficiency.

Combustion of coal is a process governed by many variable conditions, such as the size of the coal and the proportion of moisture, ash and volatiles present in it; the nature of the ash, such as the presence of oxides and sulphur; the draught and the rate of feed of the coal; all of which are independent of the boiler itself, and the appreciation of which will one day perhaps encourage engineers to talk of furnace efficiency rather than to place all the burden of losses on the boiler, which is most usually a fairly efficient piece of apparatus.

Strictly speaking, each class of coal calls for a furnace or stoker designed for its special nature, but for a variety of reasons the same type of stoker is used for various coals. The results obtained on modern stokers under test conditions or in certain cases under working conditions have been so good that there has been a tendency to overlook the primary fact that coal is inherently unsuited for firing in its raw state, because the volatile constituents are too great in proportion to the fixed carbon, and because the ash interferes with proper combustion. On the other hand, coke firing, whilst it can be carried out successfully, is not highly efficient; the fuel easiest to fire would probably be found to be a semi-coke containing 15 per cent. of volatile matter.

It may be argued, of course, that a well-designed stoker does reduce the fuel to this condition before the zone of intense combustion is reached, but experience shows that in practice the average performance falls below that obtained with fuel of such a nature or with gas fuel because the variable conditions affecting combustion are too numerous to be subject to simultaneous control.

Now, if instead of using solid fuel we use gas derived from the distillation of coal the conditions are greatly simplified, first, because the quality of the gas may be kept approximately constant, and next because the variables are reduced to those easily controllable—viz., the volume, pressure and temperature of the gas and air.

The gases most likely to be available are approximately of the following constitution and characteristics:—

Composition and Characteristics of Fuel Gas.

	Coke oven gas.	Blast furnace gas.	Producer gas.
Composition, per cent.—			
Hydrogen	50	2	10—25
Carbon monoxides	8	28	11—23
Hydrocarbons	27	—	3
B.Th.U per cubic foot—			
Gross value	490	95	165
Net value	430	95	155
Flame temperature, °C.	1,600	900	1,200

Assuming, as one must, that the burnt gases leave the boiler at a temperature above the dew point, it follows that the net thermal value is the figure of merit to be used in comparing boiler performances with different gases, though on broader grounds the gross value or total heat in the gas must be regarded; in this connection the high percentage of water vapour in the products of combustion of coke oven or coal gas should not be overlooked.

The hypothetical flame temperature is also of importance, and a consideration of this point will explain why in certain cases the use of producer or blast furnace gas has given such poor results. Flame temperature is, however, controllable within certain limits either in the manner adopted by Prof Bone in the Bonecourt boiler, or by the preheating of the gas and air of combustion.

In firing gas the conditions necessary for perfect combustion are

1. Intimate mixing.
2. Correct proportion of gas to air.
3. Sufficiently high temprature of gas and air at the combustion zone.

The variables, therefore, are few in number, and there should be no reason for inefficient combustion under steady conditions of firing, and little reason even when the rate of combustion is varied, if suitable means are provided for controlling the mixture and pressure.

In the boiler itself certain practical advantages accrue from the absence of soot and dust, and the cleaner surfaces maintained.

The direct economies of gas firing are due to:—

1. Small excess of air.
2. Unvarying radiating surface of fire.
3. Clean boiler surfaces.
4. No loss in unburnt fuel or ashes.
5. Easy control of fuel supply.

The ease with which the efficiency can be checked is also a practical advantage, and experience has shown that with proper arrangements gas firing may be depended on to give slightly higher efficiency than coal firing under test conditions and, much more important, a substantially greater efficiency under practical working conditions.

As to practical results, the following figures may be quoted:

1. In connection with the use of coke oven gas on the Yorkshire Electric Power Company's system independent tests were carried out by Mr. W. M. Selvey, M.I.E.E., under practical working conditions, which gave the following results:

Boilers: Stirling, no economiser.
Steam pressure: 175 lb. per sq. in.
Steam temperature, 554°F.
Net heat value of gas: 399 B.Th.U. per cubic ft.
Temperature of inlet gas and air: 70°F.
Temperature of flue gases: 460°F.
Boiler efficiency, minimum: 80·2 per cent.
" maximum: 83·4 per cent.
" average: 82·5 per cent.
Period of test: 40 hours.

The test results are of particular interest in that the variation of efficiency from the average is so small.

In the above case neither the gas nor air were preheated, but in the use of lean gas this is essential to high efficiency because of the otherwise low flame temperature.

2. As an example of the effects of preheating, test figures published by Mr. J. J. Mackinlay, of Lilleshall ("Iron and Coal Trades Review," January, 19, 1917) are of interest. The gas used was blast furnace gas firing a Lancashire boiler, in one case without preheating, in the other using a preheater designed by Mr. Mackinlay. The results given are:—

	Without preheater.	With preheater.
Steam pressure, lb. per sq. in.	80	76
Steam per hour, lb.	5,600	5,600
Net heat value of gas	97	105
Temperature pre-heater, deg. F.	—	1,100
" furnace, deg. F.	1,100	1,645
" at damper, deg. F.	1,625	850
Chimney loss, per cent.	53·6	22
Radiation loss, per cent.	5	3
Efficiency, per cent.	41·4	75

Digitized by Google

The reason for the low efficiency of the first test is obvious from the recorded temperatures; when the preheater was used the furnace results were good. The high exit temperature of he gases points to the unsuitability of the boiler rather than o any defect of gas firing.

Finally, one must mention gas burners, if only because so much has been written on the subject; the essentials of a good burner are the ease of control of gas and air and provision for intimate mixing; a few hours spent in the laboratory trying the effect of varying the proportions of an ordinary Bunsen burner is an excellent introduction to the subject.

Enough has been said, perhaps, to indicate the view that gas firing is a scientific operation, which can be put in the hands of moderately skilled men to carry out, whereas coal firing is an unscientific operation which requires the continued care and attention of an expert if good results are to be obtained. All that is required is to obtain suitable gas at a price which compares favourably with coal, but, of course, "that is another story."

COAL CONCRETED FROM ASHES OR DUSTS.*

BY R. GOULBURN LOVELL, A.R.I.B.A.

When in France last year, lecturing to the troops, I found the dearth of fuel so pronounced that, at one of the largest training camps, there was a constant peril of the supplies entirely failing. As you are aware, our frugal neighbours utilise their coal dust by compressing it into briquettes. The plant is costly, considerable pressure is required, and, although the resultant fuel incandesces fairly well, it does not flare up nor does it coke. At the beginning of the year, during the very hard weather, the lack of supplies from England made it necessary to use up the coke dust, slack or debris of any calorific value. One's efforts were directed to finding some matrix that might bind the dust and ashes to form a fuel quickly, a fuel that would not disintegrate in the fire or during transportation.

In co-operation with my friend Mr. C. M. Hughes, we have evolved a process which will enable a fuel to be made without pressure at any industrial locality from the waste products to be found in that locality which may possess any calorific value. This process is a humble but very important part of a great scheme for the proper utilisation of fuel. It provides for immediate necessities and utilises a residual product now of comparatively small value.

The main problem before us is (*a*) the utilisation of the waste products of any calorific value; (*b*) the production by unskilled labour and existing machinery; (*c*) the saving of transport.

If a method of production could be found by which an aggregate of breeze could be concreted by such matrices as lime, pitch or glucose, the main problem would be nearly solved. Every architect or engineer will recognise the possibility of concreting by the addition of lime, chalk or other calcium carbonate. In producing a satisfactory fuel, the main objects aimed at would be non-friability, good flare, non-caking, good coking, good incandescence and non-clinkering, otherwise a free combustion with good calorific value at a low price. Further, the use to which the fuel has to be put must be considered. It has been ascertained, however, that from these varying conditions certain relative proportions can be determined of a more or less uniform character, and this has been systematically done.

A coal is here shown which has been concreted from coal dust alone, another from coke dust alone, another from destructor ash alone, another from destructor ash and coal dust, and another from clinker, bar ash and sawdust. It will be seen in the fire that the better grades burn like Nature's coal, the lower grades like coke; they all flare, coke and incandesce. Further, these artificial coals will be found to be more lasting, in the same way as a good artificial stone is more lasting than most stones made by Nature.

The machinery and plant required practically exists in all industrial centres. The essentials are crushers or breakers, screens, drying tables, mixers and moulds, such as cast-away pails, baths, &c. For the cooking process either ovens or boilers can be used, the main object at the present time being to utilise any existing plant with unskilled labour.

The cost depends mainly upon the value put upon the bases, the cost of the matrices, such as glucose, pitch and other bitumens, and the cost of the chalk or other calcium carbonates.

Speaking generally, the cost of the materials of these seven typical examples would be, roughly:—

Calorific values. B.Th.U.	Samples.	Per ton (shillings).
7,500	No. 1, Eastbourne destructor ash	11·0
8,040	No. 2, Maples destructor and coal dust	4·6
10,320	No. 3, Maples destructor and sawdust	9·0
10,540	No. 4, Birmingham destructor and coal dust	8·0
11,840	No. 5, Birmingham coke dust	7·0
12,600	No. 6, London coke dust	10·0
12,820	No. 7, Staffordshire coal dust	10·0

The cost of the labour and establishment charges in the British Isles would not be more than 5s. a ton.

* Abstract of a Paper read before the Society of Architects.

The author claims that millions of tons of coal slack can be concreted without pressure into an excellent coal; that all coke dust can be so utilised; that excellent fuel can be made from sawdust; that household ashes and municipal destructor ashes can be made into cheap flaring coke; that all industrial concerns consuming more than 10 tons of coal a day can reduce their bill by at least one-third, and that the necessary work can be done by existing machinery and unskilled labour. Licensees would be restricted to a 25 per cent. profit.

Mr. J. H. BOWDEN (Poplar) said he was particularly interested in the proposal, as from the central station point of view the removal of ashes and clinkers was a very serious item. He had 150 tons to dispose of per week, and he had to pay 3s. 6d. to 4s. per ton to have it removed. Moreover, this week he had received an intimation from the contractors who usually carted the ashes away that they would not be able to shoot any more after the next two months. What was going to happen after then he did not know, and this was only one comparatively small works in London. There were a number of points arising out of the Paper. What happened to the ashes of the artificial coal after it had been burned? He presumed there was a clinker left and could that be treated? Every clinker or waste product used must vary according to its nature. For instance, in his case in the riddlings that went through the chain grates there was a considerable amount of useful coal which went away in the ashes. He had tested this, and found it contained about 4,000 B.Th.U., and it was for throwing this away that he was paying 3s. 6d. per ton in cartage. If that particular stuff was treated in the manner suggested in the Paper, what did the author expect to bring it up to? He had also a destructor which gave about 20 to 30 tons of clinker per day, which he never thought there was any heat value in, because it was absolute clinker, which had to be broken up to be carted away. Did the author think this material likely to be of any value in his process? He would like some idea of the licence mentioned in the Paper, and as to what it covered, and also as to the cost of a plant dealing with, say, 30 to 40 tons per day. As far as he was concerned, he was quite sure his Borough Council would be prepared to consider the thing very seriously.

Mr. LOVELL, in reply, said the ash from the dust destructors was the thing that could not be got rid of, whereas the clinker was found useful for road making purposes. It was the ash that he was anxious to handle in his process, and he would be willing to carry out a test on that ash from Poplar, which he thought would probably produce 4,000 to 5,000 B.Th.U., and could be increased by the process to 10,000 or 15,000 B.Th.U. As to the cost of the plant, all he proposed at the present time was to use existing plant, such as concrete mixers, which was lying idle all over the country. In the cooking process any old form of boiler would answer the purpose, and in that case the mixture would have to be stirred. A rotary boiler would be so much the better. In his tests at Eastbourne he used old pails, into which the mixture was put and pressed down and allowed to cool, broken up and allowed to oxidise for a little time. The longer it was exposed the harder it got. Therefore he could hardly say what was the cost of the plant. The residue from burning this artificial coal could be used up again in the same way. With regard to the licence, in addition to the condition mentioned in the Paper that the coal must not be sold at more than 25 per cent. profit, the conditions were that the ash or refuse which was proposed to be used in any particular case should be sent to him for test and for determining the right formula for the mixture. For this test 50 or 60 guineas would be charged, and further, he asked 7d. per ton as a royalty on the whole of the material produced by the licensee.

Answering further questions, Mr. LOVELL said there were three methods of making the coal. It could be heated in moulds, it could be boiled in a tar boiler, or in sunny climates all that was necessary was to place the mixture in moulds and leave it exposed to the sun. His experiments with 2 or 3 gallons took about 20 minutes, and from that it seemed that any quantity could be boiled or heated in the same time if the containing vessel was large enough. He had received an estimate from responsible people to make the coal at 6s. per ton for the actual making. The proportions of the binder necessary in each case would have to be the subject of a special test in order to arrive at the formula. The proportions in the formula would depend upon the use to which the fuel was to be put, and they would vary according to whether the resultant fuel was to be used for domestic purposes or industrial purposes. In any event, he did not think the binder would exceed half; generally it was one-third. The provisional specification for the process was ready; he was advised

Digitized by Google

that the complete specification must not yet be published, but he would be pleased to show it to anyone interested.

Mr. LANCHESTER asked what was the nature of the matrices used.

Mr. LOVELL said any form of calcium carbonate, any form of bitumen and forms of sugar waste, the latter two being used as alternatives with the calcium carbonate. Calcium carbonate was always used.

Mr. W. R. COOPER said he was not quite sure whether the author realised what was being done already in the way of briquetting, and it must not be assumed that coal slack, or even coke breeze, was not used for steam raising. The assumption was sometimes made that slack and coke breeze could not be so used. That was a mistake, so that all that was left was the fine dust, and he was not sure that there was so much in that as the author seemed to imply. When one examined the question of waste coal, it was very often found to have a high ash content, and that was very much against it for general use. There was a popular idea that there was a great deal of waste coal to be found at the pits of a valuable character, but that was not the case. The author mentioned "flare" as one of the properties of his fuel, but he (the speaker) did not know that that was a good thing, because it meant smoke due to volatile matter. The tendency at the present time was to carbonise coal and recover the volatiles and avoid smoke as far as possible. Could the fuel be used advantageously in that way?

Mr. LOVELL replied that it could.

Mr. COOPER said that more information was desirable with regard to the actual process, as it was difficult to judge either the practicability or the cost of working. The author added incombustible matter to the fuel, and he would like to know the percentage of ash in the fuel to start with and the percentage of ash in the final product. The proportion of added incombustible matter was important, because, obviously, the higher the ash the less the value of the fuel. It was unfortunate that the complete specification could not be published.

Mr. LOVELL said that Mr. Cooper's queries would be answered by an examination of the tests that had been carried out, and he would be very pleased for him to inspect them. The "flare" properties would only be added to a fuel required for domestic purposes, as people liked to sit by a flame; but it would not be bothered about in a fuel for steam raising. As to further information with regard to the process, the difficulty was the formula, which could not be a standard one, and must be determined in each case. Beyond that, the process was a simple dry process without any pressure whatever. The only complex thing was the mixing. So long as the matrices and the aggregate were perfectly well mixed the result was satisfactory, as with the mixing of concrete. The temperature at which boiling took place was 100 deg. to 120 deg.

ASSOCIATION OF CONSULTING ENGINEERS.

The annual general meeting was held on Wednesday, May 30th, at the office of Mr. H. J. Rofe, M.Inst.C.E. (chairman of the Committee).

The CHAIRMAN (Mr. H. J. Rofe), in moving the adoption of the report of the Committee for the year 1916-17, remarked that periodical statements had been issued to the members referring to the chief subjects which had engaged the attention of the Committee, and these had been appreciated by the members. They had passed through another year of extreme depression for the consulting engineering profession, and there was little left for them now to do but to "hang on" if possible and keep their staffs together in the expectation of being called in to advise on the works which had been held over in this country during the war and the works of reconstruction which would be necessary in the countries of our Allies on the conclusion of it.

The Committee had kept in close touch during the year with the Local Government Board, and had continued to urge upon them the necessity for undertaking *now* the preliminary work on such schemes as are of urgent necessity, and which should be put in hand as soon as possible after the war. A register of work which the local authorities had in view had been compiled from the returns called for in a letter issued by the Board last year, and in the case where works were considered by the Board to be of an urgent nature a further communication had been sent out, suggesting that, in order to avoid unnecessary delay when the present restrictions on the execution of works and the raising of loans for the same were withdrawn, particulars of the proposed works should be submitted to the Board as soon as practicable, when they would be considered, inquiries held if necessary, and, if approved, brought to the point when the permission for the raising of the loan only would be necessary to put the work in hand. That placed matters in a much more satisfactory condition, and was, he thought, as far as the Board could be expected to go. The matter rested with the local authorities to take the initiative.

The Board had already in certain cases granted permission for the raising of loans sufficient to cover the fees and expenses incurred in reparing the necessary plans, specifications, schedules of quantities and estimates, and it was hoped that local authorities would take full advantage of that permission, which there was no reason to doubt would be extended to similar applications in respect of works of an urgent nature. From the point of view of the local authorities, naturally the first question they had to consider was the rate at which they would be able to raise their loans. It appeared to him that, although the work might be most urgent and the necessity fully recognised for properly considered schemes being prepared *now*, so that everything might be ready to commence work as soon as the demobilisation of men from the Army and munition works commenced, the local authorities would hesitate to commit themselves to undertake the work unless the Government guaranteed their loans for such approved schemes at a fixed rate of interest.

He thought it highly probable that if the local authorities had their doubts on that important point removed the preliminary work on a number of schemes would be put in hand at once, to the benefit of the country in general and of consulting engineers in particular. In response to applications from members asking advice on matters arising out of their individual practices, the Committee had been in communication with the Priority Committee of the Ministry of Munitions with regard to plant and machinery for export, with the Director-General of National Service with reference to the service of members, with the Passport Office of the Foreign Office, and with the Ministry of Munitions with reference to the schedule of protected occupations M.M. 130.

In the latter case it was pointed out that, whereas exemption was granted to mechanical and electrical engineers over the age of 23 engaged in professional occupations and on administrative staffs, no mention was made of civil engineers, and that in many cases the services of civil engineers specialising in water, drainage or constructional work were required before the mechanical or electrical engineer could proceed with his work, and that there was as much need for the exemption of their staffs as for those of the mechanical and electrical branches of the civil engineering profession.

Each year greater use was being made of the Association by individuals, local authorities and also Government departments, when requiring the services of a consulting engineer specialising in any particular branch of the profession.

He ventured to think that the Committee had done good work in maintaining the high standard of professional conduct among consulting engineers, and as the result of consideration of points arising out of the practice of individual members in co-ordinating the general practice of the members of the Association.

Mr. SPENCER HAWES (May & Hawes) seconded the adoption of the report, which was carried unanimously.

The CHAIRMAN next presented the accounts for 1916-17, in the absence of the hon. treasurer (Mr. S. R. Lowcock), and said he thought they did called for much comment. They were extremely satisfactory under the conditions. Of course, the cash balance was considerably reduced. The fact that they had a fairly substantial credit balance was fortunate, because the Committee had decided that, under the present circumstances, it would be advisable that the members of the Association should be relieved as far as possible, and they had reduced the subscription from two guineas to one guinea.

Mr. J. H. BLIZARD seconded the motion, and it was carried unanimously.

The HON SECRETARY (Mr. A. H. Dykes) then announced that the following gentlemen had been elected as members of the Committee: *London Members*: Mr. J. S. Alford, Mr. H. Howard Humphreys, Mr. James Swinburne, F.R.S., and Mr. G. Midgley Taylor. *Country Members*: Mr. W. Cramp and Mr. J. E. Sayers.

A vote of thanks to the honorary solicitor (Mr. F. E. Wright) was passed, while Messrs. Cash, Stone & Co. were unanimously re-elected honorary auditors and also thanked for their services. On the motion of Mr. A. A. CAMPBELL SWINTON a vote of thanks to the retiring chairman (Mr. H. J. Rofe) was carried by acclamation. A vote of thanks to the honorary treasurer and the honorary secretary, which was acknowledged by the hon. secretary (Mr. Dykes), concluded the proceedings.

Electrical Indicators for Level Crossings.—At the crossing of the Nashville-Memphis main line, with the Illinois Central line to South Memphis (U.S.A.), according to the "Railway Gazette," an all-electric signalling plant has recently been installed. Signal lamps are operated from a 110-volt alternating supply, but for the mechanism and control direct current is used. Emergency power is supplied by an Edison storage battery consisting of 90 cells of 150 amp.-hour capacity. Poplar Boulevard, which crosses all four railroads, is a street on which there is a dense traffic, many motorists using it, especially at night. Realising that the occupants of motor cars might frequently fail to hear the ringing of the ordinary crossing bell, and fail to note the approach of trains, a signal of the Brach type was installed—the "automatic flagman." This gives both a visible and an audible warning. It contains eight stationary electric lamps with red lenses showing down the street in both directions. These lamps are automatically lighted one after the other in a manner to give the effect of a swinging red lantern. Above the lights in large lettering is the sign "Railroad crossing," and a large locomotive-type bell, which sounds as trains approach.

Digitized by Google

The Electrician.
FRIDAY, JUNE 15th, 1917.

CHANGE OF ADDRESS.
The Editorial, Publishing and Advertisement Offices of
"THE ELECTRICIAN"
are now at
8, BOUVERIE STREET,
LONDON, E.C. 4.

Telegrams: BENBROTRIC, FLEET, LONDON.
Telephone: 9854 CITY, 4 lines.

SOME FUEL PROBLEMS.

On the eve of the Annual Convention of the Incorporated Municipal Electrical Association we take the opportunity of dealing with certain questions which are exercising the minds of progressive station engineers. Such questions are: Should raw coal still be used for power purposes? Should it first be subjected to a carbonisation process? Can gas coke be used to advantage? Or should the fuel be completely gasified and the boilers be gas fired? These are all large questions.

As some indication of the present position of affairs, we publish this week articles by Mr. J. A. CROWTHER, Mr. E. W. L. NICOL, Mr. W. B. WOODHOUSE and Mr. GEORGE WILKINSON. Mr. NICOL'S article deals with the use of gas coke. In this connection it may be said that much progress has been made in recent years. Engineers are already familiar with the use of coke in hand firing, steam jets being used for the purpose; but this is not sufficient where fuel is used on a large scale. It is necessary that coke should also be handled effectively by mechanical stokers, such as are commonly employed in coal firing. In mechanical stoking, however, various problems arise. Coke is characterised by the fact that it contains only a very small proportion of volatile matter, and, therefore, it is not nearly so easily ignited as coal. In any mechanical stoker it is necessary to allow for this difference. Provided that the preliminary ignition can be secured, coke presents certain distinct advantages over coal. Being comparatively free from volatile, there are practically no gases to be burned, and consequently much less excess air is required. The conditions of combustion are better. There can be a larger percentage of CO_2 in the flue gases, and consequently, from the point of view of combustion pure and simple, the result should be more efficient.

There is another aspect of the question—namely, whether it is an advantage to convert coal into gas coke, thus utilising the volatile constituents of coal for other purposes rather than burning them under a steam boiler. In looking at this point of view it must be remembered that the method followed by gas works is not the only means of making coke. In competition with this method there is the much newer one known as low temperature carbonisation. By this method the tar oils are recovered at a much lower temperature, and differ materially from those obtained by high temperature carbonisation. There is also a certain recovery of nitrogen, and the coke that is obtained is more easily combustible. So far, however, not very much is known of this method, although it is now many years since the ill-fated Coalite Company came before the public. But before so very long the works of the Barnsley Smokeless Fuel Co. should demonstrate what is possible in this direction, and such schemes as those at Brighton and Barnsley for the supply of power gas from low temperature carbonisation should give food for thought on the part of station engineers.

In all such schemes the problem of gas firing of boilers becomes one of great importance, and from this point of view the article by Mr. W. B. WOODHOUSE will be read with interest. It is clear that much too little is known as yet on the subject. The problem of really efficient gas burning, the perfect mixing of the gases, the minimum supply of air for combustion, the pre-heating of the gas, the type of boiler to be used, &c., all form part of the question of obtaining the highest possible efficiency by means of gas firing.

It will be realised, however, that the carbonisation of coal and the gas firing of boilers are only part of a much larger subject—namely, the treatment of coal so that a maximum return is obtained in the shape of oils, tar acids and ammonium sulphate, instead of losing these by using raw coal. People often talk of saving our coal supplies by means of this kind. Unfortunately, it must be realised that any preliminary treatment of coal does not save coal, for the simple reason that carbonisation necessitates the expenditure of heat units. There is, therefore, a certain loss in the process, and more coal must be used than would otherwise be necessary. It may well be, however, that the final result, everything considered, may be better and more economical when all the products are taken into account than the use of raw coal without any such preliminary treatment. This aspect of the case is taken up by Mr. GEORGE WILKINSON, and although we must confess that we cordially disagree with some of the sentiments which he expresses, nevertheless we have pleasure in publishing his article, as it calls attention to certain broad questions.

We feel that we must disagree with Mr. WILKINSON, more particularly when he expresses the view that linking-up is a matter of "theoretical interest," and that it is "difficult to make out a sound case for super-stations." We are willing to go so far as to say that linking-up cannot be universally applied, and that any attempt to apply it indiscriminately would lead to inefficient use of capital, owing to the fact that so many different systems are at present in use at the various stations throughout the country. But there are, no doubt, many cases in which the principle can be applied, and the committees that have so far been formed for linking-up are satisfied that a great deal can be done in this way. Mr. WILKINSON evidently takes the view that the super-station cannot provide any better results than those obtained at Walsall. We dealt with this point at some length in a recent issue of THE ELECTRICIAN, and all we need say on the present occasion is that the small station cannot possibly take advantage of the diversity factor obtained from a large area. Moreover, the results obtained at Walsall are by no means so convincing when they are subjected to close scrutiny. At present we must confess that we see every reason to pin our faith to the super-station, notwithstanding the views of Mr. WILKINSON. Further, when it comes to the question of preliminary carbonisation of coal we think it will be agreed that such methods can only be adopted satisfactorily on a large scale.

In order to emphasise the fact that opinions of engineers are very far from being formed upon the various problems to which we have referred, it is sufficient for us to indicate that the articles which we publish to-day are somewhat contradictory. In other words, the whole question is in a state of flux. Nevertheless, we feel that it is one of great importance to all station engineers, and we think they will do well to pay careful attention to any developments which may take place in the near future.

Digitized by Google

GAS BURNERS FOR THE FIRING OF BOILERS.

Having regard to the fact that the efficiency of gas firing must depend very largely upon the correct design of the burners that are employed, the following notes on the burners now commonly in use will be of interest. Performance results are not easily obtainable, but we are able to give a few efficiency figures, and in this connection we would refer our readers also to a later article describing a plant for coke firing alternatively.

POWER GAS ECONOMY CO.'S BURNERS.

We have received from Mr. T. M. Hunter particulars of the Terbeck burner and the Hunter burner. These are shown in section in Figs. 1 and 2. It is found that Terbeck burners as a rule are best for coke oven, wood distillation and town's gas. On the other hand, the Hunter burner is suitable for producer gas, and blast furnace gas, cleaned or uncleaned. The diverging shape of the Hunter burner avoids friction in the mixing tube, so that all the energy of the gas is available for drawing in primary air. Thus the weight of primary air drawn is maintained in almost a constant ratio to the weight of gas passing. Consequently the burner is self-regulating under considerable variations of gas pressure, and the flame is not extinguished by a sudden or great increase in gas pressure. The burner does not cause trouble by firing back when very little gas is passing: the velocity of the mixture at some point in the mixing tube may become less than the explosion velocity of the flame, and if so the gas burns from that point, but it automatically returns to the usual place when the velocity of the mixture is restored.

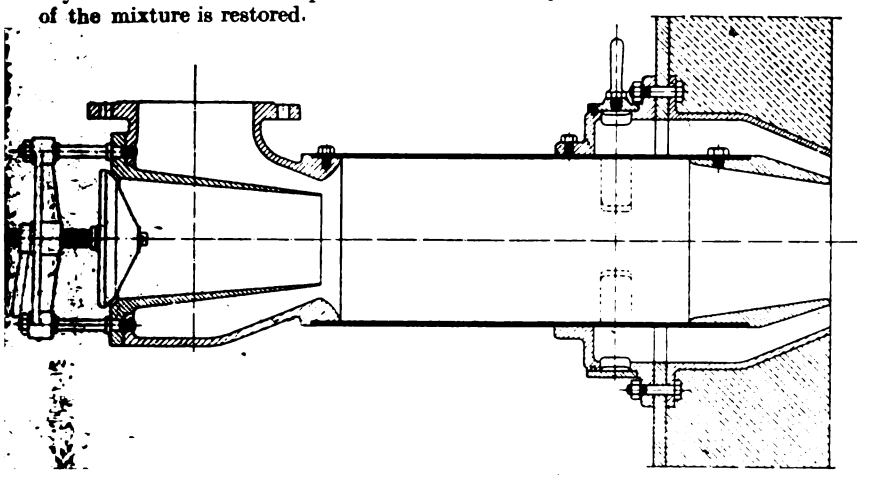


FIG. 1.—SECTION OF TERBECK BURNER.

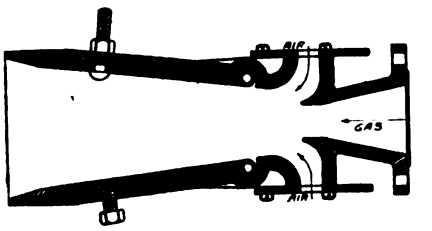


FIG. 2.—THE HUNTER BURNER.

losses in the boiler, (2) sensible heat and latent heat in the waste gases and (3) unburned gases in the flue gases. The essential requirement in any gas firing apparatus is the thorough mixing of air and gas before combustion takes place, and this can only be attained by some expenditure of power. In many cases

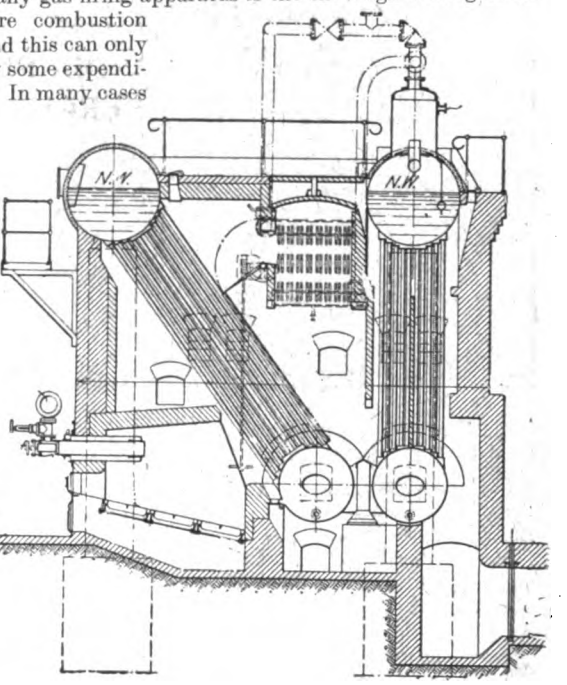


FIG. 3.—SECTION OF WATER-TUBE BOILER FITTED WITH TERBECK BURNERS.

Fig. 3 shows a section of a water-tube boiler fitted with Terbeck burners, whilst Figs. 4 and 5 are views of gas-fired boilers of the Yorkshire Waste Heat Co., and of Lancashire boilers fired with blast furnace gas. In the latter case the air is supplied under pressure, the pipe for this purpose entering at the back of the burner.

Results of Gas Firing.—Mr. Hunter states that the boiler efficiency obtained in gas firing varies from 70 per cent. to 85 per cent., depending on the conditions Using producer gas, the best results so far obtained are about 75 per cent., and with cleaned blast-furnace gas about 80 per cent.

The losses in gas firing are due to (1) radiation and conduction

the pressure at which the gas is supplied is sufficient for this purpose; for example, 2 in. to 3 in water gauge. In some cases, however, it is necessary to supply air under pressure, as shown in Fig. 5.

Unfortunately, full data of an authoritative kind in regard to gas firing are not easily available. The results in Table, obtained at the Barugh Power Station, are of some interest. Here Stirling boilers are used fitted with Terbeck burners and supplied with coke oven gas. The average actual evaporation was 25,450 lb. per hour

Table.—*Barugh Power Station. Evaporation Test on No. 2 Boiler. January* 21, 1914.

Time p.m.	Load.	Steam pressure.	Steam temperature.		Gas pressure at boiler.	Temp. of feed water.	Temp. of boiler-house.	Draft.		Temp. of flue-gases	CO_2.
			Superheated.	Saturated				Front.	Back.		
	Kw.	Lbs.	°F.	°F.	Ins.	°F.	°F.	Ins.	Ins.	°F.	...
3.30	1,606	142	540	366	3·0	125	40	0·8	0·9	460	...
3.45	...	132	570	352	3·0	130	40	8·0	0·9	460	...
4.0	1,621	160	590	360	3·2	133	41	0·8	0·9	460	7·8
4.15	...	165	572	363	3·3	130	41	0·75	0·9	475	8·0
4.30	1,73	165	580	363	3·2	130	39	0·75	0·9	475	7·7
4.45	...	170	580	362	3·3	131	39	0·75	0·9	475	...
5.0	1,707	173	575	362	3·0	134	39	0·8	0·9	470	...
5·15	...	165	572	363	2·8	135	40	0·8	0·9	470	7·5
5.30	1,210	140	542	350	2·9	135	40	0·4	0·4	44 ·	9·0
5.45	...	160	575	362	2·9	127	41	0·4	0·4	440	...
6.0	1,210	160	555	363	2·3	127	41	0·6	0·75	440	...
6.15	...	165	563	366	1·9	128	41	0·65	0·75	460	...
6.30	1,235	165	546	366	2·0	127	43	0·65	0·75	460	...
6.45	...	165	550	368	2·0	127	42	0·65	0·75	460	7·5
7.0	1,322	170	561	370	2·0	127	39	0·5	0·6	440	8·0
7.15	...	155	550	365	2·9	127	42	0·8	0·9	470	6·8
7.30	1,338	165	570	366	3·0	128	40	0·65	0·75	460	...

Digitized by Google

and the equivalent evaporation from and at 212°F. was 31,660 lb., the boiler having 6,000 sq. ft. of heating surface. It will be noticed that the average content of CO_2 was 7·8 per cent., so that the losses through waste heat in the flue gases were between 9 and 10 per cent. As the temperature of the boiler-house remained very

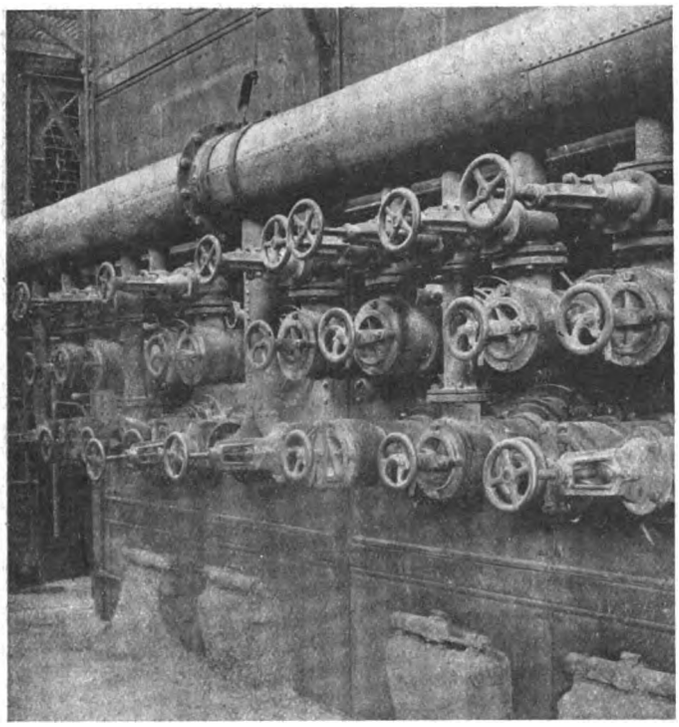


FIG. 4.—VIEW OF GAS FIRED BOILERS AT A GENERATING STATION OF THE YORKSHIRE WASTE HEAT CO.

low, it may be assumed that the radiation losses were low and that the efficiency was high.

Mr Hunter gives particulars of a test made on a Lancashire boiler 30 ft. by 8 ft. fired with blast furnace gas without superheater or economiser. Both gas and water meters were used for measure-

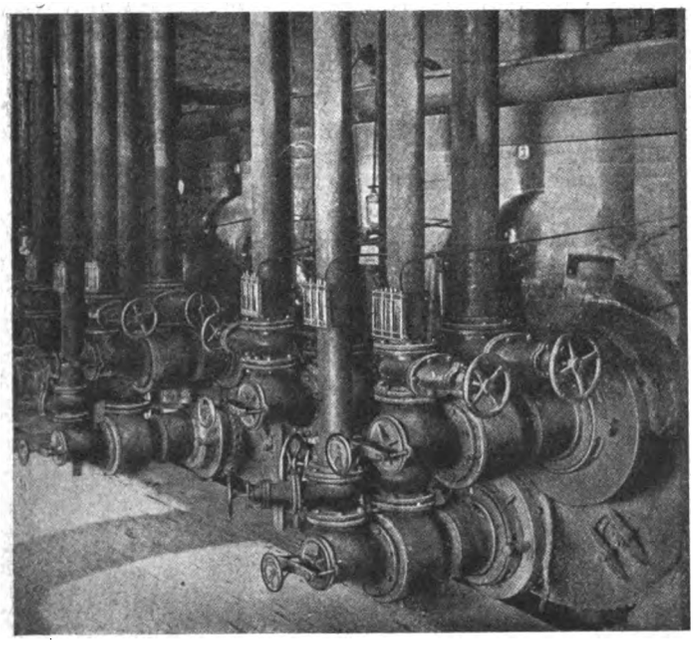


FIG. 5.—VIEW OF LANCASHIRE BOILERS FIRED WITH BLAST FURNACE GAS, AIR BEING SUPPLIED UNDER PRESSURE.

ments and the average evaporation was 6,290 lbs. per hour, actual, over a ten day's test. A boiler efficiency of 65 per cent. was obtained in this case. The average temperature of the waste gases was 350°F. and the percentage of CO_2 was 15.

The following figures apply to a Lancashire boiler, 30 ft. by 8 ft., fitted with an economiser and fired with Mond producer gas. The duration of the test was 24 hours and the figures given are averages:

Feed water, temperature	111°F.
Gas, temperature	84°F.
Gas pressure	2 in. W.G.
Steam pressure	78 lb.
Flue-gases, temperature	300°F.
Gas analysis :—	
CO_2	16%
CO	9%
H_2	19·2%
CH_4	1·2%
Calorific value of gas	98·7 B.Th.U.
Flue gas analysis :—	
CO_2	15·8%
O_2	0·8%
CO	nil
Evaporation per hour, actual	8,360 lb.
Evaporation per hour, from and at 212°F.	9,500 lb.
Loss by waste heat	13%

Finally Mr. Hunter gives particulars of results obtained with producer gas from a Moore producer. In this case a Lancashire boiler, 28 ft. by 8 ft., was used, fitted with superheater but no economiser. The test lasted 4 days, and the following are the average figures obtained :—

Feed water, temperature	49°F.
Gas temperature	51·5°F.
Gas pressure	7/8 in. W.G.
Steam pressure	63·5 lb.
Flue temperature	509°F.
Superheated steam, temperature	415°F.
Gas analysis	
CO_2	13·3%
O_2	0·1%
CO	15·4%
H_2	21·9%
CH_4	2·1%
Calorific value	135·8 B.Th.U.
Flue gas analysis :—	
CO_2	14·8%
O_2	3·8%
CO	0·4%
Calorific value of fuel as fired;	11,899 B.Th.U.
Evaporation per hour, from and at 212°F.	4,290 lb.
Evaporation per lb. of fuel put into the gas producer, from and at 212°F.	5·61 lb.

This test is of particular interest because it gives an idea of the overall efficiency of a plant completely gasifying the fuel in combination with steam raising, but no indication is given of the proportion of steam that is required by the producer.

HARPER'S BURNERS.

The burner due to Mr. F. D. Harper,* of Workington, is shown in Fig. 6. Mr. Harper finds that in most burners the mixing tube is

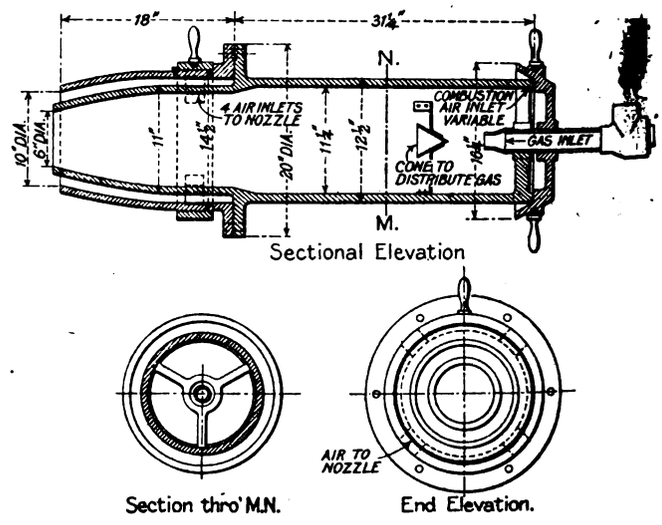


FIG. 6.—SECTIONS OF HARPER'S BURNER.

not large enough, and that consequently they require much regulating, and back fire if anything like the correct amount of air is employed. In the design shown in Fig. 6 the tube allows a con-

* British patent, No. 104,573.

Digitized by Google

siderable volume for mixing, and this is assisted by a gas-deflecting cone. Air regulation is effected by a cap which is mounted on the threaded gas inlet tube, so that it can be brought by rotation close up to the faced end of the burner or moved away from it as required, thus varying the air passages.

Mr. Harper claims that the chief advantage of his burner is that it will consume more air than any other without back-firing, and the regulating device is so arranged that it rarely requires alteration. Since the burner is enclosed, wind has no effect upon it.

We are informed that a number of these burners are in use and are giving satisfactory results.

"The Cumberland" Gas Burners.

The burners made by the Cumberland Burner Co. are in use in a number of installations. The makers claim that their burners will work efficiently with pressures down to ½ in. W.G. and chimney

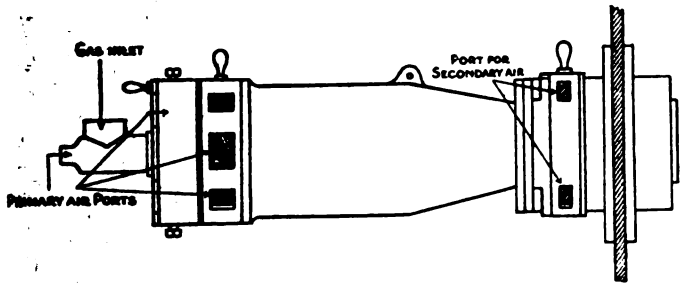


FIG. 7.—COKE OVEN GAS BURNER SUITABLE FOR LANCASHIRE BOILERS.

draught of ⅜ in. W.G. without back firing. To avoid back-firing some burners require 1½ in. to 2 in. W.G. Each burner will evaporate up to 4,000 lb. of water per hour, according to the calorific value and the pressure of the gas burnt. The interior of the burners is visible, and can be easily cleaned whilst working, so that no trouble is experienced by the collection of tar, carbon dust, &c. They are adaptable to all types of boiler, independently fired superheaters, reheating furnaces, &c.

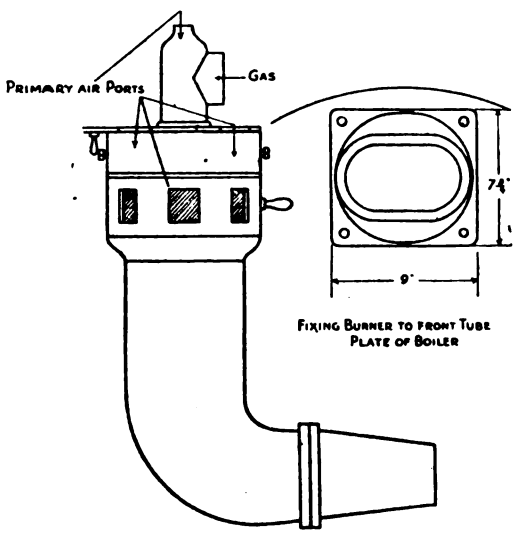


FIG. 8.—GAS BURNER SUITABLE FOR LANCASHIRE BOILERS IN COMBINATION WITH COAL FIRING.

From tests published by the makers we extract the following figures:—

—	1	2	3
Calorific value of gas, B.Th.U.....	540	540	128–135
Efficiency of boilers	76·5%	80·6%	72·1%
Evaporation per sq. ft. of H.S.	4 lb.	3·72 lb.	3·93lb.

Fig. 7 shows the Cumberland burner for coke oven gas, and Fig. 8 one suitable for producer gas, the burners being for Lancashire boilers in both cases.

Wellington's Gas Burner.

The burner designed by Mr. S. N. Wellington, consulting engineer of the Barnsley Smokeless Fuel Co., Ltd., differs from those previously described in that it includes a rotating propeller or fan, by means of which gas is supplied at a slightly higher pressure than that of the gas holder. The arrangement of the burner is seen in Fig. 10. Where use is made of producer gas, which has a large nitrogen content, this propeller also has the effect of causing thorough mixture of the gas with the controlled air supply. Further, the Venturi section of the burner tube causes vortex action, and thus a maximum of mixing is attained by regulating the speed of the propeller and the amount of air and gas to the burner.

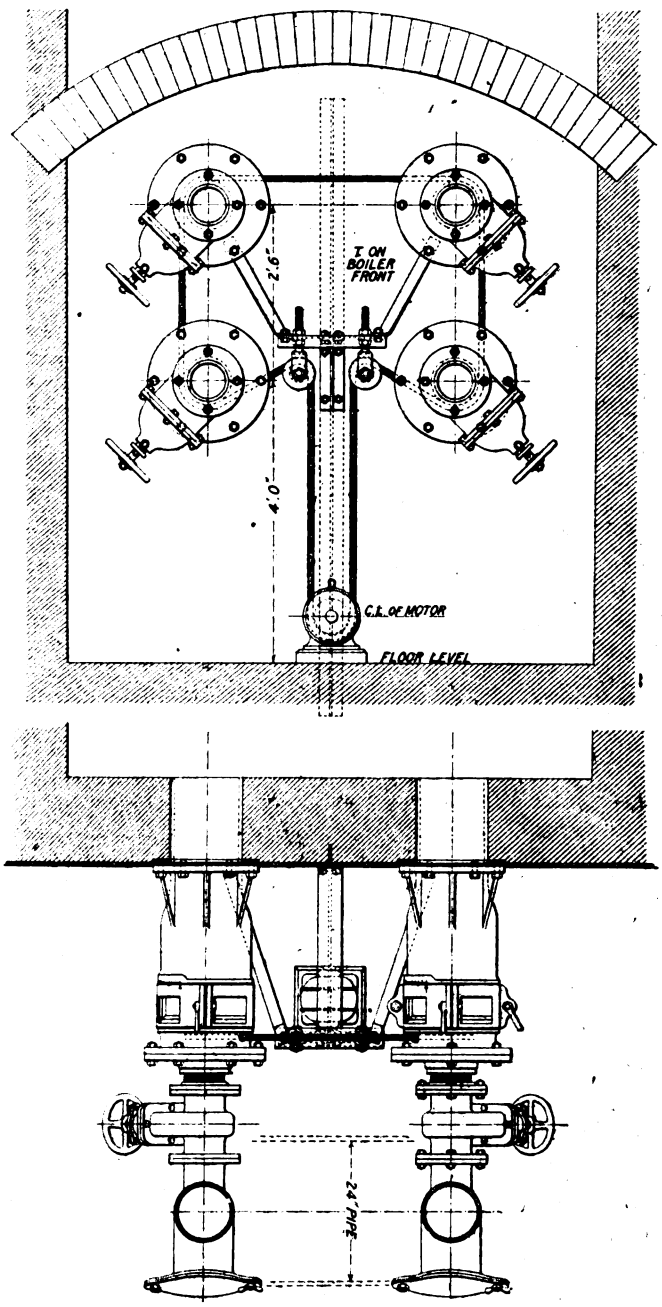


FIG. 9.—GENERAL ARRANGEMENT OF BURNERS FOR A STIRLING BOILER, SHOWING ROPE DRIVE. (Elevation and plan at Boiler front.)

The propeller is driven by an electric motor which is capable of running a number of burners by means of a single rope drive, as seen in Fig. 9, which shows the application of these burners to a Stirling boiler. If a long reducing flame is required the motor speed is maintained constant and the air ports are reduced. On the other hand, if an oxidising flame is required or one having a short high temperature flame, the air ports are opened and the motor speed is regulated until the required effect is produced. If the motor stops, the burner remains in action but is not quite so efficient. With low pressure supplies this arrangement is of great assistance in bringing the gas up to the required pressure.

Digitized by Google

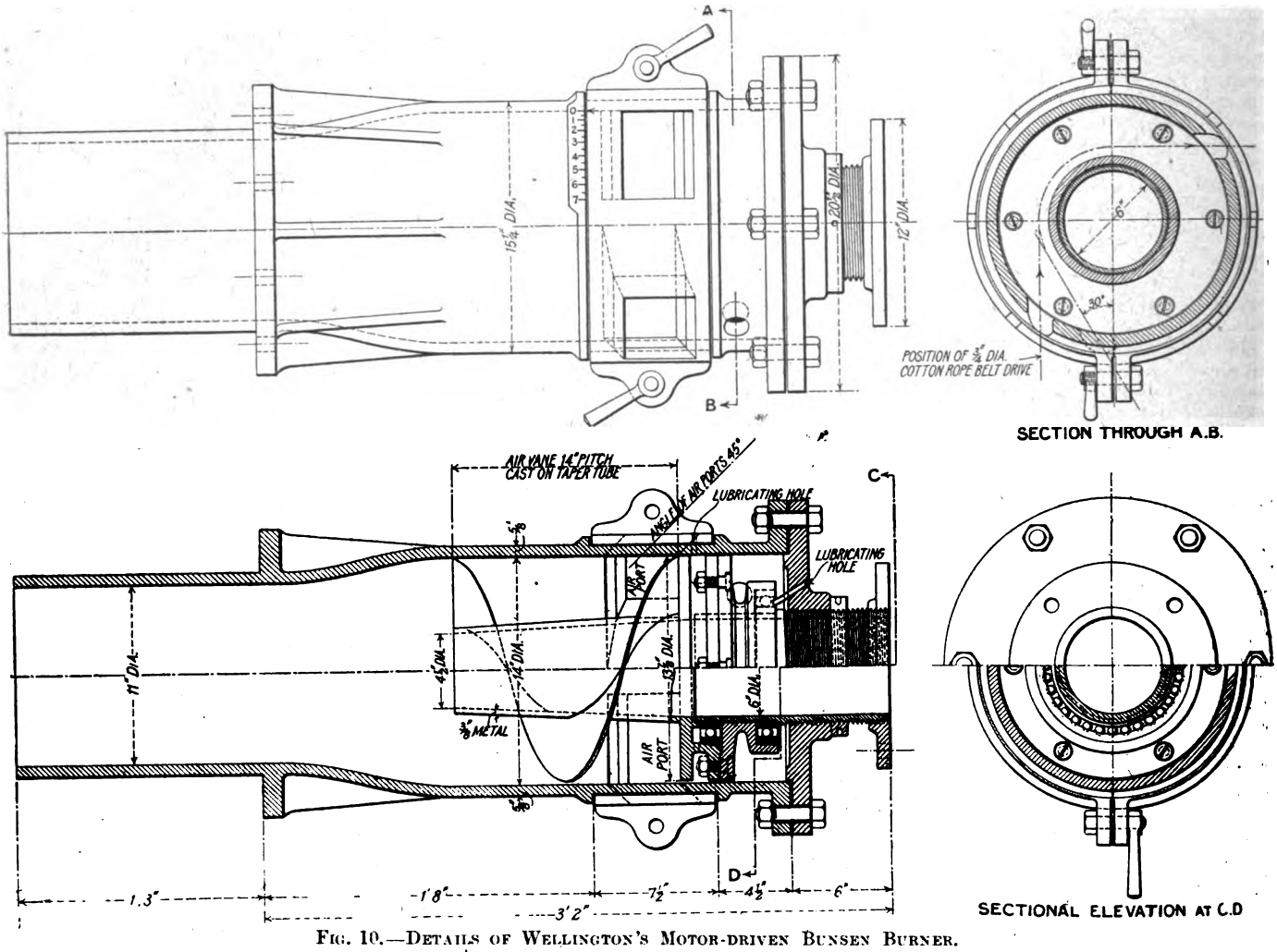


FIG. 10.—DETAILS OF WELLINGTON'S MOTOR-DRIVEN BUNSEN BURNER.

The propeller or fan is carried on a twin ball race, as shown, and the speed is maintained at about 700 revs. per min. We understand that a single cotton rope drive may be used to operate one to 12 burners from a single motor of ½ H.P. to 2 H.P. These burners are being fitted to the boilers in the works of the Barnsley Smokeless Fuel Co., Ltd., at Barnsley.

A DUAL METHOD OF MACHINE FIRING BY COAL AND GAS.

In connection with the articles on coke and gas firing, our readers will be interested in the following description of an installation in which the boiler furnaces are machine fired by the dual application of gas and coal. The installation has been carried out at the South Staffordshire Mond Gas (Power & Heating) Co.'s works, Dudley Port, Tipton. The plant comprises eight Mond producers, each capable of gasifying 20 tons of fuel per day of 24 hours, and generating sufficient gas to drive gas engines of 2,000 H.P. continuously. The total capacity of the present section is thus equal to 16,000 H.P.

The fuel is brought by boat into the canal basin, or by rail on to the siding, both having been specially constructed, and is loaded by hand into bunkers; the entrance to these from the boats is a little above water level, and at the ground level from the trucks. From these bunkers the fuel is automatically fed into two conveyors, each having a capacity of 40 tons per hour, which convey and distribute the fuel into the storage bunkers over each set of producers. The bunker over each producer will hold 40 tons—*i.e.*, sufficient to keep the producer working for two days.

The gas, after leaving the producers, is thoroughly washed in mechanical washers, and after passing through ammonia recovery and gas-cooling towers is further cleaned by three electrically-driven fans, each having a capacity of 12,200 cubic ft. of gas per minute. The gas, having been further cleaned and cooled by these fans, is passed through the scrubbers, after which it passes through the rotary meters before being compressed and sent through the mains for distribution.

In the Paper read by Mr. H. A. Humphrey before the Institution of Civil Engineers the writer states: "For each ton of coal gasified more than 2 tons of steam have to be supplied with the blast entering the firegrate of the producer, and although more than half the steam required is obtained from the system of recuperation by circulating water, which is employed in the Mond producer plant, yet a considerable balance of steam has to be made up. It is usual, therefore, to drive the greater part of the machinery by steam, and in the present instance steam is raised for this purpose at a pressure of 120 lb. per square inch, and, after passing through the various engines and pumps where it does work, the exhaust steam is collected and mixed with the air supply to the producers. 'Climax' water-tube boilers were chosen for raising the necessary steam, because they appeared to conform to the special requirements of the case. It was desirable that the boilers used should be capable of burning fine dust and small coal, which it was proposed to screen from the bulk supplied to the producers, and for this purpose the boilers had to be capable of working with forced draught. Also, in order to equalise the station load as much as possible, the boilers were to be gas fired during those portions of each 24 hours when the gas supplied to customers was comparatively small in quantity. And, lastly, for part of each day coal firing and gas firing were to be carried on simultaneously. Quick steam raisers were necessary in order to cope with the sudden demand for an increased supply, and the 'Climax' boilers seemed to meet all the conditions, and to provide the very large grate area required for burning small fuel.

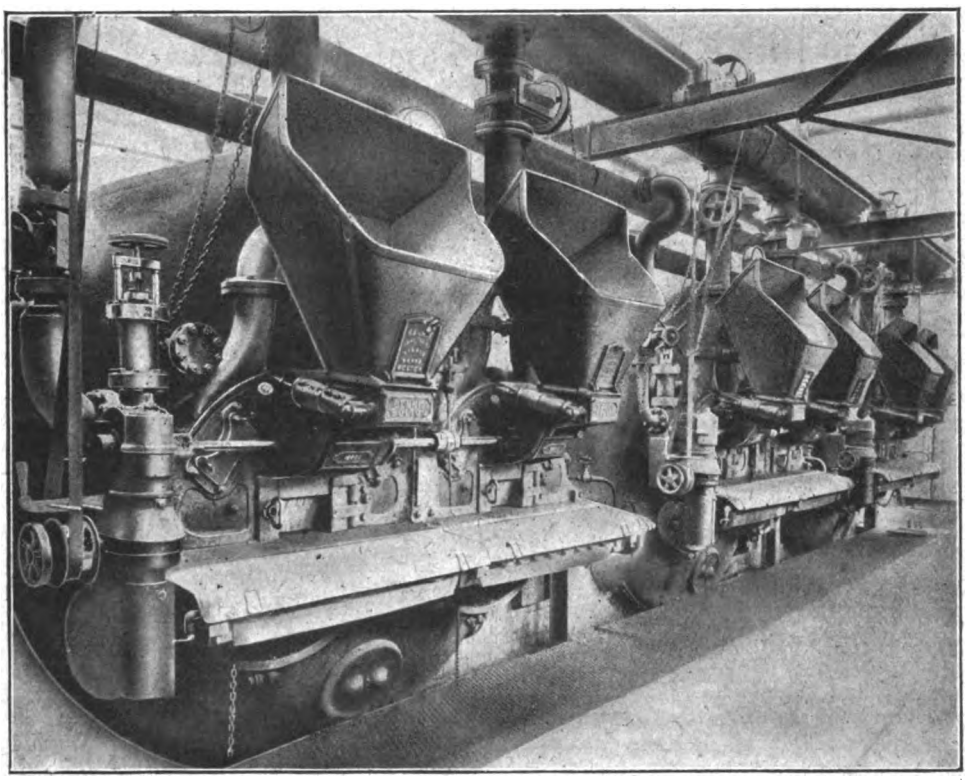
"Four 'Climax' boilers, each capable of evaporating 15,000 lb. of water per hour at a pressure of 120 lb. per square inch, were provided, two of these being sufficient to supply all the steam required. The author devised a method of gas firing these boilers whereby the ordinary coal firing is not interfered with. The gas is conducted in four pipes to a belt surrounding the boiler above the

Digitized by Google

firegrate, and is fired on the inside of this belt at a large number of 4⅜ in. holes. Each hole has a short 3 in. pipe protruding into it for supplying air, so that the air is in the centre and the gas surrounding it at each jet. The arrangement for gas firing worked well in practice, but as regards coal firing it has not been found advisable to screen the coal supplied to the producers, and ordinary slack coal is used when required.

"The water evaporated in the boilers, which is taken from the adjacent canal, is hard and not very suitable for the purpose. To purify the feed water a Mather-Platt water softener was installed, capable of treating 6,000 gallons of water per hour, and employing the usual treatment by lime and soda in the cold. It was found, however, that the cold purification was not sufficiently complete, and a considerable amount of scale was deposited in the boiler tubes, which, on account of their peculiar shape, were difficult to clean. A special feed heater using live steam was, therefore, installed, the feed was brought up to the full temperature corresponding with the steam pressure, and thus almost complete purification was obtained. Unfortunately, and contrary to all the author's previous experience with other types of boiler, it was found impossible to feed the 'Climax' boilers with the hot purified water, as excessive priming resulted. All kinds of remedies were tried, but as none proved successful even after the most careful investigation, this type of boiler has now been abandoned in favour of ordinary Lancashire boilers. The system adopted in gas firing the Lancashire boilers, which has been fitted in conjunction with Bennis' stokers for coal firing, is a very simple and successful means for solving a problem which is by no means easy.

"The method of combining the two systems of firing will be clearly seen from the views here shown, and a test lasting 40 hours with gas firing *alone* has shown a heat efficiency, as between calorific value of gas and heat in steam generated, of 79·1 per cent.



BOILERS EQUIPPED FOR ALTERNATIVE COAL AND GAS FIRING.

"Other interesting figures from this test are the following:—

"Steam pressure	84 lb. per sq. in.
Temperature of steam after superheating	332°C.
Test of flue gases	CO_2, 13 per cent; O_2, 5 per cent.
Volume of air supplied per 100 cubic ft. of gas burnt	158·6 cubic ft.
Losses to chimney stack (after superheaters and economisers)	11·4 per cent.

"The steam from the boilers is led to the various parts of the plant by ring mains, so that each steam-driven machine can be supplied through at least two separate lines of main. In fact, the steam mains, isolating valves, &c., require the same care to ensure a continuous steam supply as in a central electric station, and should be arranged so that any section may be cut out for repairs."

The stokers referred to above are the "Bennis" sprinkler type, of which an integral feature is the self-cleaning compressed air furnace. The boiler plant of the South Staffordshire Mond Gas Company consists of three Lancashire boilers, each 9 ft. by 30 ft., with extended flues, working at 120 lb. pressure. They are fitted with superheaters, the gases discharging into an economiser containing 4,000 sq. ft. of heating surface. The total grate area of each boiler is about 57 sq. ft.

A definite guarantee was given by the stoker makers that the evaporation of each boiler should not be less than 12,000 lb. of water per hour, with an overload capacity of 15,000 lb. per hour for short periods, and an over-all efficiency of 72 per cent.

We understand that the staff of practical chemists employed by the South Staffordshire Mond Gas Company were entrusted with the task of taking tests which should establish the results of the work actually done by the boilers. The tests showed not only that the guarantees were maintained, but an appreciable increase on the figures had been achieved. For instance, an overload evaporation of 17,000 lb. of water per hour from each boiler, instead of 15,000 lb. per hour, was obtained.

Prior to the installation, the South Staffordshire Mond Gas Company had found no little inconvenience owing to the fact that steam was required to be kept both during the night and from mid-day Saturday until Monday morning, when it was desirable that labour duties should stand at a minimum.

The problem was, Could the stoking plant be so arranged that it could be coal fed in the usual manner at ordinary times, and the boilers gas fired during the hours of night and at the week-ends? The flexibility of the system employed showed that the desired duality was perfectly practicable.

The gas ducts are let into the flange of the stoker front and secured by means of a gas-tight joint. The baffler plates, which are situated behind the front, are arranged with a passage, the outlet being over the grate; the gas thus passes from the ducts to the furnace. There are two ducts to each flue—that is, four to each boiler—each pair containing a breeches pipe placed immediately behind the hopper and passing thence to the gas supply, constituting an extremely simple and satisfactory arrangement. In order to ensure the requisite access of air to the gas, a valve is placed on the furnace front with an adjustable cover to regulate the amount of air supply. The air is conveyed into the furnace through a separate air duct, and does not mix with the gas until it reaches the inside of the flue where ignition takes place.

The results have been such as to justify the firm in applying the idea to all their extensions of boiler plant since the method was first adopted. The fact that repeat orders have been placed for machines of the same pattern to those already supplied, for their new installation of boilers, is in itself sufficient evidence of the efficiency of the method and its satisfactory solution of the problem it was designed to meet.

Useful Minerals in the United States.—According to the "Electrical Review and Western Electrician," a new booklet is being issued by the United States Geological Survey, entitled "Useful Minerals in the United States." The publication gives particulars of several thousand new localities where minerals exist, special interest attaching to the deposits containing uranium and vanadium in the high plateau district of the West.

Digitized by Google

COAL ECONOMY.

BY GEO. WILKINSON.
(Borough Electrical Engineer, Harrogate.)

There are few subjects more alive to-day amongst engineers and power producers than the problem of coal economy; in fact, along with the question of "linking up" it may be said at present to occupy practically the whole area of investigation by power-house engineers.

Linking up is at present more a matter of theoretical interest than of practical utility and with a few exceptions it is difficult to make out a sound case for super-stations and linking up, especially in the face of such results as have been obtained in Walsall and elsewhere.

The problem of coal economy, however, stands on a different and sounder basis. The needs of the country at the moment and the strenuous competition for business which will arise with other nations immediately after the war raises the question into one of pressing moment.

It is clear that power-houses of from 2,000 H.P. to 5,000 H.P. have come to stay, also that the larger mills and factories owning their own steam and electric power-house will not find it economical to scrap their own plant in favour of a power supply from outside. Thus, until some fundamental development takes place in the production of power—and such development is nowhere in sight at present—large numbers of boiler-houses of moderate size will continue in use; therefore methods of economy must be found which are applicable to these cases.

The most effective blow that can be struck against the present day waste of coal is to stop its use both in boilers and in the domestic grate in the raw state. It would be wise legislation on the part of the Government, as already suggested in the public Press, to pass an Act prohibiting, under heavy penalties, the use of coal for such purposes in its raw state after a certain date and offering special inducements to cease its use at early periods.

In the home this can be met by the use of electric and gas stoves, also by the use of a suitably prepared fuel of the coke order in the open fire grates. Economies in the electric power house due to improved methods of combustion would facilitate electric developments in the home by providing a supply at cheaper rates.

The question of pressing moment is, how is this economy of coal in the power station to be effected?

Some advocate the use of coke in place of coal for firing the boilers. This is not a practical solution:—

1. Because enough coke is not available for the purpose.
2. Because the increased demand would soon put up the price of coke to a prohibitive figure.
3. Because coke, even under the most favourable conditions, cannot produce more than approximately half the steam from a given boiler plant as compared with good coal.

All these are serious difficulties and the last objection alone rules the idea out because no undertaking would be willing or able to incur the cost of doubling the size of the boiler-house and the number of boilers to procure the same amount of steam from coke fuel which is now obtained from coal. Our boiler equipments are already too big and unwieldy.

Again, other experts advocate the substitution of gas firing, which is a much better proposition, but it is just as effectively barred out with negligible exceptions due (1) to no gas supply being available, or (2) where available, the cost of supply is absolutely prohibitive and cannot compete with coal.

Although it is possible to devise high duty boilers and efficient means of firing with gas, no gas undertaking with present day methods can supply gas at a price low enough to be attractive. The writer has investigated this point repeatedly on behalf of local authorities, both in cases where the gas works is owned by the authority and where owned by a company, but always with the same result, viz., that the cost does not come out anywhere near the cost of using coal.

Schemes have been prepared for producing the necessary gas on site and alternative methods are available for this purpose.

The first involves the use of ordinary gas retorts on the lines in use by the gas supply undertakings, but the heavy cost of plant and the extra labour involved decidedly outweighs the economy and advantages realised by gas-firing the boilers.

The alternative is the introduction of producers furnishing from coke or small coal a crude gas of low calorific value. Serious difficulties here again present themselves as the plant occupies large floor space, it involves an increase in capital outlay by at least three times over a coal-fired plant of equal output, it is also devoid of the necessary flexibility of output and is most expensive for extra labour in operation.

Shortly stated, there is no gas plant available at present which can be introduced as an economy over coal firing. The difficulty, however, is not an insuperable one and there is a wide field awaiting the advent of a self-contained gas and steam producing unit of reasonable size and cost, which will furnish by-products from the coal and at the same time realise the exceptionally high duties and efficiencies which are to-day being realised by the few gas-fired boiler installations in use.

Such plant must not entail a heavy increase in labour charges, it should call for no greater floor area for a given output of steam than coal plant, it should be sufficiently flexible in output to correspond with the fluctuation of demand and it should call for no more skill or intelligence in operation than is found in the average good boiler attendant and fireman.

In the author's view there is evidence to show that success is possible on the lines indicated and it will doubtless be achieved.

It is satisfactory to note that the Government is alive to the importance to the country of economy in coal and that the Privy Council has recently constituted a Board of Fuel Research charged with the prosecution of work and investigation in this direction.

The following notice has recently been issued to the public by the Press Bureau on behalf of the Government:—

> The Ministry of Munitions wishes to impress upon the public the desirability of limiting in every way possible the consumption of raw coal for industrial and domestic purposes. The valuable by-products of raw coal, which are essential for munitions of war and for food production, are recoverable only when the coal is dealt with at gas works or otherwise under proper conditions. Accordingly, whenever circumstances permit, coke and coal gas should be used instead of raw coal for steam raising, heating and cooking purposes.

It is impossible to add anything to the force of this direct and important appeal.

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. S. Clay, V.D.

Orders for the week:

Officer for the Week.—Platoon Commander No. 3 Coy.

Next for Duty.—Platoon Commander P. Bowden.

Appointments.—Sergeant E. A. Ullmann to be Platoon Commander, (dated 4/6/17).

The following to be Corporals:—H. G. Wood, W. J. Cross, G. J. D. Scott, W. E. Ismay.

The following to be Acting Corporals:—J. W. Brooks, A. E. Salisbury, W. Langford and G. T. Gillespy.

All in No. 3 Coy.

Monday, June 18.—Technical for No. 3 Coy., right half coy., at Regency-street; drill, No. 3 Coy., left half coy.; signalling class; recruits drill, 6.30.

Tuesday, June 19.—Lecture 6.30, Sergt.-Instructor Higgs, "Pontooning"; physical drill and bayonet fighting, 7.30

Wednesday, June 20.—drill, No. 1 Coy., Left Half Coy

Thursday, June 21.—Drill, No. 2 Coy., Left Half Coy.; ambulance class 6.30; signalling class.

Friday, June 22.—Technical for No. 3 Coy., Left Half Coy., at Regency-street; drill, No. 3 Coy., Right Half Coy.; recruits' drill. 6.30.

Saturday, June 23.—N.C.O.'s Class, 2.30, under Coy.-Comdr. Hyman and the Instructor of Musketry.

Sunday, June 24.—Parade Clapham Common (Tube Rly.), 9.45 a.m. for work at Bombing School. Uniform. Rations to be carried.

Armlets.—Members are warned that armlets must be worn at all plain clothes parades.

Musketry.—For all companies see notice at Headquarters.

Note.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street).

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Federation of British Industries. At the recent meeting of the Metropolitan Carriage, Wagon & Finance Co., Mr. F. Dudley Docker, C.B., gave particulars of the progress made by Federation of British Industries. Last year there were some 80 members, but the total was now between 400 and 600, comprising representatives from practically the whole of the trading community.

Mr. Docker said the membership was steadily growing, but they wanted a minimum of at least 1,000, and they were going to get them. There had never been a time in the history of the country when it had been so necessary for all to stand united, so that, though they were caught unprepared for war, they should not be found unprepared for peace. The federation would, and must, command the attention of the Government when framing industrial legislation, and be the established body to whom it would be essential to turn in all matters affecting trade, not only in the interests of the trading community, but also of the people as a whole.

After a reference to the British Trade Corpn. scheme, Mr. Docker said that in regard to dealings with labour another wave of mischievous criticism had been experienced. Doubts were cast on the integrity of business men, and an attempt was being made to drive a wedge between the manufacturer and their employees. Since the war broke out most of the manufacturing companies had been controlled firms, and had had nothing whatever to do with the question of wages or the adjustment of labour differences. They had not been consulted in any direction. The result was that strikes were as frequent and disturbing as ever. He thought a strong case had been made out for the employer to deal with his own men and their unions without outside interference. He thought in that case there would be fewer strikes and better wages. In that connection he referred to the formation of the National Alliance of Employers and Employed, the meetings in support of which in large industrial centres had had a good effect, engendering an atmosphere of greater friendliness, which he trusted would make further negotiations easier and more productive. In the future they must look forward to big trade developments, and unless capital and labour played their proper parts it would be impossible to regain the Empire's commercial supremacy.

* * * *

British Trade Corporation. A special meeting of the Council of the London Chamber of Commerce was held last week to consider resolutions adopted by the Merchants' Committee and the Financial and Manufacturers' Section of the Chamber on the proposal to establish a British Trade Corporation.

The opinions of these sections of the Chamber had been invited in order that the Council might come to a decision in view of the criticisms of the scheme in Parliament and elsewhere. After a lengthy debate, the following resolution was adopted unanimously: "That the Council being in full accord with the general objects set forth in the report of Lord Faringdon's Committee on 'Financial Facilities for Trade,' and warmly welcoming the intention of the Government to establish a corporation for stimulating and financing British enterprises, desire, however, to express their view that certain of the provisions of the general scheme appear to have a tendency to confer a monopoly, and that it should be clearly provided that the Corporation shall safeguard the interests of merchants and traders, and not engage in direct trade in competition with them." It was also decided to ask the President of the Board of Trade to receive a deputation on the subject.

On the other hand, Sheffield Chamber of Commerce consider that the recent criticisms upon the Corporation are unwarranted and ill-founded, and that, in the interests of British trade, it is of vital importance that the Corporation should commence its work without a moment's delay.

It is generally admitted that the powers of the Corporation may be so employed as to put it into competition with merchants and traders, and the Law Officers of the Crown are considering what amendments may be necessary in order to make the position quite clear on this point.

* * * *

Labour Unrest. The Prime Minister recently announced that he proposed to appoint commissions which would investigate the question of labour unrest and its causes. On Monday the names of the Commissioners were published, and are as follows:—

(1) North-East Coast.—Sir Thomas Munro (chairman), Mr. P. Bright (employers' representative) and Mr. H. Davies (employees' representative). (2) North-West Coast.—His Honour Judge Parry, Mr. John Smethurst and Mr. J. R. Clynes, M.P. (3) Yorks. and East Midlands.—Sir George Croydon Marks, M.P., Sir Maurice Levy, M.P., and Mr. J. J. Mallon. (4) West Midlands.—Major J. W. Hills, M.P., Mr. J. W. White and Mr. A. G. Cameron. (5) London and South-East.—His Honour Judge O'Connor, Mr. Allan M. Smith and Mr. J. Voce. (6) South-West.—Mr. W. W. Mackenzie, K.C., Sir A. Booth and Mr. G. Chambers. (7) Wales, including Monmouthshire.—Mr. Llewfer Thomas, Mr. Thomas Evans, and Mr. Vernon Hartshorn. (8) Scotland.—Sheriff T. A. Fyfe, Mr. Noel E. Peck and Mr. J. W. Ogden, J.P.

It is proposed that the Commissioners shall begin work immediately.

Storage Battery Combination. It has been repeatedly pointed out that one great advantage Germany possessed over Great Britain was the fact that her manufactures were carried out on a larger scale and that there was a greater community of interests between trade concerns than in this country. If, therefore, we are to be in a position to compete with Germany after the war it is evident that the large number of small concerns which are competing with each other in different branches of electrical work will have to combine. An important step in this direction has been taken by three battery concerns—the Hart Accumulator Co., the Pritchett & Gold and Electrical Power Storage Co. and the D.P. Battery Co.—who made a joint offer for the shares in the Tudor Co., recently advertised for sale by the Public Trustee.

This offer has been accepted, and it is satisfactory to note that arrangements have been concluded for the managers of the Tudor Co. to remain in office, thus ensuring continuity of business. As a natural sequence to the purchase of the Tudor shares, it is announced that negotiations are in progress for an amalgamation of the four companies, and it is hoped that a scheme will soon be evolved under which the united experience and connection of the various companies can be turned to the best account.

Progress of Electric Power. We are pleased to see that the South Wales Electrical Power Distribution Co., one of the pioneer power companies, has made substantial progress during the past year, when over 30,000,000 units were sold, an increase of nearly 1,100,000 units over 1915. Motors of 7,422 H.P. were added to the connections, making a total of about 40,000 H.P.

In responding to an appreciative reference by the chairman to the services of the general manager, secretary and staff, Mr. W. A. Chamen said there had never been a time when the prospects of the electrical industry in this country showed so much promise as now. Perhaps a new departure which was likely to come about within the next few years was the application of electricity to agricultural purposes, not merely in ploughing and performing agricultural operations, but in the actual stimulation of the growth of crops. Experiments were being carried on actively at Hereford, and he saw no reason why, as those experiments promised so well, a great deal of the same kind of thing should not develop in rural districts, such as the Vale of Glamorgan and the Cowbridge area.

* * * *

Electricity Supply in Salford. The annual report of the Salford Corporation electricity department is abstracted in another column, and the manager (Mr. J. A. Robertson) and his staff are to be heartily congratulated upon the notable success they have achieved under conditions of difficulty. The output was increased by 4,700,000 units, owing to the demand for power; the gross profit was about £16,000 and the net profit about £5,000 more than in the previous year. A sum of £12,000 was devoted to the relief of rates and a balance of £9,300 carried to the renewals fund.

The most satisfactory feature, however, is the modernisation of the generating plant which has been carried out during the past three years, mainly out of the renewals fund. We have always been strong advocates of the creation of adequate reserve and renewal funds for electric supply undertakings and the experience of Salford clearly proves the great utility of these funds, especially in times of crisis like the present when there are difficulties in obtaining borrowing powers. As there is no well-managed progressive business without its reserve, depreciation and renewal funds, so there should be no municipal electricity undertaking without adequate financial resources, in the shape of reserve or renewals funds to meet contingencies, to provide for the obsolescence of plant and to pay for connecting up new consumers whenever necessary. As our readers know, the legislation relating to the electric supply industry is not very satisfactory, and we think the time has come when every undertaker—local authority or company—should have adequate powers to develop its undertaking to the utmost. The good of the community requires this much and we hope that one of the results of the Electric Power Committee of the Board of Trade will be a codification of the Electric Lighting Acts and such a modification of the law as will remove the present shackles upon the industry.

* * * *

Controlled Establishments. It is announced that the Minister of Munitions has made further orders under the Munitions of War Acts, 1915 and 1916, under which 44 additional establishments have been declared controlled establishments, bringing the total number of controlled establishments up to 4,942.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Derby.—To cover the cost of extensions at the electricity generating station application has been made for sanction to borrow £7,500.

The Council is also recommended to sanction an expenditure of £2,000 for mains and £4,000 for electric motors, and application is to be made for sanction to borrow these amounts.

Hackney (London).—In November last application was made to the L.C.C. for a loan of £6,500 for linking-up the Council's undertaking with the North Metropolitan Electric Power Supply Co.

It appears that the Borough Council has no authority to borrow money in respect of expenditure upon work outside the Council's area, and the arrangements with the North Metropolitan Co. have been modified so that the company shall defray a moiety of the cost, and the Council will provide the other moiety (£3,500) in respect of works wholly within the Council's area. Upon the loan of £9,685 for extensions of the electricity station buildings, &c., the rate of interest will be 5 per cent. and it is proposed to take up this loan from the L.C.C.

Luton.—Application has been made to the L.G. Board for sanction to borrow £3,660 for extending the supply mains to various factories.

Tonbridge.—Last week the Urban Council decided to sanction extensions of the electric supply undertaking in order to be able to supply electrical energy to two large works in the district.

The chairman of the Electricity Committee (Councillor P. G. LAWSON) announced that they had received a letter from the Eyre Smelting Works, stating that the firm were prepared to sign an agreement to take a certain amount of electricity from the Council, and also another large firm had made an application for a supply of electricity on the following terms: Consumer to pay loan charges in respect of cost of overhead cables from works (estimated at £2,400). No guarantee would be given as to quantity of electricity to be consumed, but, in the event of the annual revenue exceeding £1,200, 10 per cent. on amount of loan charges was to be deducted for each £120 of additional revenue. He moved that the chairman and clerk be authorised to affix the seal of the Council to the agreement with the Eyre Smelting Works on an assurance being obtained that the loan of £2,730 could be obtained at a rate not exceeding 5¼ per cent. The other firm's application was for an amount of power which meant doubling their output at least. If they had had their way they would have deferred the work till after the war, for the present was a very expensive time for extensions. They did not know whether the cost of engineering works had reached its maximum; they certainly did not think it was likely to be much reduced when the war was over, nor possibly for a number of years afterwards. But the war had brought them that business, and it rested with them to take the opportunity for extension, for although the business involved the spending of a large amount of money it also had the advantage that they had immediate customers and were assured of a large guaranteed income, which would nearly cover the working cost and loan charges on the capital raised. Last year's output was 346,000 units. The first of the new customers would require 300,000 units, and the second 384,000 units, which would amount to £4,275 per year. The capital required was £17,000, which at 9 per cent. for loan charges would represent £1,530 per year. He was more than ever convinced of the possibilities of Tonbridge as an industrial centre. Its geographical position and its position as a most important railway junction made it a highway to the Continent, and if they were in a position to supply unlimited cheap power, there was nothing in the way of making Tonbridge one of the most attractive of industrial positions.

Wolverhampton.—The Electricity Committee report that with regard to a proposed extension of plant estimated to cost £67,100, the position had recently changed, in consequence of representations made by a Government department.

Further supplies of current had been asked for, the department itself requiring another 4,000 kw. It was, therefore, necessary for further boiler plant to be provided at once. The boilers originally arranged for, even with a special priority certificate, could not be made until very late in the year, and the Government department agreed that, in order to meet the new conditions, it would be necessary to commandeer (if possible) boilers made for another purpose. Through re-arrangements made elsewhere, the Government were placed in possession of a number of Stirling boilers which were being completed for other work. These boilers were each smaller than those already arranged for, and the electrical engineer (Mr. S. T. Allen) had prepared a scheme for utilising three of the smaller boilers instead of two larger ones. The estimated cost, including the three boilers with mechanical stokers and an extra chimney stack and flues, is put at £24,687, compared with £18,457, the amount of the tenders which the committee had proposed to accept, but the evaporative capacity of the three boilers would be 20 per cent. higher than that of the two original boilers. The Corporation, however, think that only £2,960 of the extra cost should be borne by them.

The chairman of the Electricity Committee and the Electrical Engineer have been authorised to accept a tender for e.h.t. switchgear, estimated to cost £2,100.

An agreement has been entered into with Messrs. Albright & Wilson for a supply of electrical energy.

GENERAL.

Birmingham.—The accounts of the tramways and electric supply departments for the past year were approved by the Corporation last week.

Certain increases of tramway fares were authorised.

It was also decided to purchase a piece of land at Nechells at £1,600 for the electricity department.

Board of Trade Electric Power Committee.—In addition to those previously mentioned in our columns, the following local authorities have passed resolutions protesting against the inadequacy of the representation of municipal electricity undertakings on the committee.

Burnley, Canterbury, Carlisle, Colchester, Exeter and Gloucester Corporations and St. Anne's-on-the-Sea and Tonbridge Urban District Councils.

Bootle.—The Electric Power and Lighting Committee has had to decline new consumers as the capacity of the generating plant has been reached, and new plant cannot be obtained. The new consumers would have meant a revenue to the committee of about £9,000.

Clayton.—A further discussion on the electric supply question took place at the recent Council meeting.

Mr. ANDREWS moved that the Council rescind its resolution (passed on Dec. 6, 1916) whereby it gave consent to the granting by the Board of Trade to the Electrical Distribution of Yorkshire (Ltd.) of a provisional order. He said the Council ought to be prepared to open up the question of the merit of the schemes of the company and Bradford for supplying electricity to Clayton.

During the discussion it was pointed out that the Council were not in possession of Bradford's final terms, and to throw over the company before knowing Bradford's terms would decrease the Council's bargaining power. Eventually Mr. Andrews agreed to postpone his motion until a future meeting of the Council.

Derby.—Last week the Council revised the scales of pay and war bonuses for their employees.

In the course of the discussion Ald. Wilkins stated that at the electricity works 72 men were now doing for £142 a week the work for which 108 men were paid £168 before the war, while output had increased from 7,000,000 to 12,000,000 units.

Falkirk.—The burgh electrical engineer (Mr. R. Allan Brown) has resigned in consequence of his acceptance of a commission in the R.N.V.R., attached to the R.N.A.S. The Council are endeavouring to find a substitute to carry on until the conclusion of the war.

Halifax.—At last week's meeting of the Corporation Ald. Spencer submitted an option to purchase land at Copley as a possible site for new electricity works, and he moved:—

That the Council empowers a sub-committee to take expert opinion as to whether the land is suitable for the purpose of new electricity works or whether any other site is more suitable, such sub-committee to be allowed to spend £350 or such sum as may be necessary to obtain detailed information useful for them to report to the Council at a later meeting as to the advisability of erecting a new electricity station.

The resolution was lost by one vote, and subsequently it was resolved that the question be adjourned to a special meeting of the Council to be held at an early date.

Increased Charges for Electrical Energy.—The charges for current are being increased at the following places:—

Newport (Mon.) Council is increasing its charges by 10 per cent.

Worksop Council is increasing the charge for current for lighting by ½d. per unit.

Sheffield.—The Electric Supply Committee proposes to increase the salary of the general manager and engineer (Mr. S. E. Fedden) from £900 to £1,000 per annum, with two further annual increments of £100 each. The salary of Mr. H. E. Yerbury (deputy general manager and engineer) is to be increased from £600 to £700.

It is proposed to apply to the Board of Trade for a provisional electric lighting order for the Wortley rural area and other districts surrounding Sheffield.

The electric supply mains are to be extended so as to supply two or three additional factories.

The Health Committee has asked the Electric Supply Committee to provide a reserve supply of electricity for the Dumley-street destructor, at a cost of £830.

Wallasey.—It was announced that the Government had paid £6,203 compensation for the commandeering of a turbo-generator. That had practically placed the undertaking in the position it would have been if the plant had not been removed, so far as finance was concerned, and it had also established a basis for future claims.

Digitized by Google

Wolverhampton.—The General Purposes Committee has endorsed a recommendation of the Electricity Committee, that the salary of Mr. S. T. Allen, borough electrical engineer, be increased from £600 to £800 per annum, as from the 1st inst.

LIGHTING AND INDUSTRIAL POWER.

Electric Cranes in Tin-plate Works.—"The Iron & Coal Trades Review" contains brief particulars of the sheet and tinplate plant which is being built by the Bethlehem Steel Co. at Sparrows Point, Md.

The hot-mill building is 147 ft. by 980 ft., with a bar shed 70 ft. by 280 ft. and a 15-ton electric crane. The mill building is constructed to accommodate 24 mills and accessories. The hot mills are driven by two 1,200-H.P. motors, three mills on each side of each motor. This building contains two 25-ton electric cranes. Each mill is equipped with 3 furnaces, one pair furnace and two sheet furnaces. The cut sheet bars are delivered at the rear of the furnaces by a 10-ton electric crane and charged into the pair furnace automatically by an electric charger. The cold-rolling department consists of 12 stands of 24 in. by 36 in. cold rolls, driven in tandem of three by a rope drive from 1,200 H.P. motor. When the 24 mills go in operation there will be an annual production of approximately 2,000,000 base boxes.

Spain.—A new company, entitled the Sociedad Industria de Cobre Electrolitico, has been recently formed in Barcelona for the erection of works for the electrolytic production of seamless copper tubes.

During the past year the Bassonia Co. expended about £40,000 in modernising their steel sheet and tin-plate works at San Miguel de Basauri and in putting down electric power plant.

ELECTRIC TRACTION.

Birkenhead.—The Tramways Committee have abolished half-penny fares and generally revised and increased the tramway fares, in order to meet the increased expenses.

Blackburn.—The tramcar service between Witton Stocks and Cherry Tree will be discontinued in order that the rails may be taken up and utilised in repairing other sections.

Blessington Steam Tramway.—There is an agitation to get the Government to take over the control of this line.

At a meeting of Wicklow ratepayers last week a resolution in favour of this course was adopted.

Mr. John Moran, solicitor and secretary of the Ratepayers' Association, said that if the Government would not take over the line they should make a grant to clear the debt, and give the company a chance of negotiating with some other concern and possibly have the line electrified.

Bootle.—After lengthy negotiations the Council entered into a new agreement (for 25 years from July 1) with Liverpool Corporation for the repair and maintenance of the local tramways.

The agreement provides that Liverpool shall pay a rental of £500 a year for the first six years and £1,000 a year for the remaining period. Liverpool Corporation will be responsible for the upkeep of the rails and paving within the tramway limits, and Bootle Corporation will do the final reinstatement work. With regard to the overhead equipment, Liverpool will allow Bootle £43 per mile per annum for maintenance, the equipment to be handed over to Bootle at the end of the period in a proper useable condition. All claims under the arbitration proceedings are to be withdrawn, each party paying its own costs, and Liverpool Corporation is to refund to Bootle the amount of rent outstanding.

Glasgow.—The Tramways Committee has instructed the manager (Mr. James Dalrymple) to discontinue the prize drawing.

The sale of tickets has been suspended, but, in view of the success of the scheme, the committee is endeavouring to legalise the drawing, either under the Art Unions' Act or by special legislation favouring prize drawings for war purposes by public bodies.

Last week the Corporation granted a war bonus of 4s. per week to male employees and 2s. per week to female employees having six months' service, except those in receipt of Government or Corporation allowances. The increase represents about £40,000 per annum.

Manchester.—On Tuesday the Tramways Committee considered the City Council's demand for £100,000 in relief of the rates this year, instead of the £50,000 which the committee proposed to contribute.

A sub-committee was instructed to devise ways of raising the money, which may involve a slight increase of fares.

It will be remembered that at the recent meeting of the Corporation a resolution instructing the Committee to increase their contribution to £100,000 was carried by 48 votes to 45. Some councillors contended that "by the system of rate aid they raised fares and put the burden on the working man so as to save the rates of the big man."

A motion to increase the contribution of the Electricity Committee from £16,570 to £30,000 was, however, lost.

Middlesex Tramways.—Last week the County Council sanctioned an increase in the fares of the Metropolitan Electric Tramways.

The new fares are based on the principle of three consecutive stages for a penny. Workmen's fares are to be half those for ordinary passengers, with a minimum of 1d. and a maximum of 4d.

Mr. MARLOW REED said the amount of the advance had been settled by arbitration, and the increased fares were granted conditionally on as large a sum as possible from the advanced rate being allocated for the benefit of the employees.

Nottingham Tramways.—Nottingham Corporation has applied to the Board of Trade for 12 months' further extension of time for the purchase of lands in connection with the proposed tramways from Beeston to Nottingham, authorised by the Nottinghamshire and Derbyshire Tramways Act, 1903.

Tramway Transfer.—Eccles Corporation intend to lease the tramways in the borough to Salford Corporation for 35 years from March 31, 1904.

Salford Corporation is to pay to Eccles Corporation £6,676. 16s. per annum (10 per cent. on cost of construction and electrical equipment); and also the amounts required annually for redemption of balance of capital (£10,381. 17s. 8d.) expended by Eccles Corporation.

Tramway Workers' Wages.—Last week the Committee on Production (Sir David Harrel, Mr. J. Duncan Elliot and Mr. Geo. Rowe) heard applications made by the Amalgamated Association of Tramway and Vehicle Workers to a number of tramway authorities in Lancashire and Cheshire for a 10s. a week advance in wages for male and female employees.

MISCELLANEOUS.

Coal Economy in France.—The Government has issued a decree prohibiting the use of gas from 8.30 a.m. to 12.30 p.m., from 2 to 5.30 in the afternoon and from 9 at night until 4.30 in the morning, but the Minister of Armaments may grant exemptions from this rule.

The engineers of electric supply companies have been instructed "to endeavour to find means of substituting electrical energy for steam engines in factories."

Enemy Firms Wound-up.—The Controller of the British Graetzin Light Co. has applied for a release. Objections to the Board of Trade before June 16.

Engineers' Wages.—The chairman (Mr. J. T. Brownlie) and general secretary (Mr. R. Young), of the Amalgamated Society of Engineers, have presented a new demand for an increase of wages for their members.

It is stated that, in accordance with the agreement arrived at between the Engineering Employers' Federation and the trade unions in the engineering and foundry trades in February, 1917, they are making an application for a national advance of wages, on behalf of their journeymen and apprentices, equivalent to 100 per cent. on the wages obtaining in July, 1914—that is, a wages advance of 100 per cent., less advances granted during the war period by the Committee on Production. It is understood that the claim of the men's representatives is that the 100 per cent. asked only represents the difference in cost of living. The cost of living, they say, is now twice as much as it was in July, 1914.

Exports from Foreign Countries.—The supplement to the "Board of Trade Journal" of the 7th inst. contains complete lists of articles which, according to the latest information received by the Board of Trade, are prohibited to be exported from Norway, Portugal, Russia, Spain and Sweden. The supplement also contains a reprint of the United Kingdom contraband list in its present form. Copies may be obtained at a cost of 3d. (3½d., post free) from any bookseller, or from H. M. Stationery Office, Imperial House, Kingsway, W.C. 2.

New Home Industries.—The Board of Trade Department of Commercial Intelligence (73, Basinghall-street, London, E.C.) invites manufacturers to inform the department of new industries or development of existing industries established in this country.

Nottingham and Derbyshire Tramways Bill.—This Bill was read a third time in the House of Commons on Monday. It has already passed the House of Lords.

Tribunal Cases.—At Sheffield last week the cases of 149 employees of the Corporation Electric Supply Department were dealt with.

It was said that 183 men in the department had been either exempted or scheduled, but there were 84 men who were neither one or the other. They could not give up voluntarily any of their 267 men, but, in fact, could do with more. In a pre-war year they produced 26¼ million units of electrical energy, but the present output was 220 millions. Applications were now in hand for an increase of 40,000 h.p. and there was also another scheme on hand. The department did not wish to retain the young single men, but if they lost any of those men efficient substitutes must be forthcoming.

In view of negotiations in regard to substitution the Tribunal agreed to adjourn all the cases for 14 days on the understanding that appeals could be made in all cases not covered by certificates or exemption.

Digitized by Google

TENDERS INVITED AND ACCEPTED.

Boiler-House Plant and E.H.T. Switchgear.

GLASGOW Corporation invite tenders for the supply of boiler-house plant and extra-high-tension switchgear (2,000 volts). Specifications and forms of tender from the engineer, Mr. W. W. Lackie, 75, Waterloo-street, Glasgow. Tenders to the town clerk, Sir John Lindsay, City Chambers, Glasgow. *See an advertisement.*

Induced Draught Plant, Fuel Economiser Extensions and Cooling Towers.

The Corporation of NEWPORT (Mon) invite tenders for (Section 1) induced draught plant; (section 2) additions and extensions to fuel economisers; and (section 3) cooling towers. Forms of tender, &c., from Mr. A. Nichols Moore, M.I.E.E., borough electrical and tramways engineer. Tenders to the town clerk, Mr. Albert A. Newman, by 10 a.m. June 30. *See an advertisement.*

Laying Cable Ducts, &c.

KEIGHLEY Corporation require tenders by June 18 for laying porcelain cable ducts and building manholes in connection with a new h.-t. feeder. Particulars from Borough Electrical Engineer.

Coal Bunkers, &c.

WOLVERHAMPTON Corporation require tenders by June 22 for the erection of re-inforced concrete coal bunkers at the electricity works.

STRETFORD.—The Council has accepted the tender of Veritys Ltd., for two 15 H.P. motors at £92 15s. each, and that of G. Bullock & Co. (at £20) for the repair of the jet condenser.

WOLVERHAMPTON.—The Council has conditionally accepted the following tenders:—

Willans & Robinson, turbo-alternator set, consisting of 5,000 kw. steam turbine-driven alternator, with exciter, condensing plant, auxiliary steam and motor-driven pump, piping and connections, air-filtering plant, &c., £22,690; Higgs Bros., three 10 H.P. and one 5 H.P. motors, £180; Stirling Boiler Co., boiler plant, £24,687; Gibbons Bros., steel works for roof of engine-room, £350.

APPOINTMENTS VACANT.

The Governors of the Central School of Science and Technology, Stoke-on-Trent, invite applications for the post of principal of the department of mechanical and electrical engineering. Salary £500 to £750 per annum. Forms of application, which must be returned by June 23, can be obtained from the clerk to the Governors, Dr. W. Ludford Freeman, Education Offices, Town Hall, Hanley.

The Government of the Union of South Africa require an industrial adviser to the Industries Section of the Department of Mines and Industries. Salary, £2,000. Applications to the High Commissioner, 32, Victoria-street, London, S.W. 1, by July 31.

Switchboard attendants are wanted for a generating station in the Manchester district. *See advertisement.*

BUSINESS ITEMS.

The New Switchgear Construction Co. (Ltd.) have appointed Messrs. Plunket & Abbott, of Lynwood, Llanishen, Cardiff, as representatives in the S. Wales District (including Glamorgan and Monmouth); and Mr. R. H. Willis, M.I.E.E., 211, Produce Exchange, Cathedral-street, Manchester, is the company's representative in the Manchester district.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of July 12. *Further particulars are set out in an advertisement.*

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against the Colston Electrical Works (Ltd.) (in liq.), 9 Denmark-street, Bristol, are to be sent by June 22 to Mr. C. H. King, 26, Baldwin-street, Bristol.

The discharge of Harry Neville Kaye, engineer, 31, Kingsthorpe-road, Sydenham, Kent, is suspended for two years ending April 27, 1919.

Winding-up Petition.—A petition for the winding-up of Steel's Electric & Engineering Co. (Ltd.) will be heard in the High Court on June 19.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Birmingham.—The accounts of the municipal tramways for the year ended March 31 show gross capital expenditure £2,494,256 (increase £4,825), of which £18,688,876 is outstanding.

Revenue was £838,725 (against £771,117 in previous year) and working expenses were £632,165 (£534,080), leaving gross profit £206,560 (£237,037), to which is added £10,085 (£10,213) from motor-bus account, making total gross profit £216,645 (£247,250). Interest and sinking fund charges, &c., absorbed £140,354 (£139,501), leaving net profit £76,291 (£107,749), of which £66,206 (£57,749) is being transferred to reserve and £10,085 to suspense account. Average traffic revenue per car mile was 10·040d. (12·974d.) and working expenses were 10·667d. (9·057d.). Passengers carried were 171,445,020 (163,258,584), and car miles run 14,223,007 (14,151,683). Units used were 2·002 (1·9) per car mile.

Huddersfield.—At Dec. 31 last the electricity department had a gross expenditure of £293,637 (increase of £5,000 over 1915), of which £137,574 is repaid or in sinking fund.

Revenue was £79,508 (compared with £63,945) and working and general expenses were £54,857 (£42,326), leaving £24,651 (£21,618). Interest required £11,389 (£9,193) and redemption fund and repayments £9,162 (£8,984), so that the net surplus was £4,099 (£3,441), of which £2,200 (£2,150) is being devoted to relief of rates. Units sold were 14,323,631 (10,536,374). There are 6,674 (6,461) consumers, with 811,845 (687,704) equivalent 8 c.-p. lamps connected.

Nottingham.—The accounts of the electricity department for the year ended March 31, 1917, show gross capital expenditure £485,109, of which £252,785 is outstanding.

Revenue was £115,939 (compared with £109,544 in previous year), working and general expenses were £82,775 (£69,487), leaving gross profit £33,164 (£40,057). Interest required £10,585 (£11,132), and sinking fund and repayment of loans £17,247 (£17,247), and £2,332 (£6,677) has been placed to reserve, leaving a balance of £3,000 (£5,000), which is to be applied in aid of rates. Units generated were 16 296,086 (15,336,017) and sold 14,717,442 (13,854,461). The total maximum supply demanded was 6,856 kw. (6,775 kw.).

Salford.—In presenting the accounts of the electric supply department to the meeting of the Corporation last week, the chairman of the Electricity Committee (Councillor Billington) said that last year he was able to announce an increased output and also an increase in the amount of the gross and net profit. This year's results constituted a new record. The increase in output was no less than 4,700,000 units, while the income had increased from £133,764 to £156,953. The gross profit had increased from £70,139 to £86,029, which was equal to 11 per cent. on the total capital expended, or 21 per cent. on the unredeemed capital of the undertaking.

After contributing the large sum of £32,400 to sinking fund and £17,000 for interest, there was a net profit of £21,354, compared with £10,598. That result did not, however, represent the full value derived from the partial modernisation of the works. When compared with pre-war conditions, they found that the department was now paying £27,000 of additional expenditure owing to war conditions. The increased cost of fuel was responsible for £12,000, increased sinking fund £6,000, increased taxation nearly £3,000, allowances to men on service and war bonus, about £3,500, interest and insurance about £2,600. Against that increased expenditure there was an increased income of £13,300 resulting from the increased charges which came into operation last year, so that the net cost to the undertaking of additional charges due to the war was £14,000, or, in other words, under pre-war conditions, the net profit (which was due entirely to the changes made during the last three years) would have been £35 000 instead of £21,000. The increased output was largely due to the demands made by manufacturers for power to carry out war contracts and ordinary extensions (except in special cases) had been suspended during the war. The capital account had been increased only by £26,500 during the year, while the amount redeemed had been £32,400. It was a striking fact that while the department had during the last three years replaced the obsolete plant in the engine room with modern plant of nearly twice the capacity, and had also adopted a high-tension transmission system involving the laying of new high-tension mains and equipment of three sub-stations in addition to smaller sub-stations on consumers' premises, the capital indebtedness was actually less than it was prior to the alterations being made. From the net profit £12,000 had been allocated to the relief of rates, and the balance of £9,300 carried to

Digitized by Google

renewals fund, which now stood at £18,000. During the last two years there had been expended from that fund £41,000 on work which would, under normal conditions, have been purchased with new capital. On the other hand, the fund had been increased by £26,000 from profits and by £19,000 from the sale of disused copper mains. It would be generally agreed that those results showed the department to be in a thoroughly sound financial position, and with increasing business there was every reason to believe that the good results of the year would be continued. While they had partially modernised the works and had been able to cope with a 50 per cent. increase in the demand which could not possibly have been met under the old conditions there still remained much to be done. They were nearing the limits of output from the existing works, and it would be necessary for the committee to carefully consider the whole situation with a view to making such extensions as would be sufficient for present purposes and to meet all the demands for electricity which were likely to arise in the future. Cheap power was a vital necessity for manufacturers, and that town depended wholly on its manufacturers for its life and prosperity. It was the duty of the Corporation owning the undertaking to do everything possible towards assisting manufacturers, and placing them in such a position that they might be able to meet competition from their rivals in other towns and from abroad. The expended capital of the undertaking was £760,000, and there has been paid off £360,000, leaving a present debt of £400,000.

Councillor MCDOUGALL (deputy chairman) said the next time the members had an opportunity of going through the electricity works they would find practically all the old plant scrapped and new machinery in working order. It had not always been the wish of the Council to pay for brains in connection with that undertaking, but it was the payment for brains which had brought about the results the chairman had given them.

Walsall.—The accounts of the tramways department for the year ended March were approved by the Council on Monday.

The net profit was £11,170, out of which it was proposed to allocate £5,000 to relief of rates, in addition to £2,000 already set aside for that purpose. The passengers carried were 10,394,050, and total revenue was £53,584, the highest on record. The balance (£3,146) on the omnibus service was placed to a special reserve fund.

West Hartlepool.—At March 31 the capital expenditure of the electricity department was £147,377 (increase £1,954), of which £53,718 has been redeemed, in addition to which the sinking fund amounts to £6,701.

Revenue was £22,014 (against £18,939 in previous year), and working expenses were £12,154 (£8,747), leaving gross profit £9,860 (£10,192), increased to £19,030 by interest on sinking fund investments, &c. Interest on loans required £3,107 (£3,292), income tax £862 (£342), loans redemption and sinking funds £3,707 (£4,218) and instalments of loans £2,839 (£2,175), net result being a deficit of £496 (compared with a surplus of £316). Coal cost £3,279 (£1,646), but the bulk of the power is derived from waste heat obtained from local blast furnaces in return for energy supplied.

The tramway accounts show gross capital expenditure £83,767 (increase £5), of which £8,082 has been repaid. The reserve fund amounts to £7,979 and sinking fund to £310. Revenue was £22,870 (£19,482) and working expenses were £15,084 (£13,126), leaving gross profit £7,786 (£6,355), or £8,012 (£6,445), including discounts and interest on investments. Cost of lease of line and interest on loans absorbed £3,453 (£2,864), sinking fund £1,560 (£1,486) and repayment of loans £847 (£816), leaving £2,151 (£1,278) to carry to reserve. Car miles run were 488,870 (468,792) and average total revenue was 11·22d (9·97d.) per car mile.

COMPANIES' MEETINGS AND REPORTS.

ALTRINCHAM ELECTRIC SUPPLY (LTD.).—At the recent meeting it was stated that during the past year 36 new installations were connected to the mains, and after allowing for disconnection and reconnections there were on Dec. 31 last 1,699 actual consumers. After providing for interest on debentures, premium on debenture redemption policy, &c., the profit is £4,903, which added to £918 brought forward, makes £5,822. Deducting dividends on the preference shares (£2,400), the sum available is £3,422, of which £500 has been placed to general reserve, £1,500 to reserve for depreciation of plant, &c. and £447 reserved for excess profits duty, leaving £975 to be carried forward. The sum of £10,357 has been expended on additional plant, mains, &c. Plant absorbed £7,575 of this, the principal items being in respect of a new turbo-generator, &c., which was found to be necessary to cope with the additional current required for power. The expenditure has had to be met temporarily out of the company's resources, and under these circumstances the Board do not consider it desirable to declare any dividend upon the deferred shares.

BIRMINGHAM DISTRICT POWER & TRACTION CO. (LTD.)—At the meeting on Monday Mr. C. S. B. Hilton said that their difficulties had been intensified during the past year and he feared they could not look for much relief in the near future. The traffic receipts of the tramways were £63,070, or nearly £7,000 better than in 1915, and the total revenue (£113,986) showed the substantial increase of £7,900. The expenses, owing to the increase in the cost of materials, additional war bonuses and advances in wages, showed a considerable increase. They had credited £9,000 to renewals fund and £5,000 to reserve, but only £515 was expended on renewals during the year, compared with £2,517 in 1915, owing to the impossibility of obtaining materials or labour. The wear and tear of the track and rolling stock was becoming more accentuated day by day, and the cost of renovation, when that became possible, would inevitably be increased. It was, therefore, wise to accumulate as large a fund as possible for that purpose, and they now had £26,472 in the renewals account and £26,493 in the reserve account. The directors recommended a dividend of 4½ per cent. on the preferred ordinary shares for the year, leaving £5,569 to be carried forward, compared with £2,251 brought into the account. The returns from investments amounted to £46,910 (against £45,364), or about 4¾ per cent. The largest individual payment was received in respect of the holding in the Shropshire Power Co. That company's net receipts for the year amounted to £55,998, and after placing £12,080 to reserves it paid a dividend on the ordinary shares of 4 per cent. (compared with 3½ per cent.), carrying forward £4,665, against £1,984 brought in. The company's output showed an increase of 115 per cent. and it was still growing. The business of the Birmingham & Midland Motor Omnibus Co. was adversely affected by the petrol restrictions and shortage of skilled labour. It had to reduce its services wherever possible; the less remunerative mileage had been eliminated and the fares had been increased, with the result that the company was able to pay a dividend of 5 per cent. on the ordinary shares and to carry forward £2,672. Having so large an interest in an omnibus undertaking he thought it would be interesting and useful to remind them that every omnibus in regular work contributed in taxes from £50 to £60 per annum, or about ½d. per mile run, which ought to be spent in road maintenance, but which during the war had been diverted to other objects, and meanwhile individual road authorities were endeavouring by other means to compel omnibus owners to contribute to road maintenance in addition to the heavy sums paid to the local rates. That was very undesirable from every point of view, and would, he hoped, be strongly resisted. The tramway companies in which the company was interested had in almost every case paid slightly larger dividends and carried forward increased amounts to reserve. The provision for repairs and renewals was a matter requiring the most careful consideration, and provision on as large a scale as possible had been made for carrying out the necessary work when conditions were favourable. The larger amount at credit of reserves arose to a great extent from the fact that the companies had been unable to expend the proper and requisite amount on repairs and renewals as they would have done under normal conditions. The reserve funds of their own company and its subsidiaries now reached £313,140. He expressed the gratitude of the board to both the head office and local staff, and mentioned that the able and energetic secretary (Mr. Kingsford) had been appointed a director of the Shropshire Power Co. He had done yeoman service in connection with the various troublesome and difficult negotiations which were continually taking place with the different Government departments.

EDISON ACCUMULATORS (LTD.)—At the third annual general meeting last week the chairman (Lord Montagu of Beaulieu) said that the profit for the past year, exclusive of provision for excess profits tax, was £4,614. The excess profits tax, as at present arranged operated especially to the disadvantage of companies such as theirs, which had to build up new business. Even in the case of older companies it prevented provision being made for the severe competition inevitable after the war, but, while admitting the necessity for taxing large profits as a fruitful source of revenue, young companies, he considered, should be leniently treated. Last year he referred to the difficulties of freight and insurance, but during the year under review their troubles in that respect had greatly increased. Apart from the fact that they had paid over £18,000 in freight and war risk insurance, which under normal conditions would have cost about an eighth of that figure, they had been hampered and delayed by the formalities introduced by various Government departments. It was necessary to go through the mill of no less than three separate departments before an order could be executed, so that they could realise that the increasing Governmental formalities were becoming serious. Considering the shortage of petrol and the fact that their vehicles now in operation were estimated to be saving no less than 700,000 gallons of petrol per annum, he certainly thought in the national interests that their company should receive more consideration from the departments concerned, especially from the Priority Committee. At present they had some £100,000 worth of unexecuted orders, and had paid many thousands of pounds for vehicles which were lying in New York, all of which would save labour, petrol and expense if only they could be put to work. The value of orders received during the year was no less than double those of the previous year, which showed a large increase on the previous record. A most satisfactory feature was the number of repeat orders, which confirmed the views he had previously expressed as to the utility and economy of transport by Edison Accumulator vehicles. When they saw such up-to-date firms as Messrs. Harrods, John Barker & Co., Whiteleys, Selfridges and the Hovis Bread Flour Co. constantly extending their fleet of vehicles (Messrs. Harrods alone had now 80 in use) they might rest assured that the stability of the industry which their company was formed to promote was proved beyond question. The Midland Railway Co., who were now using in London and provincial towns over 50 Edison Battery vehicles, found they could make their deliveries at a lower cost than before either with horses or petrol lorries. That company was now considering increasing their fleet of electric vehicles very materially, and other railway companies who had the matter under consideration would undoubtedly follow suit. Co-operative societies at Glasgow, Leeds, Blackpool, Leicester and other places had adopted the Edison vehicle with advantage to themselves, and one of the largest fields for the use of electric vehicles—viz., the collection of house refuse and other municipal work—had brought them more orders than they were able to handle. The Sheffield Cleansing Department had now 10 electric vehicles in service and other cities employing them were Glas-

Digitized by Google

gow, Chester, Accrington, South Shields, Halifax, Dover, Surbiton, Leyton, &c. Those municipalities were greatly in favour of electric vehicles, being able to utilise the current generated by them for locomotion, which enabled them to run those vehicles at a very small cost. Another branch that they had developed to great advantage was the use of industrial self-propelled trucks in factories, and for handling luggage, parcels and goods in railway stations. In these days when it was so necessary to adopt labour-saving devices, no works could afford to postpone the use of or be without these handy trucks, a considerable number of which are used by the Daimler Co., Kynochs, Vickers, Woolwich Arsenal, L. & N. W. R. and the G. W. R. companies, Birmingham Small Arms Factory, Armstrong, Whitworth & Co. and others. He had every hope that as soon as the war was ended the results they had attained would attract the necessary capital to enable the Company to operate on a scale commensurate with the demand which will undoubtedly exist.

GREAT NORTHERN TELEGRAPH CO. (LTD.)—At the meeting at Copenhagen the chairman (Consul-General W. Weimann) stated that during the past year 10 of their cables in European waters had suffered 15 interruptions, whilst 29 breaks had occurred in nine cables in the Far East. They had not as yet been able to repair their cables in the Baltic, which had been interrupted since November, 1914. The cable steamer "H. C. Orsted" had been occupied in Europe for 102 days and the "Store Nordiske" and the "Pacific" in the Far East for 167 days. The cable steamers had done excellent work during the past year, and the "H. C. Orsted" had often met with considerable difficulties in executing repairs of the cables. The Vladivostok and Kiachta routes have been maintained in good working order by the Russian Telegraph Administration. The traffic between Europe and the Far East transmitted by those lines had decreased considerably during the past year, owing to circumstances beyond the control of the company. The concession granted by the French Government for landing and working the cables between Denmark and France expired last year, but had been provisionally prolonged without alteration. Negotiations for a definitive arrangement will have to be entered into after the war. The rates over their cables in the Far East had been reduced in respect of certain classes of traffic exchanged with Japan. The rates over the Iceland cable had also been materially reduced as from Jan. 1 last. The arrangement with the Danish Government for the erection and working by the company of two local wireless stations in the Faroe Islands was finally concluded about a year ago. The installations (by Marconi's Wireless Telegraph Co.) were recently so far completed as to admit of an ad interim service being started. At the same time the company moved into their new house at Thorshavn, which accommodates the offices for both the wireless and the cable service. On Jan. 1 last a serious fire broke out in the company's building at Shanghai, in which they also house the Eastern Extension Telegraph Co. and the Commercial Pacific Cable Co. The two upper stories, containing their instrument-room, their workshop and the Eastern Extension Co.'s offices, were completely destroyed. The damage, which was covered by insurance, was extensive and many of their instrument were destroyed. During the year the company experienced increasing difficulties in managing the business. The most serious of the difficulties was that connected with the maintenance of the cables. Nearly all their cables in Europe crossed the continually expanding minefields and prohibited areas, and should breaks occur in such places it might prove impossible to have the cables repaired. They had also met with difficulties in supplying their stations with instruments, telegraph paper, &c., owing to the scarcity of material, diminution of transport facilities, and to the export and import prohibitions in force in practically all countries. The measures taken by the belligerents had also affected their staff arrangements. Thus, it proved now and then difficult to obtain the necessary permission to appoint Danish operators to their stations in the countries involved in the war, and in England they have had to resort to a large extent to female labour, especially to replace their British employees who, voluntarily or by order, joined the colours. In Petrograd the military authorities had, as a measure of precaution, gradually displaced their Danish and Russian operators and had in their stead appointed Russian Government employees to work the instruments. That measure was adopted through no fault of the company. The financial results had been so satisfactory that the directors after careful consideration had come to the conclusion that they were justified in proposing the distribution of a total dividend and bonus of 24 per cent., or 2 per cent. more than for 1915. The directors, however, warn the shareholders that the extraordinary prosperity which the company is now enjoying will disappear when peace is concluded, or very soon after. As the cost of living, the taxation and the working expenses, which are at present very high and increasing almost from day to day, are not likely to become normal for some years after the conclusion of peace, a considerable decrease in the net receipts of the company may be looked for. In these circumstances the board considered it desirable to increase the dividend equalisation fund by £55,555. 11s. 1d. The renewal fund for cable steamers was not sufficient to cover the cost of replacing the two oldest of their steamers, and, therefore, they proposed to add £27,777. 15s. 7d. to the fund. The board granted a similar amount (£27,777. 15s. 7d.) to the staff's pension fund. The addition to the reserve and renewal fund for the year was limited to £83,333. 6s. 8d. As the war taxes will undoubtedly increase during the present year, £111,111. 2s. 3d. was set aside for that purpose. The increase in the traffic receipts and interest had been about £113,000 and £4,700 respectively, whilst sundries decreased by £7,600, owing to the steamers having been chartered less than usual by other administrations. Expenditure was about £451,000, whilst that for the previous year (inclusive of amount reserved for extraordinary taxes) was £371,000, an increase of about £80,000, directly or indirectly due to the war.

METROPOLITAN CARRIAGE, WAGON & FINANCE CO. (LTD.)—At the annual meeting last week the chairman (Mr. F. Dudley Docker, C.B.) said that in the judgment of their board the electrical industry was one that had remained too long in foreign hands. There was no doubt that the work of electrical construction would play an essential part in British trade development, and continuing the policy that directors had always pursued, anticipating rather than following, they had acquired a controlling interest in the British Westinghouse Company. It was a considerable event in itself, and they might perhaps be pardoned if they were somewhat proud that that control should be in British hands, and more particularly in their own. They might not stop there. Chapter three was only just beginning. They had always generously supported the policy of the board which had been a forward and expansive one, and, honestly, he did not think that hitherto they had had very much cause to regret what they had done. Their board and staff had served them well in the past; they were alive to the tremendous call the future would make upon their energies as well as their abilities. They opened the new chapter with confidence, and they would "make good."

NORTH METROPOLITAN ELECTRIC POWER SUPPLY CO.—The accounts for 1916 show a net revenue, including £6,043 brought forward, of £80,293. After providing for mortgage, loan and debenture interest, transferring £2,000 to debenture reserve fund and £10,542 to renewals reserve (making it £125,000), a dividend of 6 per cent. has been declared, together with a bonus of 8s. per share, leaving £1,775 to be carried forward. Last year a similar dividend was paid, but no bonus.

SOUTH METROPOLITAN ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The total revenue during 1916 amounted to £68,793, compared with £69,281 for 1915. After adding balance brought forward and deducting expenses, and after setting aside £4,000 to renewals fund, the surplus is £12,878. The directors recommend that £4,000 be placed to reserve, and that a dividend at rate of 5 per cent. per annum be paid on the Preference shares for the year to Dec. 31st, 1915 (£8,478) leaving £400 to be carried forward. The gross receipts from the working of the tramways and light railways were £48,437, an increase of £27. The net receipts from the motor omnibuses amounted to £2,434. The gross receipts from the electricity supply section (including amount represented by sale of energy to the tramways), were £17,467, against £17,242. The total number of units sold (including 214,209 supplied to tramways), was 1,267,631 against 1,195,371. The number of units sold for lighting and power was 1,053,422, an increase of 58,366 units, The number of consumers was 2 301, against 2,229.

SOUTH WALES ELECTRICAL DISTRIBUTION CO.—At the annual meeting last week Mr. W. Gascoyne Dalziel said 30,058,461 units were sold last year compared with 28,967,656 in 1915, an increase of 1,090,850 units. The output had been affected to a considerable extent by the supply of tonnage at the coal shipping ports, because the shortage, combined with the Government restrictions on the export of coal, had naturally reacted on the working of the colliery undertakings which took their power supply form the company. The result was that they had experienced considerable fluctuations in the output from week to week and month to month, and that affected their revenue and also their costs, because the whole of their working expenses and standing charges remained the same, whether the output was above or below the average. The surplus enabled them to pay a year's interest on the original debenture stock, leaving £2,554 to be carried forward. The company's mains extended to over 130 miles, the public utility of the supply had become established, and it was reasonable to believe that it would in due time form the heart and arteries of the industries of South Wales. The additional electrical plant connected to the company's mains last year amounted to 7,422 H.P., the total being now nearly 40,000 H.P.

Mr. T. O. Callender, J.P., seconded the resolution, which was carried, and the retiring directors and auditor were then re-elected.

CITY NOTES.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units sold to consumers during the five weeks ended March 30, 1917, amounted to 2,391,238, compared with 2,122,507 units in the corresponding period of 1916.

MADRAS ELECTRIC SUPPLY CORPN. (LTD.)—The directors recommend payment of the 6 per cent. preference dividend for the year 1916.

MANILA ELECTRIC RAILROAD & LIGHTING CORPN.—A dividend of 1½ per cent. ($1.50 per share) has been declared for the quarter ending 30th inst.

PROVINCIAL TRAMWAYS CO.—An interim dividend of 8d. per share has been declared on the ordinary shares in respect of the year ending Sept. 30.

TORONTO RAILWAY CO.—A dividend of 2 per cent. has been declared for the quarter ending June 30.

TRAMWAYS & LIGHT RAILWAYS ESTATES CO. (LTD.)—For the year 1916 the directors recommend a dividend of 3 per cent., applying £100 in reduction of goodwill, and carrying forward £626, against £558 brought down.

YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS CO.—An interim dividend at rate of 6 per cent. per annum on the preference shares for the half-year ending June 30 has been paid.

Digitized by Google

THE ROUND TABLE.

By "KVA."

"Fuel Economy" is the subject for discussion at this year's I.M.E.A. Convention. I wonder how many of the speakers who will take part in the discussion have electric fires in their houses, or cook their meals by electricity? I think President Long should ask each speaker on Mr. Robertson's Paper if he uses coal or gas for domestic purposes. If the delinquents are "barred" from speaking, I think there may be no discussion.

* * * *

The war has given us many new girls: the conductorette, the switch girl, the post-woman, the munitioneesses, the V.A.D. girl and a whole heap of other feminines. A lot of these lose their charm in masculine jobs, though many take on new

THE HANDELEK GIRL.

graces. I think this must be said of the "Handelek Girl," whom Mr. H. Scholey introduces in this little picture. So long as she is connected to the electric circuit she will "vac" anything from a cobweb to a speck of dust, or even a "bit of green" in your eye! * * * *

Makers of controllers may justly claim that their occupation is now one of the most important in the country. Has not the age of controllers now dawned? I wonder that advertisement capital has not been made of this fact by electrical manufacturers. "Food Controllers may come and Ship Controllers may go, but Our Crane Controllers Never Quit Service." Or thusly: "Don't Confuse Mistake our Controllers with those made by the Government. Our Controllers are absolutely unaffected by Atmospheric, Electric or Political Disturbances. To avoid delay address your orders to us, and not to Whitehall."

* * * *

Anent the above a correspondent calls my attention to a headline in a contemporary, "The Manufacture of Controller Drums," and suggests that there should be quite a good sale for these just now. * * * *

This week's chestnut from the "Financial Times":—

An ingenious American has invented a device to prevent such motoring accidents as arise from over-speeding. He describes his contrivance as follows: "While the car is running 15 miles an hour a white bulb shows on the radiator, at 25 miles a green bulb appears, at 40 a red bulb, and, when the driver begins to bat 'em out around 60 per, a music-box under the seat begins to play 'Nearer, my God, to Thee.'"

I have two congratulations to extend this week. The first is to Major A. W. Vignoles, borough electrical engineer, Grimsby, now at the front, upon his decoration with the D.S.O. His confrères at the I.M.E.A. Convention will doubtless show their keen appreciation of this coveted award. The second is to my old friend Mr. W. P. Hancock, generating superintendent, Boston (Mass.) Edison Co., upon a quarter of a century's service with that enterprising electric power concern. "Bill," as he has been appropriately dubbed by his friends, is well known in power supply circles over here, and before the war was an annual visitor to "bulk" stations and the larger municipal undertakings. He is one of those genial spirits whose next visit will be looked forward to with great pleasure.

* * * *

A press report says: "Following several loud explosions, about 100 ft. of pavement became displaced through the fusing of an electric cable igniting a quantity of gas which had accumulated under the footway." This, of course, is the perfectly proper method of showing that vigorous co-operation between gas and electric interests is now taking place!

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, June 12, 1880.]

INDIANA.—Mr. C. Reitz is getting ready an electric-light apparatus for the Medical College of Indiana. It is to be of 2,500 candle-power. The motor will be a 2½ H.P. gas-engine.

ELECTRIC LIGHT ON BUOYS.—"The whistling buoys now in use weigh about 15 tons each, and in their plunging, even during calm weather, a force of nearly 3 H.P. is evolved. To utilise this waste energy Mr. Edison has devised a small dynamo machine, to be carried by the buoy, the current from which will sustain an electric light equal to one gas jet. If successful, these self-illuminating buoys must be of great use to mariners." We quote the above from our contemporary the "Scientific American," which, however, gives no explanation as to how the energy is to be utilised. Ideas of this kind are cheap, but the means of carrying them out are by no means hit upon.

DOUBTING PROGRESS.—The "St. Louis Journal of Commerce" says:—"In the eight years from 1790 to 1798 there was as much real progress made with the root and stem of electricity as there has been in all the years since, because both the production of electricity and chemical decomposition were known and applied. Salva in 1798 worked a line 26 miles long with frictional electricity. In the eight decades since, we have only added the so-called dynamo-electricity. The balance of the labour bestowed upon the science has been in the perfection of the details touching the use of the fluid in a multitude of ingenious ways after it has been produced, and the perfection of these details has been the chief source of the benefits we have derived.

West Hartlepool.—The accounts of the electric supply and tramways department for the year ended March 31 were approved by the Council last week.

The Mayor stated that the gross income from the electricity undertaking was £22,014, an increase of £3,000 over 1916. The working expenses were £12,154, an increase of £3,400. After meeting interest, redemption on loan and other liabilities the net deficiency was £339, the first for many years. There was a distinct national saving by the use of waste steam for the generation of electricity. If the total power had been generated by coal firing they would have used 7,600 tons more than was actually consumed.

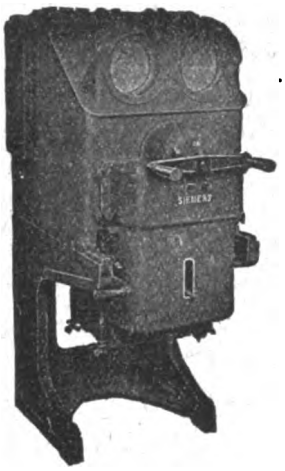
Councillor Charlton stated that the increase in the tramcar mileage was 20,078 and in passengers 709,355. The surplus profit (£3,428) was carried to reserve, an increase of £2,151. They would have to consider the laying of a double track to Seaton Carew.

TUNGSTEN FOR ELECTRICAL CONTACTS
MORE EFFICIENT AND MUCH CHEAPER THAN PLATINUM.
Recommended for use for X-Ray Targets, and as Contacts on Induction Coils and Tapping Keys, Magnetos and similar devices where there is frequent making and breaking of Electric Current. Also suitable for Gas Engines, Circuit Controllers, and like purposes.
Write for Particulars:—
THE L.P.S. ELECTRICAL COMPANY, 14, Howick Place, Westminster, S.W.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Goslplat, Ox., London." 4746 Gerrard.

Digitized by Google

SIEMENS



IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars
Distribution Boards
Main Switchboards

Write for particulars to —

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-69, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

"Some think I am dangerously brilliant."

POPE "ELASTA" LAMPS

are equally suitable for Factory Lighting, Hotel, Theatre, and Home Lighting. They have exceptional lasting qualities and retain to the end their initial brilliance.

For Street Lighting
POPE
"ELASTA"
(British Made)
WIRE LAMPS
Strong — Brilliant — Economical.

Advt. of Pope's Electric Lamp Co., Ltd., Hythe Road, Willesden, N.W. 10.

ELECTRICITY AND GAS SUPPLY.

In the course of an interesting address to the Waverley Association of Gas Managers last week, the President (Mr. J. D. Keillor) said that a great push in industrial progress must come in the near future, and it was their imperative duty to further that progress by all the means which science had placed at their disposal. It was their business to see that they did not rest upon their oars, satisfied and content with the business they had already acquired, heedless whether they advanced with the requirements of the times. It was their business to see that no opportunity was lost of advancing the claims of the industry in a tactful and convincing manner, so that wherever and whenever lighting and power were required, gas would be the method adopted. In electricity they had their chief rival to-day. It was electricity that had given the chief stimulus to enterprise in gas development, and, it was not to be gainsaid, it was electricity that prompted the recent "Wake up, Gas," and the exigence for better organisation.

If they were to rise to the greatness of their opportunities some remedies in their organisation must be applied—and those promptly and effectively. The opposition of electricity was so formidable that if gas was to maintain an honourable position in the realm of light and power they must apply a driving force so great and of such endurance that their place would be for ever assured, and that gas would be a force to be reckoned with. Always in their minds should they remember that they were not monopolists in the supply of light and power. Their rival had received all the care and support that scientific thought and influence could bestow upon it, and, speaking generally, had enjoyed an amount of patronage and encouragement never bestowed upon gas. To what extent it might in future years be developed was a matter of speculation, but he felt sure that soon its opposition would be more formidable than ever. Perhaps at no time more than the present, when the industry was threatened with a new form of competition from its chief rival, had there been need of the highest and acutest intelligence and initiative. The time called for the highest directive ability on the part of the leaders of the profession, the most perfect organisation, complete unity of effort, and the fullest use of science. The attention of all of them had been directed to a movement in which the Board of Trade was taking an active interest—the proposal to link up electricity supply undertakings in certain industrial centres; a proposal which need not necessarily be confined to one or two areas. It appeared to him to be a very serious attempt to regulate and foster the resources of an industry in the national interest, and it would be apparent to all close observers—for the gas industry it was a matter of the gravest moment—that it was a movement not so Utopian as it might at first sight appear. It was proposed with a view to promoting a more general economy and efficiency in the supply of electric current which, if the idea fructified, would have a far-reaching effect, probably a disastrous effect unless they could effectively combat it, upon the gas industry. If such a scheme be possible with electricity it should not be impossible to attain similar results with gas. Centralisation in production must make for economy in manufacture. Centralisation in gas production must not be preceded by centralisation of electric supply. The will to do it, supported by a sane and enlightened policy and hearty co-operation throughout the industry, were the factors necessary for the realisation of such a project—gigantic, no doubt, but a task, he thought, not superhuman.

In the discussion which followed the address, Mr. J. W. NAPIER (Alloa) said it was true that, in a number of towns where electricity had been introduced, notwithstanding its success and progress, the demand for gas had not ceased. For certain requirements, however, electricity was the only power: and it was interesting to observe that even the larger undertakings preferred to take a public supply than generate their own electricity. Electricity was, in the near future, going to secure a large share of the demand for lighting. While that was so, it need not in any way detrimentally affect the interests of gas, because the gas industry had its field of progress.

Mr. W. M. MASON, secretary of the British Commercial Gas Association, thought the gas industry was only beginning to open-up a tremendous field of progress. There was plenty to be done for electricity in the future, but he was absolutely convinced there was infinitely more to be done in the gas industry.

Mr. JAMES M'LEOD (Greenock) said they were faced with a great amount of competition from electricity, but electricity, unfortunately, was not their only competitor. At one time he thought gas-furnaces had no competitor at all. He had, however, realised since that they had three competitors against them in the furnace business—oil, solid fuel and electricity. It was astonishing how the electric furnace was developing for many purposes. If electricity could be cheapened, the furnace purposes would be ultimately served entirely wit it. Nevertheless, he was convinced that the field of gas was absolutely enormous.

Mr. DAVID FULTON (Helensburgh) said that, in speaking of electricity, most of the speakers had referred to it in the region of lighting only, but he thought it was of greater importance in the region of power. Both gas and electricity were public necessities, and there was no reason why they should not work hand in hand for the benefit of the public.

In reply, the PRESIDENT remarked that there was no doubt about gas being displaced by electricity. It was all very well for Mr. Napier, who had the joint control of gas and electricity in his own town. He (Mr. Keillor) had no such control. Hawick was supplied by two private companies—gas by a private company and electricity by a private company. The competition he had to contend with in Hawick was a

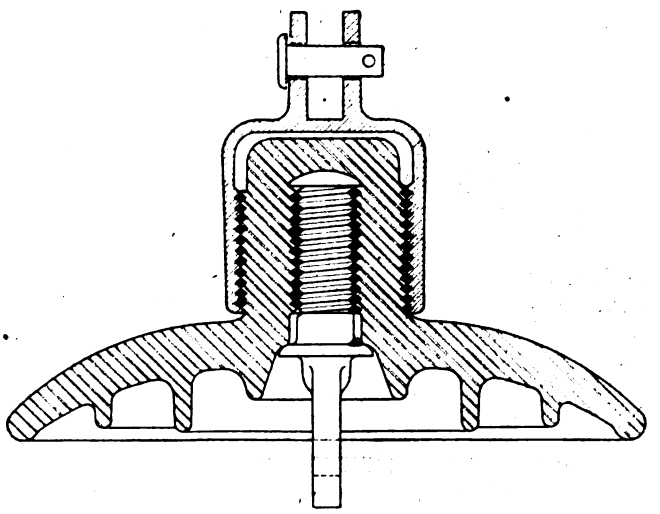
Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

PRESCOT

HIGH-TENSION INSULATORS.



(Patent No. 5341/16.)

No more cracked porcelains due to different co-efficients of expansion.

The thickened lines represent hemp cord or other suitable material wound into the inner thread, the diameter of which is appreciably less than that of the outer thread, though the pitch is the same. *The hemp cord thus becomes the male thread.* Screwed home you cannot pull it out.

To those who have suffered in the past, we need say no more.

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED SECOND HAND

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Vicmaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh. *See our Illustrated Advt. last week.*

Digitized by Google

ECONOMY IN CONSUMPTION OF RAW COAL.

The Ministry of Munitions states:—"With regard to steam raising for industrial purposes, it has been found, as a result of trials with different boiler installations, that under proper conditions, coke, or a mixture of coke and raw coal are as effective as raw coal alone."

The TAYLOR STOKER

has proved its ability to ensure smokeless combustion with low grade fuels in numerous plants throughout the world.

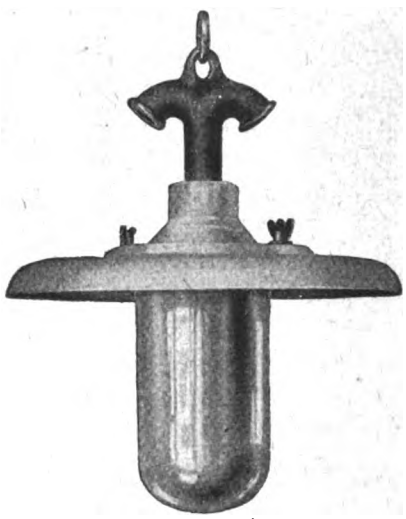
Write for the following booklets:—
(1) "Double the Capacity of your Boilers."
(2) "The Taylor Stoker and Low Grade Fuels."
(3) "How to Meet Sudden Overloads Instantly."
(4) "To Save Labour and Upkeep of Boilers."

SCHOLEY & CO., Ltd.,
56, Victoria Street, LONDON, S.W.1.

menace. The cut-throat methods adopted by the electricity company got them business, and his methods had had to be adjusted more than anything else with the view to holding on to what he possessed. In the power field, he could not get a look-in. The factories in Hawick were mostly textile, and they were all modern factories. They had numerous gas engines that were appreciated and doing excellent work. They realised the economy of the gas engine; but they found, as a rule, that where a series of machines had to be driven, particularly on different floors, the electric motor was preferred. It was a common practice for the electricity company's representatives to go into houses and ask people how much gas was costing them per annum. Very often they let the electricity company see their gas bills for the past 12 months, and then the electricity company made an offer to light up the premises for the same money as the people were at the time paying the gas company.

WEATHERPROOF LANTERNS.

The new Simplex porcelain body watertight lantern, which is illustrated below, is specially made up to resist corrosion and weather deterioration. It consists of a heavy china body into which is cemented a metal threaded nut, to take the suspension fitting or downdrop of the conduit system. The well glass, which is held by a metal ring with two bolts and fly nuts, completely protects the lamp



and prevents corrosion of the contacts, and prevents moisture from entering the system. This ring and the nut themselves are galvanised for protection. The standard well glasses are used with the fitting, so that in the event of the glass breaking, replacement is easily effected. The body of the lantern also has an overhanging projection which acts as a shade. It is a cheap and effective fitting and as it is substantially made for rough usage, it is specially useful for garages, stables, yards, factories and other exposed positions.

Electrical Engineers and Manufacturers

The House for Electric Heating.

Special Offer of "Quead" and "Ensign" Fires from Stock. Be Patriotic and Save Coal.

Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.

Telephone: Gerrard 7601 (2 lines)

Petrol Engine Sets.

Manufactured in sizes from 2 kw. to 20 kw.

Quotation for larger sizes on application.

F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON

GENUINE
M & M VULCANISED FIBRE.
MOSSES & MITCHELL, 122 & 124 GOLDEN LANE, LONDON, E.C.

FOR
High and Low Tension
SWITCHGEAR
THE
NEW SWITCHGEAR CONSTRUCTION CO., Ltd.
SUTTON, SURREY, ENGLAND.
ABC Code 5th Edition. Telephone: Sutton 773.

Manufacturers of
PHOSPHOR BRONZE, GUN METAL, MANGANESE BRONZE

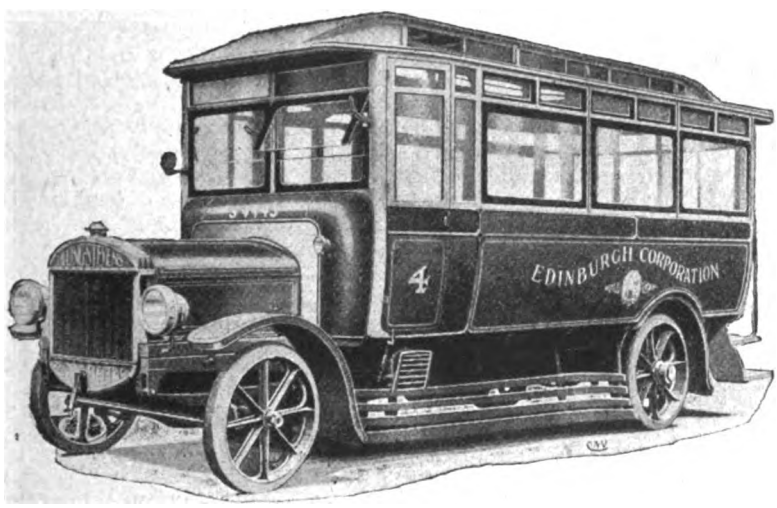
TRADE MARK.

Brass & Copper Tubes and Sheets.
BRASS CONDENSER TUBES FOR STANDARD SHIPS, &c.
CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.

Digitized by Google

C.A.V

Dynamo Lighting
FOR
Commercial Vehicles



Over 3,000 busses at home and abroad are now C.A.V. equipped.

One of the Tilling-Stevens busses supplied to the Edinburgh Corporation.

Fitted with the C.A.V. Standard bus equipment, comprising:—'H' type dynamo, No. 4 switchboard, T110 battery, interior light and head, side and tail lamps.

Our Commercial Vehicle Department will be pleased to answer all enquiries.

C.A. Vandervell & Co. Ltd.
ELECTRICAL ENGINEERS,
ACTON, LONDON, W.
Birmingham. Manchester.

Members of

FERRY **FERROZOID**

CONSTANTAN **CHRONIC**

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:
HENRY WIGGIN & CO., Ltd.
George Street, Birmingham.
TELEPHONE: 6400 CENTRAL.
GRAMS: "WIGGIN BIRMINGHAM."

AGENT:
LIONEL ROBINSON,
3, Staple Inn, London, W.C.
TELEPHONE: 6323 HOLBORN.
GRAMS: "FERRYDOM, LONDON."

Digitized by Google

"The Light that Never Failed."

MASTER
Tungsten-Light BATTERIES.

WE KNOW HOW
MASTER

COST NO MORE—LAST LONGER.

Stock these long-lived Batteries for Fall trade. Though imported from America, their energy when not in use is wonderfully preserved; hence they are sold under a liberal guarantee.

Made in every standard size, each uniform in quality and best for its purpose.

Handsomelyfinished. Sealed in attractive cartons

The MASTER line includes a complete range of unique and beautiful Flashlight Cases. Deliveries of any size from large London stock or by direct importations from the U.S. Request catalogue and interesting quotations for next season's business.

THE RIVER PLATE COMMERCIAL COMPANY
EXPORT ORDER DEPARTMENT.

UNITED BATTERY CORPORATION.

MANSION HOUSE — 15, GEORGE ST. — LONDON, E.C.

"FORMITE"
INSULATING VARNISH
FOR COIL INSULATION.

Write for Samples and Particulars to:—

THE DAMARD LACQUER CO., Ltd.,
98, BRADFORD STREET, BIRMINGHAM.

Telephone: MID. 1421. Telegrams: "DAMARDEST B'HM."

THE CHANNEL TUNNEL.

At the meeting of the Channel Tunnel Co. last week the chairman (Baron Emile d'Erlanger) said that never in the last 30 years of the career of the company had public opinion shown a more decided turn in favour of the construction of the tunnel than in the last 12 months. The question had been taken up very seriously in Parliament and a committee had been formed to advocate its construction and he believed it was the most numerous and the strongest committee that had ever been formed in the House of Commons. He thought he was perfectly justified in expressing the hope that the Government would see its way, if not to authorise the construction of the tunnel during the war, at least to give a decision in principle as to the advisability of its construction, so that the work which still had to be done to bring the scheme to complete perfection should be carried out without any loss of time.

Sir Robert Perks, Bart., M.P., who claimed to be the only survivor of the 20 proprietors who, in the year 1881, signed the articles of association of the company, said it was specially important that the Government should be asked to approve the scheme in principle at once, because the South-Eastern & Chatham Railway, which was the highway to Europe, was under the necessity of coming to some decision as regarded the making of a new route from Dover to Folkestone.

WORCESTER ELECTRICITY WORKS.

The accounts of the electricity department for the year ended March 31 show gross capital expenditure £186,668 (increase £14,154).

Revenue was £25,178 (compared with £21,225 in previous year), total costs were £13,576 (£9,968), leaving gross profit £11,602 (£11,256). Interest required £3,974 (£3,851) and redemption of capital £6,816 (£6,801), leaving net profit £812 (£604). The ultimate result, however, after providing £986 (£725) for capital works out of revenue, was a deficit of £173 (£121). Units generated were 4,127,300 and sold 3,487,561 (2,567,104). There are 1,241 (1,227) consumers, with 162,400 (135,333) equivalent 30-watt lamps connected.

Mr. C. M. Shaw (city electrical engineer) says in his report the undertaking has been thoroughly modernised during the past 10 years, and £11,920 has been spent out of revenue in work of a capital nature, which has resulted in apparent deficits for several years, but has permitted the building up of a very substantial power load, forming the mainstay of the business. The capital value (£82,979) is more than covered by the assets. At the Hylton-road works six additional h.t. switch-panels and a special sub-station for converting 2,000-volt two-phase to 6,600-volt three-phase current have been erected. The converting apparatus now totals 1,500 kw., the 288 tube economiser has been extended by 128 tubes. The water power works at Powick generated 757,895 (compared with 607,682) units. Power and heating units were 2,967,928 (1,944,423). Costs of production were 0·86 l. (0·89d.) per unit sold. Economies can be effected by increasing the working head of water at the Powick works, and it would be possible to obtain from 600 H.P. to 900 H.P. at the Diglis weir, and so generate about 1¼ million units per annum.

INSULATION BEADS

The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.

HOLDER-HARRIDEN, LTD., 35/37, NOBLE STREET, LONDON, E.C.

BUYERS of every description of Scrap Metals, viz: COPPER, BRASS, GUN METAL, BRONZE, ALUMINIUM, LEAD, ZINC, &c. All descriptions of RESIDUES.

ESTABLISHED 1867.

METALS.

J. B. GARNHAM & SONS,
132, UPPER THAMES ST., LONDON, E.C.

Telegraphic Address: "Garnham Cannon London."
Cables .. .. .. "Garnham London."
Telephone .. .. .. Bank 5726.
ABC Code, 4th and 5th Editions and Lieber's Code.

ENQUIRIES SOLICITED

SELLERS of COPPER and BRASS SHEETS, PLATES, TUBES, RODS, WIRE, &c., &c.

BASTIAN METERS

FOR DIRECT CURRENT ONLY.

Made in ENGLAND with
BRITISH CAPITAL and BRITISH LABOUR.

THE BASTIAN METER COMPANY, LTD., BARTHOLOMEW WORKS, KENTISH TOWN, N.W.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,040. [Vol. LXXIX. No. 12] FRIDAY, JUNE 22, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 455
Arrangements for the Week 457
The Convention of the Incorporated Municipal Electrical Association ..... 458 and 473
Individual Interest in Municipal Enterprise. By J. Horace Bowden 460
Fuel Economy. By J. A. Robertson 462
The Federation of British Industries 464
Heating of Dynamo Electric Machines With Various Loads and at Different Speeds. By Prof. Magnus MacLean, D.Sc., and D. J. MacKellar, B.Sc. Illustrated 465
THE FUTURE OF EVENING SCHOOLS 468
Industrial Research in the United States of America. Illustrated 471
The Institution of Electrical Engineers 472
CORRESPONDENCE 475
PARLIAMENTARY INTELLIGENCE 476
LEGAL INTELLIGENCE 476
Volunteer Notices 476
COMMERCIAL AND INDUSTRIAL SECTION 479
Electricity Supply 480
Tenders Invited and Accepted 482
Financial Matters 483

NOTES.

The Convention of the I.M.E.A.

THE Annual Convention of the Incorporated Municipal Electrical Association has this year been held once more on a very restricted programme. Apart from the Presidential Address, only two Papers have been read, one being by Mr. J. H. BOWDEN, on "Individual Interest in Municipal Enterprise"; and the other by Mr. J. A. ROBERTSON on "Fuel Economy." Both these subjects are distinctly controversial, and quite opportune at the present time. We shall refer to them in greater detail in our next issue. The Presidential Address by Mr. F. M. LONG gave an interesting survey of the present position of the electrical industry. It is important to realise that, owing to war conditions, several new branches of the industry are arising. For example, we now have calcium carbide at Manchester on a considerable scale, while at Wolverhampton we have phosphorus and arcorundum, which is a new type of abrasive. Further, there is the question of the use of electricity in agricultural areas, an application which was brought forward by Mr. W. T. KERR, of Hereford, last year. Undoubtedly, it is only necessary to push this development for it to become quite important in our agricultural districts.

Progress of the Electric Furnace.

BUT the most remarkable development is that of the electric furnace. Before the war very little was heard of the electric furnace, and steel makers were very shy of making use of this new implement. Since the end of 1914, however, Mr. FEDDEN states that he has connected up 27 steel furnaces in Sheffield, ranging in size from 260 kw. to 3,000 kw., making a total of 27,350 kw. This is remarkable progress. The advance of the electric furnace is also shown by a table which we publish elsewhere. In the early part of 1910 it appears that seven furnaces were at work in Great Britain. Eighteen months later the number had increased to 16, which figure remained stationary for another year and a half. At the beginning of 1916, 46 furnaces were in operation, and during the year an additional 42 furnaces were set to work, making a grand total of 88 in operation or under construction at the beginning of 1917. This amounts to about 19 per cent. of the world's total. The corresponding figures for the United States are: At the beginning of 1910, 10; in July, 1913, 19; in January, 1915, 41; January, 1916, 73; and at the beginning of 1917, no less than 136. It will be noted that during the last three years Germany has increased her furnaces from 34 to 52, and Austria from 10 to 18, neither country having made any increase during the last year, so far as our information goes. Of the furnaces installed, the Héroult type leads, the number installed being 181 out of a total of 471. The Rennerfelt comes next, with a total of 70. The induction type takes the third place with 50, and the fourth place is taken by the Grönwall-Dixon (Electro-Metals) type, with 29. Amongst the remainder, 28 are of the Snyder type, 24 Stassano, 23 Girod, and 20 Greaves-Etchells. It is probable that the positions occupied by the various furnaces will be considerably modified during the next few years, but in any case the increase in the world's total from 213 at the beginning of 1915 to 471 at the beginning of 1917 is highly satisfactory, and brings the days of cheap power for industrial purposes appreciably nearer.

South African Engineering.

READING between the lines of Sir LIONEL PHILLIPS's recent review of the position and prospects of the Central Mining and Investment Corpn. (Ltd.) one is forced to the conclusion that the winning of gold is a hazardous business from the financial standpoint, as well as from danger to life and limb. Many people hold wrong, and what may aptly be called "Klondyke," views regarding the gold mining industry, whereas the truth is that in most cases, buried deep in the earth, there is ore from which the utmost yield of gold does not exceed about 33s. per ton of ore. Bearing in mind the many stages of the process before the gold is ready for the market, it is evident that nothing but engineering of the highest class throughout could return a profit on the capital invested. Always strong on mechanical engineering, the mining engineers of South Africa, with commendable courage, embarked on an ambitious scheme of electrification. At every step difficulties were encountered, and experience was paid for in cash. A perusal of the specifications issued in connection with the more recent electrical equipment gives one the idea that the South African engineers expect of the manufacturer of electrical plant what they have been accustomed to get in the past from the mechanical firms. Of late a good deal of prominence has been given to the so-called defective German engineering in South Africa. It is well to remember that much of it was pioneer work, and it would be folly to imagine that the German engineers would not speedily remedy the defects brought to light. The reason why the Germans obtained such a strong foothold in South Africa has always been obscure to us, and we do not pretend to understand the magic which enables electrical manufacturers of repute to sell hundreds of tons of electrical machinery at or about 4½d. per pound, and, at the same time, to be in a position to declare handsome dividends in Berlin.

Digitized by Google

The British Trade Corporation.

THE position of the British Trade Corporation has now been cleared up to some extent by a declaration as to the true intent and meaning of the proposed Charter. The fear of the man in the street has rather been that the object of the Corporation would be to help itself, instead of helping other people. This is only natural. In the report of Lord Faringdon's Committee so much stress was laid upon the possibility of such a Corporation aiding British enterprise that it was a little surprising to find the Charter giving powers which might enable the Corporation to act as a competing contractor, merchant or trader. The Corporation is now prepared to give under its seal a declaration defining its policy and eliminating such undesirable activities. We think it will be felt, however, that this is a roundabout way of doing things. If the Charter requires defining, why not alter it so that it requires no such definition? There seems little point in giving a Charter on broader lines than are intended, and some doubt may be felt whether any such declaration would be binding on the successors of the present Board, though we have the assurance of the Law Officers of the Crown that a breach of the declaration would be a cause for the withdrawal of the Charter. We do not think that the proposed method is one to give complete confidence.

House Wiring by Supply Authorities.

ON another page we reproduce some interesting replies to a letter of inquiry recently sent out by the "Electrical World" on the subject of house wiring by electrical supply authorities. This is a matter which has been vigorously discussed in this country from time to time. It will be noticed that in the United States, where there are very few municipal undertakings, it is not necessary to obtain legal powers for carrying out work of this kind. On that account the engineer of an electric supply undertaking is in a position to decide for himself whether he will undertake wiring work. Where local contractors are unwilling to do this work in a manner which will help to build up the central station load, the engineer can start a wiring department and get busy with both domestic and industrial installations. In such circumstances an installation department can often be carried on quite profitably, and the action of the engineer in establishing it is fully justified. So far as this country is concerned, it seems to us that the matter is one in which the local conditions should be the governing factor. It is the experience of a large number of British central station engineers that if the local electrical contractors are indifferent to development, then the supply authority should itself endeavour to carry on the business of wiring and installation work. We think that even the Electrical Contractors' Association would not object to this course being taken. On the other hand, if representations were made to the Association to create a local electrical contracting interest this body should make the effort in order to ensure uniformity of practice. So far, the Association has done very little to exercise this function, and we suggest that it might seriously consider the matter as a solution of a problem which is an important one, and which affects the future of industrial and domestic electric service. Generally speaking, we think it far more profitable for the supply authority to work in close co-operation with local contractors of good repute, the supply engineers then being free for their own sphere of work—namely, the generation and sale of electric energy.

Industrial Research in the U.S.A.

ON another page we publish a selection of photographs which appear in a Paper by Mr. A. P. M. FLEMING on "Industrial Research in the United States of America," this Paper being the first of a series which is being issued by the Department of Scientific and Industrial Research. We have adopted the spectacular method of dealing with the subject, as we feel that these illustrations show so much at a glance. They afford sufficient evidence that industrial research on a large scale is a paying proposition, apart altogether from its value in other directions, and every thoughtful man will ask himself, How can we expect to compete satisfactorily with those who adopt these methods if we do not adopt them ourselves? If research of this kind is carried out in the proper way it necessarily means that those firms indulging in it are in the forefront of the battle. In the preface to this publication it is pointed out that all American industry has not reached the standard that would be suggested by these illustrations. Thus, Dr. WHITNEY, the Director of the Research Laboratories of the General Electric Co., recently deplored the neglect of true scientific research in the universities and colleges of the United States, and pointed out how essential research in pure science always is to industrial advance. Nevertheless, it must be admitted that the start which has been made in the United States in this direction is very substantial, and there is every reason to suppose that other undertakings will follow along these lines. It behoves manufacturers in this country to consider the position seriously, and to ask themselves whether, in regard to research, they are taking full advantage of the facilities now provided for them by Government in order to meet the keen competition which will arise in the near future.

Institution of Electrical Engineers.—The Institution of Electrical Engineers has received the following cablegram from the American Institute of Electrical Engineers in response to a message expressing the Institution's appreciation of the American Nation's entry into the War:—

> The American Instituto of Electrical Engineers duly appreciates your message. We hope that the Electrical Engineers of Great Britain and of America working together in close co-operation can bring to a satisfactory conclusion the many electrical problems of the War.

Faraday House "Journal."—We have received the summer term issue of this journal. Its chief feature is a most excellent portrait of the Principal, Dr. Alexander Russell, which all old Faradians will be pleased to see. Dr. Russell has been associated with the College for 27 years. The remainder of the journal contains notes of the doings of old students, obituary notices of those who have fallen for their country, and short articles on the Dublin Electricity Works and on Winding Systems.

British Engineers' Association.—At the recent extraordinary general meeting of this association the members adopted the revised memorandum and articles of association, which have been approved by the Board of Trade.

Considerably extended powers are conferred on the association, and membership, hitherto restricted to manufacturing engineers, is thrown open to the engineering departments of the British public services or companies and to individuals.

Among other matters discussed at the meeting, which was presided over by Mr. Wilfrid Stokes, were the new programme of the association (which includes the organisation of sections for each branch of the industry), proposals for a more vigorous campaign in China, a comprehensive scheme of engine ring education and research, and questions dealing with the problems of the reconstruction after the war.

Sir Wm. Ramsay Memorial.—In a communication to "The Times" of Monday it is announced that the Executive Committee of the Ramsay Memorial Fund, after prolonged and careful consideration, have resolved to aim at raising a sum of £100,000 and to devote that sum to two principal objects: (1) The provision of Ramsay Research Fellowships, tenable wherever the necessary equipment may be found; (2) the establishment of a Ramsay Memorial Laboratory of Engineering Chemistry in connection with University College, London. In the communication, which is signed by the President, Vice-presidents, the Chairman of the Executive Committee and the Treasurer, it is pointed out that as the late Sir William Ramsay's interests were very closely connected with chemistry

Digitized by Google

as applied to industry and manufacture, the Committee are confident that the objects of the appeal are such as would have commended themselves to his warmest sympathy. Accordingly they desire to appeal to friends and admirers of the late Sir William Ramsay, to old students, to all persons who are interested in chemistry and its application to industry and manufacture, to contribute to this great national and international memorial to the late Sir William Ramsay, and to send their subscriptions to the hon. treasurers of the Ramsay Memorial Fund at University College Gower-street, W.C. 1.).

Diesel Engine Users' Association.—At the May meeting of the above Association a Paper was read by the President, Mr. Geoffrey Porter, A.M.I.C.E., on "Tar Oil Fuel and Diesel Engines." The author gave a summary of some experiences of tar oils offered by distillers. In view of the present difficulty in obtaining sufficient supplies of residual petroleum oils, and the high prices ruling for fuel of the kind, the successful utilisation of tar oils of home production is of great consequence.

After protracted negotiations, an agreement has been concluded with the Inland Revenue Authorities to increase the rate of depreciation upon Diesel engines to 10 per cent. per annum, with the proviso that this increase shall remain in force for three years after cessation of the war, when either party shall be at liberty to claim a revision. Having regard to the present high level of taxation, this increased allowance represents no inconsiderable saving to those companies and corporations entitled to the concession, and which is due to the efforts of the Diesel Engine Users' Association. This Association had previously been successful in bringing about a reduction in premiums charged for insurance against breakdowns.

The Annual Report of the National Physical Laboratory. The annual meeting of the General Board of the National Physical Laboratory was held at the Laboratory on the 19th instant. The President of the Royal Society, Sir J. J. Thomson, is chairman of the Board; Lord Rayleigh is chairman of the Executive Committee. The annual report is now available, and we contemplate referring to it in fuller detail shortly. The outstanding feature of the year has been the growth of the gauge testing work. Nearly the whole of the gauges required for the inspection of munitions are now examined at the N.P.L., the number averaging about 10,000 weekly. By arrangement with the Ministry of Munitions, a new building has recently been erected to accommodate the work. There has been a great increase also in the number of optical and electrical instruments tested for the Admiralty. A new branch of work is the testing of luminous dials for instruments of various kinds. Investigations carried out have been in the main of a confidential character. Aeronautical research has continued to be of great importance, and the William Froude National Tank has carried out much work for the Admiralty. In the Metallurgy Department researches on light alloys and on optical glass have been continued, while in the engineering department, hardness tests, methods of impact-testing, the fatigue resistance of materials under combined bending and twisting stresses, the transmission of heat from surfaces to fluids flowing over them—as in the flow of air over an aeroplane engine—are among the questions examined. Much attention has been given recently to the question of the future of the Laboratory, and in particular to its relations with the Department of Scientific and Industrial Research, and a scheme will no doubt be arranged whereby close relations with the Department will be established.

Electric Furnace Progress.—In a booklet recently issued by the Society for Electrical Development on "Industrial Heating as a Central Station load," statistics are given of the electric furnaces in use in various countries at the end of 1916.

The number of electric furnaces is given as 471, against 303 in the previous year. Though the figures in the table below are interesting, they are not up to date so far as Great Britain is concerned, and probably the statistics for the whole of Europe are incomplete. This is, however, not to be wondered at, seeing the rapid progress made in electric smelting during the war. In this period the number of electric furnaces in Sheffield has increased from 15 to over 50; but in the United States the number has grown from 73 to 136 in 12 months. The output of electric steel in the States has increased from 55 tons in 1908 to 175,000 in 1916. In the current year the output will probably exceed 300,000 tons. The United States Steel Corpn. is building an electrical steel plant at South Chicago with a capacity of 4,000 tons a week. In Sweden there are 10 furnaces, with an output of about 130,000 tons of pig iron per annum, and a considerable number of new plants are being built. Germany produced 225,000 tons of electric steel last year, nearly double the output of 1915.

—	Heroult.	Girod.	Induction.	Stassano.	Snyder.	Rennerfelt.	Electrometals.	Greaves-Etchells.	Miscellaneous.	Total.
Austria-Hungary	10	2	3	2	...	1	...	...	...	18
Australia	...	...	...	...	...	...	1	...	...	1
Belgium	2	1	...	...	...	...	...	...	...	3
Great Britain	34	1	2	4	6	7	14	20	...	88
Canada	5	...	...	...	3	...	1	...	10	19
France	19	7	2	...	...	1	...	...	...	29
Germany & Luxmberg.	19	5	19	2	...	...	...	...	7	52
Italy	4	...	2	13	...	...	...	...	10	29
Japan	1	...	1	...	...	...	...	...	...	2
Mexico	...	...	1	...	...	...	...	...	...	1
Norway	...	...	2	...	...	6	...	...	1	9
Roumania	1	...	...	...	...	...	...	...	...	1
Russia	3	1	1	2	...	7	2	...	...	16
Sweden	3	...	1	...	...	34	2	...	...	40
Switzerland	1	2	...	...	...	1	...	...	...	4
Spain	...	...	1	...	...	...	1	...	...	2
United States	79	4	3	1	19	13	8	...	8	135
Locality not given	...	...	12	...	...	...	...	...	9	21
Total	181	23	50	24	28	70	29	20	45	471

The table gives the following figures for other types of furnace: Three Keller furnaces in Germany and five in Italy; four Nathusius in Germany, five Chapelet in Italy, one Wile in Norway, one Greene in the U.S.A., and nine special furnaces in Canada. Totals are also given for the years 1910-16.

OBITUARY.

DEATHS ON ACTIVE SERVICE.—The following are reported to have died on active service:—

Capt. B. J. W. M. Moore, M.C. (R.F.C.), who was killed in a flying accident on June 10, was a member of the Institution of Electrical Engineers, and had served his time in the works of Messrs. J. C. Fuller & Sons, of Chadwell Heath. He returned home from Canada on the outbreak of war to enter the Army, and he received the Military Cross at the hands of the King on Feb. 14 last.

Capt. H. Kember (S. Lancs. Regt.), 32 years of age, who was formerly employed in the British Westinghouse Co.'s works, is reported to have died in action.

PERSONAL.

At Oxford, on the 12th inst., the honorary degree of D.Sc. was conferred on Prof. Arthur Schuster, who afterwards delivered the Halley Lecture. "Nature" reports that, in presenting Prof. Schuster, the Public Orator (Mr. A. D. Godley) spoke of his eminence in various departments of physical research, deploring the inadequacy of the Latin language for dealing with the technical details of the professor's work in the subjects of electricity and magnetism. He alluded also to Prof. Schuster's services as secretary of the Royal Society and to the value of his labours to the nation.

Mr. A. Hugh Seabrook, borough electrical engineer, of Marylebone, and Mr. W. C. P. Tapper, borough electrical engineer of Stepney, are assisting the Advisory Committee of the Ministry of Munitions dealing with the utilisation of fuel and the economical use of coal.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, June 22nd (to-day).

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

10 a.m. At the Institution of Civil Engineers, Great George-street, S.W. Annual General Meeting. To reassemble if necessary to complete any adjourned business.

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, Imperial Institute-road, S.W. Papers to be read on "The Determination of Coma from a Central Ray," by Mr. T. Smith, B.A., and "Chromatic Parallax and its Influence on Optical Measurements," by Mr. J. Guild, A.R.C.S.; "Graphs of Bessel Functions," by Mr. B. Hague, B.Sc. It is hoped also to have some optical demonstrations by Mr. S. D. Chalmers and, possibly, others.

TUESDAY, June 26th.

ASSOCIATION OF SUPERVISING ELECTRICIANS.

7.15 p.m. At St. Bride Institute, Ludgate-circus, E.C. Annual General Meeting.

Digitized by Google

THE CONVENTION OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

London, June 21st.

Owing to the war, the Annual Convention of the Incorporated Municipal Electrical Association is once again being held in London. Last year the place of meeting was the Institution of Electrical Engineers. This building, however, is no longer available, and therefore the Convention is being held at the Institution of Civil Engineers, whose home has, fortunately, not so far been commandeered by the Government.

There was a considerable attendance of members, though the inroads of military services were still more marked than last year, and those in responsible positions are finding themselves labouring under increasingly difficult conditions.

Those attending the Convention included central station engineers and committeemen from all parts of the country, and also many well known professional electrical men and representatives of prominent manufacturing firms. Among the delegates and visitors were Messrs. F. M. Long (Norwich), President, S. L. Pearce (Manchester), H. Faraday Proctor (Bristol), S. T. Allen (Wolverhampton), S. J. Watson (Bury), F. Ayton (Ipswich), W. W. Lackie (Glasgow), J. H. Bowden (Poplar), J. Christie (Brighton), H. Dickinson (Liverpool), C. H. Yeaman (Stoke), P. P. Wheelwright (Blackburn), E. G. O'Kell (Plymouth), W. J. Wood (Bolton), J. K. Brydges (Eastbourne), S. E. Britton (Chester), H. R. Burnett (Barrow-in-Furness), F. W. Purse (Carlisle), R. W. L. Phillips (Bedford), W. A. Jackson (West Bromwich), H. Foulds (Birmingham), W. Wyld (Hampstead), W. J. Bache (Cheltenham), W. M. Rogerson (Halifax), T. Roles (Bradford), A. Nichols Moore (Newport, Mon.), F. H. Whysall (Greenock), J. W. Beauchamp (West Ham), A. H. Shaw (Ilford), E. E. Hoadley (Maidstone), A. W. Barham (Watford), S. E. Fedden (Sheffield), H. Tomlinson-Lee (Wimbledon), Geo. Wilkinson (Harrogate), J. A. Robertson (Salford), J. R. P. Lunn (Darlington), W. C. P. Tapper (Stepney), L. L. Robinson (Hackney), H. F. Street (Southampton), J. H. Clothier (St. Anne's-on-Sea), J. E. Edgcome (Kingston-on-Thames). The committeemen delegates included Ald. G. Pearson (Bristol), Ald. A. Sinclair (Swansea), Ald. Leek (Stoke), Bailie Smith (Glasgow), Ald. Vaughan (Maidstone), Ald. Smith (Barrow-in-Furness), Ald. Smith (Liverpool), Ald. Walker (Manchester), Bailie Stewart (Glasgow), Ald. Robinson (Bradford), Councillor West (Coventry) and Ald. Mansfield (mayor, West Ham).

The visitors included Dr. S. Z. de Ferranti, Mr. C. H. Wordingham (President, Institution of Electrical Engineers), Mr. J. H. Rider, Mr. W. A. Chamen (South Wales Power Co.), Messrs. W. M. Selvey, A. Devey (British Insulated & Helsby Cables), G. Seton Chisholm (Siemens Bros. & Co.), A. J. Deverill (Brush Electrical Engineering Co.), J. Snow Huddleston (Siemens Bros. & Co.), F. S. Grogan (Arora Co.), J. M. Johnston (Stirling Boiler Co.), A. S. Barnard (Chloride Electrical Storage Co.), W. E. Gower (Underfeed Stoker Co.), and R. H. Schofield (Ferranti Ltd.).

The President, in opening the proceedings, asked the meeting to send congratulations to Mr. W. A. Vignoles on being awarded the D.S.O., and to Capt. E. A. Barker (Barnsley) on gaining the Military Cross; also good wishes to Major H. Richardson (Dundee) and to others on active service.

The President then delivered his address, which we give in abstract below. A vote of thanks to the President was moved by Mr. Leese (Stoke-on-Trent), and was seconded by Mr. W. A. Chamen, who remarked that he hoped the proposed Electricity Bill would not be delayed, as the President seemed to suggest, until the Government took the matter in hand. The Bill had been drafted so that it could go forward without delay. The President, in replying to this observation, stated that he only suggested delaying the Bill until the intentions of the Government were known. The vote of thanks was carried with acclamation.

PRESIDENTIAL ADDRESS.*

BY F. M. LONG.

(City Electrical Engineer, Norwich.)

Although our summer gatherings are still shorn of all festive characteristics, and the President's duties at this time are confined to purely business meetings, the year has been one of great interest. It marks what may be the beginning of a new era in the work on which we are engaged, for in it have been taken the first steps towards the realisation of that larger development of the use of electricity in the service of the country, with the possibility of which we have been long familiar. While very little has yet been accomplished, we may see in the schemes for linking up and the appointment of a special Committee by the President of the Board of Trade, to consider the question of electric supply, the beginning of a movement which is bound to develop and vitally affect the whole problem of the generation, distribution and uses of electricity.

Before, however, considering these points I should like to touch on the records of the past year and the prospects before us as soon as the war is over.

While the growth and development of the supply of electrical energy, with which this Association has been so intimately connected, has been marked all through by steady progress and increasing spheres of usefulness, at no time has the development or the service rendered to the community at large by the supply undertakings in the Kingdom, and especially those owned by local authorities, been on so large a scale as in the last two years. It may be stated as an undisputed fact that the ability to meet the great demands for power has been an important factor in the production of the vast quantities of munitions required for the war.

Many stations have been running up to the hilt without any spare plant whatever. The most serious difficulty appears to be as regards boilers. A turbine may run for a long period without requiring any repairs, but unless boilers can be taken off regularly for cleaning and inspection, trouble is bound to ensue. It is impossible to express any opinion as to the restrictions on the supply of new boilers to municipal undertakings, and one can only draw attention to the risk that is being run.

The war has already given a great stimulus to the utilisation of electrical energy in processes which before had been very little developed in this country, among which the following may be mentioned.

Steel Furnaces.—Electric furnaces are now being extensively used in those districts where the manufacture of steel is carried on, and I may quote from some interesting notes given me by Mr. Fedden, of Sheffield.

> Since the end of 1914 I have connected 27 steel furnaces, ranging in size from 260 kw. to 3,000 kw., making a total of 27,350 kw. Fourteen others are awaiting completion and connection. Showing the progress that furnace loads have made since the war, I estimate that by the end of next month (April) there will be at the rate of 85,000 tons of electric steel made per annum from this Department's supply, making a total of approximately 100,000 tons per annum made in Sheffield.
>
> The chief factor in electric furnace development at the commencement of the war was due to the enormous quantity of steel turnings and the numerous other turnings in connection with war material. The majority of these turnings contain a good percentage of valuable alloys, and the greater portion of these would have been lost if the turnings had been melted in the ordinary steel furnaces. There is also a difficulty in dealing with these turnings in the ordinary steel furnaces, owing to their lightness and difficulty in handling, which is easily overcome in the electric furnace.
>
> The steel manufacturers are very prejudiced against trying any new developments, but after their experience in electric furnaces they realise that they can make high-grade steel equal to crucible steel in ingots of almost any size. Further, they can carry out refining to any desired extent, and it is possible to make electric steel of a high-grade quality from raw material containing impurities, which would be impossible in either the Siemens or the crucible furnaces.
>
> I have no doubt that after the war considerable developments will take place in the manufacture of electric steel, as it is possible to make mild steel of a guaranteed less carbon than by other processes. This will enable motor-car castings, together with all these kindred requirements, to be much lighter.

From a steel manufacturer I get this opinion:—

> The advantages of making steel by electricity are, that you can get a very much better control of the heat than in any other furnace, and that you are enabled to use turnings and other scrap in place of expensive hematite iron, for the production of high-class steel.

* Slightly abbreviated.

Digitized by Google

Steel furnaces have been put down in many parts of the country, as in Birmingham, Bradford, Glasgow, &c., and there can be no doubt that developments will be very considerable in all steel-producing areas, absorbing very large quantities of power.

Air Nitrates.—Another development of very great interest is the establishment in Manchester of a factory for the manufacture of nitric acid from the air utilising the new Kilburn Scott three-phase furnaces. The first plant to be erected, of an experimental character, will require some 1,000 kw., but if successful, it is expected that this may develop into a very large undertaking ultimately requiring some 15,000 kw. and it will be a 24-hour day load. The immense demand for nitric acid, not only in the preparation of explosives, but also for the manufacture of fertilisers and other products, makes this development one of the utmost importance.

Carbide Factories.—Mr. Pearce informs me that a carbide factory is being established alongside the Stuart-street Generating Station at Manchester, the ultimate demand of which will be of the order of 10,000 kw., mainly of an off peak character. It is estimated that the consumption will run from to 50 to 60 million units per annum.

Phosphorus.—From Mr. Allen I learn that a factory for the manufacture of phosphorus will be starting at Wolverhampton next year, requiring 4,000 kw., and that another 4,000 kw. will in all probability be required.

Arcorundum.—Mr. Allen also informs me that the manufacture of arcorundum has been started in Wolverhampton. This is an abrasive material similar to carborundum made by fusing bauxite in electric furnaces. This is an entirely new industry in this country and the plant at present consists of one 300 kw. furnace with another going in shortly.

The above are a few instances of the use of electric furnaces, and there are others that cannot be referred to at present. Until a few years ago it was considered that electric energy could only be supplied at a sufficiently low rate for such purposes where water power was available, and this was looked upon as a self-evident fact. It has been pointed out though, that owing to the capital outlay necessary the cost of water power is by no means negligible as compared with power from coal, and, further, that the cost of freight may more than compensate for the difference. It is also a great advantage to manufacture a commodity as near as possible to the largest selling field.

Now that experience has been gained in this country there is every probability of a great development of such industries resulting in enormous demands for electrical energy.

Beyond these larger uses of electric energy it is interesting to note that there has been started in various parts of the Kingdom the manufacture of articles that were formerly imported from Austria or Germany. This all means additional power to a greater or less extent, which in the aggregate will be quite appreciable. For example, in Wolverhampton a firm have built large works taking 200 kw. to 300 kw. for the manufacture of enamelled ironware of a class which used to be imported from Germany.

The manufacture of magnetos is another branch of work for which we were before the war dependent mainly on Germany, but which has been taken up actively in many centres. The same applies to glass and optical instruments.

Chemical industries apart from those using electric furnaces are very active on new lines.

In a district in the south of England supplied by a municipal undertaking works are proposed or have been started for the production of a substitute for aspirin, emollients and other fatty medicinal products, phosphorus compounds, coal-tar dyes, antiseptic and disinfectant products of the formalin class, plant for acetylene welding, acids, glycerine, &c., each of these requiring from 20 kw. to 300 kw., and in the aggregate estimated to require 5½ million units per annum. Experimental work is being carried on for the production of a number of other products of a chemical character which may be expected to result in important industries later on.

In the Midlands and elsewhere a number of firms are producing small articles from lampholders to toys and fancy goods, which in peace times were largely imported, all helping to increase the demand for power.

Electricity in Agricultural Areas.

Over and above the development of industries as above, which for the main part concern the larger towns, there is the question of the development of the use of electricity in agricultural areas, which is a matter that concerns small as well as large undertakings.

The possibilities in this direction and the importance of the matter were so clearly brought before this Association last year by Mr. Kerr, that your Council has appointed a Committee specially to deal with the question on the lines so successfully pursued by the Electric Vehicle Committee. It is proposed that the Committee shall embrace representatives of all Associations concerned in agricultural development, and seek the co-operation of all who can render assistance. The question is one of National importance.

Electro-culture is a matter of very great importance. It has shown such results in the experimental stage that there can be no doubt that when it is more fully understood it will be a factor of enormous benefit to the country. Though the actual amount of energy required is very small and could be supplied in other ways, the existence of a supply of electrical energy at hand will make a very great difference in practical working.

The use of electricity for light railways, for canals, and for charging electric vehicles, are also matters which may become of great importance.

The problem of supplying such areas is a large one and many difficulties will have to be faced. To bring electric power within the reach of all possible users in the country involves an extensive system of overhead wires. This, however, must be a matter of development, the natural course of which would be for lines to radiate out from existing supply stations. It must necessarily be many years before it will be feasible to run bulk supply mains from stations on the coal fields to supply such areas as, say, the eastern or southern counties, and until such time these areas must depend on such supply stations as already exist, as the erection of special plant to supply agricultural districts is out of the question.

It is a matter, therefore, that should appeal to those local authorities owning supply stations so situated, as they, and they alone can give these facilities.

Setting aside for the moment the questions of obtaining powers and of way-leaves, which I deal with later, there is the outlay to be considered. This, for supplying any large area, might be more than a small town could take responsibility for, and means would have to be found for dealing with it. Small extensions, however, could well be made, and what has been done at Hereford could be done elsewhere. This would prepare the way for further developments later on. What is wanted now is that each undertaking should investigate this problem and prepare a scheme which could be put into effect after the war is over. It is most desirable, however, that there should be uniformity as regards system, in view of possible linking-up or bulk supply later on, and it will be one of the functions of the Committee to standardise methods of distribution and appliances.

It is hoped also that this Committee will before very long be in a position to give information and advice on the many points that are sure to arise.

Board of Trade Committee.

It has been apparent for many years that the conditions under which the supply industry has laboured have been a great hindrance to free development, and efforts have been made from time to time to deal with some of the difficulties.

Many committees have sat and reported, but with little practical effect. Now, however, as a result of the changed attitude towards industry brought about by the war, the Government have realised that something must be done and a preliminary step in this direction was taken by the appointment by the Board of Trade of a Committee to inquire into the question of electrical trades after the war. This Committee, which was presided over by Sir Charles Parsons, has, it is understood, presented its report, although the same has not yet been published.

While there is some dissatisfaction on this account, although no doubt there are good reasons for its being withheld, it is satisfactory to know that the matter has not been shelved, but that as a result in all probability of the recommendations contained in the report, the President of the Board of Trade has appointed a further Committee. It is evident from this reference that the report of the Trades Committee must have fully demonstrated not only the vital necessity of much greater development of the supply of cheaper electric power, but also the urgent need of steps being taken to enable this to be brought about. We may see in these terms welcome evidence of a new attitude of the Board of Trade towards the electric supply industry, in striking contrast to the old methods to which we have been accustomed, and may, under the changed conditions, anticipate a beneficial outcome.

Without attempting to discuss in detail the problem with which the Committee is dealing, I may perhaps give expression to some salient points. There are innumerable matters on which legislation is required, but the fundamental necessity is the re-organisation of the Government control of the industry, together with the granting of additional powers.

This view was given expression to by the Council of the Institution

Digitized by Google

of Electrical Engineers in their second recommendation to the Trades Committee, which was as follows :—

> " A Government Tribunal of the most independent character that can be devised to be appointed to control the electricity supply industry of the country, and also to prevent indiscriminate addition or extension of power-stations or systems undesirable from the point of view of size, locality, or system."

This resolution met with some criticism on account of the doubtful meaning of the word " control," but on the understanding that it does not imply either the owning or operating of electricity works, it was endorsed by your Council.

Your Council have, however, gone further, and at the request of the Trades Committee, before whom your representatives gave evidence, have made some specific recommendations, which, however, it is not possible at the present stage to make public. I may, however, touch on a few points of principle.

It has long been felt that the control of municipal undertakings by three departments of the Government, the Board of Trade, the Local Government Board and the Home Office, is not at all satisfactory, and that the powers exercised by these departments under the Electric Lighting Acts should be conferred on one department, or Board specially appointed.

This Board should be as free as possible from political influence and should have full powers conferred upon it. It should include among its members engineers of extended experience of electricity undertakings, who should devote their whole time and interest to this business. Its powers should be such as to enable it to deal, without reference to any higher authority, with all matters concerning electricity undertakings, excluding only the owning or operating of such.

With such a Board, which would be fully in touch with all the requirements of electricity undertakings, and whose function it would be to make recommendations where legislation were required, there would be some hope that powers so urgently required for the development of the industry would soon be obtained. It might also be hoped that procedure would be simplified so that matters would be more expeditiously dealt with, and much of the present expense avoided.

The Committee has recently published certain conclusions that it has arrived at, and while these conclusions contain nothing new the publication is important as indicating the lines that the report of the Committee is likely to take. The principles involved have been discussed and generally approved by all familiar with the conditions of electricity supply, but now that they seem likely to be put into practice it becomes desirable for this Association to consider how such proposals can be best carried out for the good of the industry generally, and so that existing undertakings not only may not suffer loss, but that they may also share in the benefits of the lower costs of production that should result.

SUPPLY OF ELECTRICITY BILL.

With the further powers that municipal undertakings have been seeking for many years, we are all familiar, but there are some additional powers sought in the Supply of Electricity Bill which has been drafted by representatives of your Council, in conjnction with the Association of Electric Power Companies, to which reference may be made. These are wayleaves, lines above ground, joint working and methods of charging.

The questions of wayleaves and powers to run overhead lines are recognised as vital to the development and supply of cheap power, and though hitherto of more concern to power companies, they are equally important now to municipal undertakings, in view of linking-up and the supply of rural districts.

Powers for joint working of undertakings whether municipal or company are desirable and necessary in view of the advantages that can be derived from linking-up where the conditions are favourable, and the granting of such powers is not likely to give rise to difficulty or opposition. The exercise of such powers is, however, another matter, and one fraught with far-reaching effects. The drawing up of agreements so that the benefits to be derived from joint working may be fairly proportioned between the several parties, will call for much skill and foresight, combined with a spirit of fairness and mutual regard.

The question of methods of charging is one that needs to be put on a more definite basis. It has been found necessary, in order to extend the use of electricity for all purposes, to differentiate between charges for supplies for light, power, heat, &c., as well as to devise special methods of charging, the validity of which can only be settled in a Court of Law. This is not satisfactory, and it is proposed that power should be given to the Board of Trade to approve methods of charging whether for energy supplied, stand-by supply, or other services rendered. Such methods would then have legal authority and opportunities for vexatious litigation would be removed.

For the present nothing further can be done, but the draft-Bill was put before the Trades Committee and has presumably been handed on to the new Committee.

Should the Government create a special Board or delegate to a special department of the Board of Trade the powers already outlined, the obvious course would be for such Board or Department to take over the Bill, amending it as they think fit and to promote legislation to give it effect, but until it is known what the Government, will do, the matter must remain in abeyance.

INDIVIDUAL INTEREST IN MUNICIPAL ENTERPRISE.*

BY J. HORACE BOWDEN.
(Chief Electrical Engineer, Borough of Poplar.)

The only irrefutable argument against municipal trading as carried on at present, is that it does not allow full scope for individual interest, the lack of which tends to induce laxity in management, and disregard of the interests of the public.

The scope of municipal enterprise may be regarded as an intervening stage between industrial co-operation and State control. Public opinion is now undoubtedly undergoing a very radical change in regard to the conduct of public business, and, having found it necessary, during war, to institute State control of railways, coal fields and the production of foodstuffs, it is reasonable to assume that such control will be retained for a considerable period after the war, or may be incorporated into practical politics for the future.

With the retention of State control of national monopolies, it may be anticipated that a considerable impetus will be given to municipal enterprise, particularly in the generation and distribution of electrical energy, and it is with the object of eradicating the only irrefutable argument against municipal trading of to-day that the author has ventured to place his views before the Convention.

Viewing the position attained in the business world by the electrical industry at the present day, together with its enormous scope in the future, it must be admitted that the average remuneration bestowed on those responsible for the management of municipal undertakings is considerably less than that derived from positions of equal importance in other branches of industry.

There are reasons for this unsatisfactory state of affairs, firstly, because in the past, when the industry was " in its infancy " and engineers had still their reputations to make, one position was considered a stepping-stone to another of greater importance, and so on until the top of the profession was reached. To-day a different order of things prevails, and the transitory periods are few. Secondly, security of tenure in municipal work is greater than in private enterprise, and in a number of instances provision against retirement is made by the municipality ; therefore, the incentive to strive after higher remuneration in order to provide for old age is not nearly so great.

To successfully control a municipal undertaking, concentration of thought during an undisturbed period of a number of years is necessary on the part of those responsible for the management, and, in order to secure this, not only should the municipality pay sufficient remuneration to prevent distraction from undivided attention by their official staff, which striving after increased remuneration engenders, but should also offer inducements to the staff whereby the desired results might be attained to the material benefit of those responsible for their attainment.

The interests concerned in electricity supply are those of the consumer, the ratepayer and the staff.

The consumer's interests may be stated as follows : Low prices, continuity of supply and efficiency of service. The ratepayer's interests are : Security of guarantee, the creation of such an asset that a cheap supply of power brings to any municipality by the increase of rateable value and participation in profits. The interests of the staff are : Satisfactory working conditions, adequate remuneration, security of tenure and participation in profits.

The primary interests of the consumer and the ratepayer are linked

* Abstract of a Paper read yesterday at the Convention of the Incorporated Municipal Electrical Association.

Digitized by Google

indissolubly together. Cheap prices and participation in profits may appear to be diametrically opposed, but it must always be borne in mind that the ultimate result of low charges means that all ratepayers would become consumers, and therefore any apparent injustice by contributing to rates out of profits would eventually disappear.

The author does not wish it to be understood that he supports the idea that municipal trading should be undertaken purely for the purpose of relieving the rates out of profits resulting therefrom, but he considers that this should be done in a modified form and to a well-defined scale on the lines introduced later on in this Paper, in preference to the present-day practice of mulcting the profits of electricity undertakings to the detriment of their financial positions.

Consumers' and staff interests are linked, inasmuch as satisfactory working conditions, adequate remuneration and security of tenure tend to ensure continuity of supply and efficiency of service. Low prices to the consumer, and participation in profits by the staff can be made of identical interest by the introduction of proper safeguards to the consumer into any profit-sharing scheme.

The interests of the ratepayers and the staff have everything in common respecting security of guarantee. Judicious capital expenditure is the most effective medium of profit production, and a municipality may anticipate that every possible consideration would be given before capital expenditure is recommended by a staff participating in profits. An asset which has been built up judiciously presents the greatest security for the guarantee of the ratepayers.

The interests of the ratepayers and staff are also common in respect of profit sharing, and the author is of the opinion that the scheme submitted in this Paper will ensure the best results to the ratepayer, and, at the same time, secure for an undertaking a sound financial footing. It is of paramount importance that every municiapl electricity undertaking should be placed upon a sound financial basis in priority to any other consideration. Until this is accomplished, little can be done towards reduction of prices or participation in profit by the municipality or staff. For a number of years prior to the introduction of a profit-sharing scheme at Poplar, and before any contribution whatever was made to the rates, a drastic policy of writing down and scrapping obsolete plant was adopted, together with a system of payment out of revenue for all assets for which loans could not be raised for periods of 20 years or over. All existing loans were converted from the annuity or annual instalment to the quarterly instalment system. No money for machinery has been borrowed since January, 1914, all new plant having been purchased out of amounts written down in respect of obsolete plant. All machinery of any description laid down prior to 1905, with the exception of two boilers and original low-tension switchgear, has been entirely written out of the books of the undertaking.

In furtherance of this policy, therefore, it was necessary, before considering the disposal of surplus profits, to lay down a schedule of first charges upon surplus profits as follows, viz.: (1) Minor improvements to buildings and plant; (2) new meters and services; (3) wiring, cooking and heating installations; (4) showroom and test room fixtures; (5) instruments, office furniture and tools; (6) cost of reclaiming disused cable; (7) removal and re-erection of machinery; (8) sundry expenses connected with capital work and plant; (9) lay aside of £1,000 per annum over and above requisite amount of redemption for reducing the debt on account of services, instruments and accumulators. Working balance at end of each financial year to be made up to 10 per cent. of the total income for that year.

After payment of the foregoing charges on surplus profits, the available balance (if any) in any year is apportioned as follows, viz.: 40 per cent. is placed at the disposal of the Finance Committee of the Council; 20 per cent. of a sum up to £6,000 available for disposal, and 10 per cent. on available sum over and above £6,000, for division amongst the members of the permanent staff. Remaining balance is placed to the credit of capital machinery account for writing down obsolete plant.

The amount placed at the disposal of the Finance Committee may or may not be utilised for relief of rates, but preference is given to its utilisation for works which would have a beneficail effect upon the rates. It has been found desirable to establish a fleet of motor vehicles for the disposal of destructor clinker, removal of house refuse and road-sweeping, and the surpluses from the electricity department are being utilised for this purpose.

The bonus to staff is apportioned as follows, viz.: A moiety to the principal officers of the staff, and the other to the junior officers and workmen permanently employed *pro rata* to the normal salaries and wages paid in the year in which the bonus is earned.

The proportion payable to the principal officers is divided as follows, viz.: One-half to the chief engineer and manager, one-fourth to assistant manager, one fourth in equal proportions to the station and mains engineers and sales manager.

The financial soundness of this scheme must commend itself to all concerned, as, no matter how rapidly an undertaking may develop, the cost of new connections and all improvements to the existing system must be taken from revenue before any sum is available for bonus.

In advocating the adoption of the profit-sharing scheme by the Poplar Borough Council, the author advanced the suggestion that, by granting some recognition to the permanent staff proportionate to the results obtained, not only would every man employed feel a direct interest in economical production, but would also feel concerned in advocating the use of electricity at every possible opportunity. Thus a *potential canvassing staff, which, in many other undertakings, is a direct charge upon revenue, would be created.*

On the side of labour the greatest objection to profit-sharing schemes of any description is the tendency to reduce individual labour and rate of wages by holding out prospects of increased bonuses to the staff.

As far as electricity supply is concerned, this objection is not of much account, as an electricity undertaking is not a manufacturing concern wherein output can be calculated at so much per head of workmen.

Allocation of Bonus to Staff.

The proportions payable to the principal officers of an undertaking, as set out in the Poplar scheme, may not appeal to every municipality, and, as an alternative, the distribution may be made wholly as a percentage of annual salary or wages. To illustrate the difference between the two systems the author submits the payments made by the Poplar Borough Council as a result of last year's trading, viz., 1915-1916:—

Amount available for distribution, £1,262 3s. 10d.

Principal officers	£631	2	0	or 36·6 per cent. of salaries.
Junior officers and workmen ...	631	1	10	or 6·09 per cent. of salaries or wages.

Had the alternative proposition been in force, the whole of the staff would have received 10·43 per cent. of their annual salary or wage.

The view is expressed that the alternative scheme would not have provided adequate remuneration for the officers primarily responsible for the results. As the general manager is the responsible officer over all departments, upon whose judgment the decision in all matters must finally rest, it appears an equitable arrangement to allot double the amount received by his chief assistant, which is usually the proportionate difference in salary. Furthermore, it must be recognised that the financial policy of an undertaking has a greater bearing upon the net results than anything arising out of the workshop, the generating station, or the mains.

Investment of Profits on Behalf of the Staff.

No profit-sharing scheme would be complete unless careful consideration were given to the encouragement of thrift amongst the staff, and opportunity afforded for reasonably advantageous investment of at least a proportion of the share of profits accruing to the participants. It is a debatable point whether compulsory investment in an undertaking should be insisted upon, and much can be advocated for and against compulsion. The earning of a profit equal to, say, 5 per cent. of the annual wage, paid within a reasonable period after the close of the municipal financial year, provides the necessary sum for the enjoyment of an annual holiday, which, as is very often the case, would otherwise be spent in loitering at home to the detriment of the individual and family, and incidentally of the undertaking. In order to ensure the desired utilisation, it would probably be the best policy to defer payment until a date immediately prior to the commencement of each individual's annual holiday.

The British workman appears to have an inherent abhorrence of anything in the way of compulsion, or even advice in regard to earnings, and considers, perhaps rightly, that he should be a free agent in this respect. On the other hand, it may be anticipated that, by investing savings in the business in which he is employed, a greater interest in the working of the business would be engendered, and it would appear that every facility for investment should be given as a means to that end.

Furthermore, pension schemes, as a rule, provide for the employé only in old age, but not for his family. A workman may have contributed for 40 years to a pension fund, but, should he die immediately after his retirement, his family gain nothing therefrom, and are dependent upon a compassionate allowance from the municipality, which may or may not be granted. The author submits that it would be advantageous to the employer and employé alike if a certain proportion of the share of profit were to be invested on behalf of the staff.

In the Poplar profit-sharing scheme provision is made for a working balance of not less than 10 per cent. of the annual income of the under-

Digitized by Google

taking, and, as no provision has been made for working capital in any of the Electric Lighting Acts; it is reasonable to assume that no legal objection would be raised to the municipality accepting deposits from the staff up to the stated amount, and interest allowed thereon not exceeding the rate at which money could be obtained from the usual sources. It may also have been noted that the Poplar scheme allows for a 20 per cent. bonus on available balances up to £6,000 per annum and 10 per cent. on any sum available over £6,000.

A line of demarcation between voluntary and compulsory investment suggests itself, and the author submits that the benefits of any profit-sharing scheme would be enhanced if the amount accruing at the rate of 20 per cent. were to be handed over to the staff to be invested in the undertaking or otherwise at the option of the employé, and that accruing at the rate of 10 per cent. be compulsorily invested in the undertaking, all on terms suggested.

There can be no doubt that current events indicate that in the near future labour will command a much greater share in the profits of all enterprises, whether national, municipal, co-operative or private, and the greatest evil to be feared from this much to be desired state of affairs is the misapplication of the prospective enhanced income of the worker.

SLIDING SCALE TO ADJUST BONUS WITH CHARGES FOR SUPPLY.

Under normal conditions of the country, charges for supply of electrical energy should have a downward tendency until the irreducible minimum is reached.

As the Poplar scheme was introduced prior to the war, the possibility of any advance in charges was considered remote, and no provision was made in connection therewith.

Last year it became necessary to advance the price of power by 10 per cent., which will yield about £6,500, and the total net surplus will probably reach £11,500. Seeing that the work of the undertaking was carried out under more arduous conditions than appertaining in previous years, the author has been forced to the conclusion that no profit-sharing scheme would be complete without a sliding scale to adjust profit-sharing applicable to increase as well as decrease in charges for supply.

The point five system of charging (which originated at Poplar) is admirably adapted for working in conjunction with a profit-sharing scheme. As most of the members are aware, this system comprises an annual charge based upon the probable demand of each consumer, plus 0·5d. for each unit used. The author proposes to recommend that this system shall become permanent, and when it becomes necessary to increase charges, a pre-determined percentage would be added to each account, but if it is found after balancing the books for any year, that a rebate of 2½ per cent. or multiples of 2½ per cent. can be allowed to consumers, the determined amount shall be allowed on the following year's accounts.

The present bonus scheme would hold good under the normal point five system, and the following scale applied for advanced prices:

Increase in charges.	P.c. of bonus up to £6,000 available surplus.	P.c. of bonus over £6,000 available surplus.
Per cent.	Per cent.	Per cent.
5	18	9
10	16	8
15	14	7
20	12	6
25	10	5
30	8	4
35	6	3
40	4	2
45	2	1
50	Nil.	Nil.

A sliding scale applicable to decrease in charges appears to be a much more difficult problem, firstly, because the cost of production is likely to steadily decrease for many years to come, and finality in this direction is difficult to anticipate; secondly, a financial policy carried out on similar lines to that in vogue at Poplar would eventually wipe out machinery entirely from the loans account, thus reducing capital charges to a large extent; and, thirdly, because the interests of the consumer, the ratepayer and staff should receive equal consideration.

After mature deliberation, the author has arrived at the following conclusions, viz.: That a minimum available sum for profit sharing, contribution to rates and reserve for displaced machinery should be fixed, which, in the case of Poplar, the author has earmarked at £6,000. That is to say, if the amount for disposal reaches £6,000, the following division would be made, viz.:—

Finance Committee, 40 per cent.	£2,400
Bonus, 20 per cent.	1,200
Reserve for displaced plant	2,400
	£6,000

In the event of a greater sum being available, which would allow of a rebate of 2½ per cent. or multiples of 2½ per cent., then the minimum amount for disposal should be increased by £1,000 for every 2½ per cent. granted as rebate. Any balance after allowing for the minimum sum according to scale, to be carried forward for the purpose of allowing further rebates.

On this basis the minimum sum for disposal, plus necessary amount of rebate, varies from £7,000 for a rebate of 2½ per cent. up to £26,000 for a rebate of 50 per cent.

A table of anticipated progress is given, showing a bonus to staff of £1,600 when the output of the undertaking is 24,000,000 units, and a bonus of £3,200 when the output is 72,000,000 units.

FUEL ECONOMY.*

BY J. A. ROBERTSON.
(Borough Eectrical Engineer, Salford.)

The necessity for fully utilising our national resources to meet the economic conditions arising out of the war has made the question of fuel economy one of urgent and vital importance.

The author gives diagrams and figures showing that the output of coal per annum per person employed in mining is diminishing in this country and the cost is rising, whereas the converse is the case in the United States. Whether we like it or not, we have to face the fact that as regards cheap coal for manufacturing purposes, we are gradually losing the favourable position we have hitherto occupied.

It is proposed to discuss in the paper the possibility of economising fuel:—

(*a*) By centralising the production of power; and

(*b*) By combining the carbonisation of coal and by-product recovery with the generation of electricity.

For the present purpose the discussion may be confined to the better utilisation of *coal*.

From statistics it appears that, after deducting the amount of coal exported, the home consumption of coal in 1911 was 184 million tons. Electricity supply works accounted for 4½ millions. It remains to be considered in what directions economy is possible.

In giving evidence before the Royal Commission in 1905, Sir George Beilby estimated that 5 lb. of coal were consumed in the factories of Great Britain for each indicated horse-power hour produced. This is now probably less, say by 10 per cent., but it will be fairly safe to estimate that at the present time each horse-power hour produced entails a consumption of 4½ lb. of fuel. To engineers who consider this a high figure, it may be pointed out that at the time the estimate was made the consumption in central stations appears to have been not much lower than the average for factories. For the undertakings furnishing returns for the 1907 census of production the consumption of coal comes out at 5·1 lb. per kelvin, or about 3·9 lb. per electrical horse-power hour. Owing to the cheapness of coal there has not been the same inducement to put down economical plant as there is at present. But the central station has enormously improved its position relatively to the private power plant during the last few years. In a census taken last year of four groups comprising 26 electrical undertakings in Lancashire and Cheshire, it was found that the consumption of coal varied from 2½ lb. to 8 lb. per unit sold. Very little consideration is required to show that a considerable fuel saving could be effected by an immediate transference of the factory power load from private plants to central stations.

The Lancashire consumption of 3·2 lb. per kelvin sold does not, of course, represent the limit of fuel economy in power production. Several stations in the four groups—and these not the largest—are operating at approximately 2½ lb. per kelvin. It will be useful to consider what further economies are possible. With a consumption of 3·2 lb. per kelvin, of fuel containing 12,500 B.Th.U. per lb., the thermal efficiency comes out at only 8½ per cent. It will hardly be questioned that a much higher efficiency is now possible. Under a centralised system of production operating with power stations equipped with generators of 15,000 kw. or 20,000 kw. capacity, com-

* Abstract of a Paper read yesterday before the Convention of the Incorporated Municipal Electrical Association.

Digitized by Google

bined with water-tube boilers of 10,000 kw. each, and auxiliary plant designed and arranged so as to reduce the heat losses to the absolute minimum, a continuous thermal efficiency of 18 per cent. is well within the range of possibility. In support of this claim the following estimate prepared by a well-known firm of manufacturers for a combined generator and water-tube boiler unit of 15,000 kw. capacity is submitted.

Steam pressure at stop valve	200 lb.	
Initial steam temperature	650°F.	
Vacuum at turbine exhaust (30-inch barometer)	29 in.	
Feed water temperature to economiser	160°F.	
Steam consumption at full load per kilowatt hour	10·4 lb.	
Power required for condenser auxiliaries	2	per cent.
Thermal efficiency of turbine, generator and auxiliaries	25·19	,,
Boiler efficiency	84	,,
British Thermal Units per kilowatt hour	16,120	
Thermal efficiency, boilers, economisers, turbine, generator and condenser plant	21·15	per cent.

If we add the power required to operate artificial draft plant, coal and ash conveyors, and circulating water pumps (this should not under normal conditions exceed 3 per cent.), the efficiency of the plant, *i.e.*, the ratio between the heat units contained in the coal consumed and their equivalent in kelvin delivered at the switchboard is 20·5 per cent.

Further economies in fuel consumption are possible by increasing the pressure and temperature of the steam. The boiler manufacturers are satisfied that there will be no trouble in constructing boilers for pressures as high as 500 lb. or 600 lb., and the turbine manufacturers are prepared to guarantee turbines to operate at this pressure with steam superheated up to 750°F. Boilers have already been constructed for 350 lb. pressure, and the following estimates which the British manufacturers guarantee may be compared with the figures in the previous table :—

Steam pressure at stop valve	350 lb.	
Initial steam temperature	700°F.	
Vacuum at turbine exhaust (30-in. barometer)	29 in.	
Feed water temperature to economiser	160°F.	
Steam consumption at full load per kilowatt hour	10 lb.	
Power required for condenser auxiliaries	2	per cent.
Thermal efficiency of turbine, generator and auxiliaries	26·39	,,
Boiler efficiency	84	,,
British Thermal Units per kilowatt hour	15,370	
Thermal efficiency boilers, economisers, turbine, generator and condenser plant	22·17	per cent.

The increased efficiency due to increased pressure and superheat is approximately 5 per cent. Allowing 3 per cent. for operation of auxiliaries and 12 per cent. for transmission and transformer losses, it is possible to obtain an overall efficiency of 18·8 per cent. for energy delivered to the consumer. The coal consumption on this basis would amount to 1·45 lb. per kilowatt hour sold, or 1·09 lb. per electrical horse-power.

Under the assumed conditions, the author is of the opinion that 10 per cent. would be ample to cover stand-by and light load losses.

The author puts the efficiency of domestic heating by coal at 5 per cent., and that of gas fires at 10 or 12 per cent. Taking the same basis of comparison, the efficiency of electric radiators and cooking devices may be as high as 85 to 90 per cent., while for convenience and cleanliness they far surpass the gas fire or gas cooking stove.

It is difficult to form a precise estimate of the possible saving in fuel used for domestic purposes, but the following instance may be cited as an illustration. In this case a domestic consumption of 13 tons of coal per annum was reduced to 2 tons by the adoption of electricity for cooking and partial heating. The increased consumption of electricity for four quarters of one year amounted to 6,820 kelvins. Assuming a consumption of 1¾ lb. of coal per kelvin, the total amount of coal consumed at the central station for this output would amount to 11,900 lb. or approximately 5⅓ tons per annum, as compared with 11 tons saved, or a reduction of nearly 52 per cent. If only one-half the cooking and heating for which coal is now used was performed by electricity supply from central stations, there is a possible saving of nearly 10 million tons per annum.

Interconnection of Electrical Undertakings.

The interconnection of electrical undertakings has been frequently discussed during the last year, and various committees are at work in different parts of the country on local schemes. The discussion of the question has already lead to several undertakings linking up on a co-operative basis, and the movement has also done much good. Linking-up proposals must, however, be considered with relation to the bigger scheme of centralisation and it will be necessary for the local joint boards who operate such schemes to possess powers with regard to extensions of plant in all the undertakings in their group, and so ensure that extensions will only take place at those stations which are favourably situated for economical generation.

Carbonisation of Coal.

Hitherto, with few exceptions, the generation of electricity has been dependent on the direct burning of coal in boiler furnaces. It is common knowledge that from a purely thermal efficiency point of view the carbonisation of coal in gas-works is a much more efficient process than the direct burning of coal in central power stations. The thermal efficiency of a gas-works may be as high as 65 or 70 per cent., whereas the average thermal efficiency of central power stations is in the neighbourhood of 8 or 9 per cent., although several large power stations are obtaining efficiencies of between 12 and 15 per cent.

The following comparison will illustrate this point :—

Thermal Efficiency of Gasworks an Electricity Power Stations Compared.

Electricity Works.	Gasworks.
One ton of coal (12,500 B.Th.U.) burned direct in boiler furnaces will produce at 2½ lb. consumption per Kelvin 896 units of electricity. Thermal value 2,965,000 B.Th.U.	One ton of coal (12,500 B.Th.U.) will produce 11,000 cubic feet of gas 6,050,000 B.Th.Us., 9 cwt. of coke of 9,500 B.Th.U. per lb. 9,576,000 B.Th.U., 10 gallons of tar 1,550,000 B.Th.U. Total 17,176,000 B.Th.U.
Thermal efficiency, 11 per cent.	Thermal efficiency, 64 per cent.

Total heat in coal 26,992,000 British thermal units.

The advantages of electricity which have led to its adoption in preference to gas are due to the higher efficiency obtained in its application for industrial and domestic purposes. It is claimed, therefore, that if the high thermal efficiency of coal carbonisation could be combined with the efficient application of electricity we should have an ideal method for the economical utilisation of fuel.

There are one or two questions that require to be carefully considered before accepting such claims. The most important is the question of by-products. There is no direct economy in carbonising coal for the purpose of producing gas to be utilised for firing steam boilers. To obtain the highest possible efficiency in power production from the carbonisation of coal, involves the employment of internal combustion engines. The high thermal efficiency of gas engines (about 27 per cent.) has often attracted power engineers. In smaller sizes, say up to 1,500 H.P., the gas engine has still a limited field for employment, but for generation on the scale required in a centralised power scheme, they may be left out of account.

There are two systems apart from the carbonisation of coal in gas-works (where illuminating gas is the chief product) which may be considered. These are the Mond and the coke oven installations. When Mond plant is employed for by-product recovery, sulphate of ammonia is obtained equal to about 4 per cent. of the weight of coal carbonised and about 3 per cent. by weight of a somewhat inferior tar. It will be a fair estimate to assume that the efficiency under conditions for ammonia recovery is about 57 per cent.

Gas Firing of Boilers.

Considerable difference of opinion appears to exist regarding the efficiency of gas-fired boilers, some authorities placing it as low as 75 per cent. while others claim 85 or 90 per cent. The lower efficiency is probably the result of tests made with boilers and furnaces originally designed for the direct burning of coal. Assuming an efficiency of 90 per cent. for gas firing and 80 per cent. for direct coal firing, we obtain the following results :—

	Per cent.
Efficiency of gas-fired producer with by-product recovery	57
Efficiency of gas-fired boiler	90
Combined efficiency	51·3
Efficiency of direct-fired boiler	80

In other words, for every 100 tons of coal consumed for direct firing we require 155 tons to produce the same amount of heat from producer gas fired boilers, against which we recover 4 per cent. by weight of sulphate of ammonia, and 4 per cent. by weight of tar.

It is apparent, therefore, that the whole case for gas firing from producer plant rests on the production of by-products. The most valuable of these is sulphate of ammonia. The amount of this by-product depends upon the percentage of nitrogen present in the fuel. The average for British coals may be taken at 1·3 per cent., yielding in a "Mond" producer from 80 lb. to 90 lb. of ammonia sulphate per ton carbonised.

The following estimate, based on results obtained from smaller plant, is put forward as an illustration of what might be expected from a producer gas-fired boiler installation of 20,000 kw. capacity,

Digitized by Google

dealing with a maximum demand of 15,000 kw. and operating with a 40 per cent. station load factor.

Direct Firing. (Boiler efficiency 80 per cent.)

53,000,000 kelvins at, say, 2lb. of coal per unit generated tons =	48,000
Coal at 15s. =	£36,000

Gas Producer and Gas Fired Boilers with By-Product Recovery.

Boiler efficiency 90 per cent.
Combined efficiency 52 per cent.

74,000 tons of coal at 15s.		£55,500
2,960 tons of acid at £2		= 5,920
Extra labour on gas plant at 1s. 3d. per ton carbonised		4,625
Extra stores		1,500
Extra labour on by-product recovery including bagging sulphate of ammonia		2,850
Interest, depreciation and maintenance on cost of producer and recovery plant, 15 per cent. on £52,000		7,800
		78,195
Less 2,960 tons ammonia sulphate at £14 per ton	£41,440	
Less 2,960 tons tar at £1 per ton	2,960	
		44,400
		33,795
A saving per annum over direct firing of		2,205

The figure of £14 for ammonia sulphate is above the average price received during the last 10 years, but about £2 less than the present war price of £16 per ton. If the present price is taken, the saving would be increased from £2,205 to £8,125. On the other hand, on the basis of £12 per ton, which approximates to the average pre-war price, the saving of £2,205 would be converted into a loss of £3,715.

Although producers have been in operation for 20 years it is not suggested that finality of design has been reached. Experiments have recently been made with a view to utilising the heat generated by the producer to supply the steam required for by-product recovery, and it is possible that developments in this direction may increase the producer efficiency by 8 or 10 per cent. It has also been shown that producers can deal successfully with the lower grades of fuel, and as these poorer grades frequently contain as high a percentage of nitrogen as the richer grades, it may be possible to utilise the producer with by-product recovery for burning grades of coal which it is not profitable under present conditions to bring to the surface.

Coke Oven Gas.

The distillation of coal at low temperatures for the primary purpose of producing metallurgical coke and yielding in addition a quantity of surplus gas of high calorific value in addition to other by-products, has been advocated in certain quarters as a universal solution of the fuel economy problem. Each ton of coal distilled produces about 15 cwt. of hard blast furnace coke, which at present has a higher market price than its equivalent weight in coal. On the other hand, the yield of ammonia is less than from gas producers, being about 25 lb. to 30 lb. per ton of coal. Hitherto the industry has been confined to steelworks and collieries, where its advantages are unquestioned, but the importance of the by-products recovered and the possibility of utilising the surplus gas has drawn attention to the possibility of combining low temperature distillation with the production of power. The amount of surplus gas is equal to 4,000 to 5,000 cubic feet per ton, having a calorific value of 550 B.Th.U. per cubic foot. The expense of the installation, however, is very great and the amount of coal consumed to produce a given amount of heat in the form of surplus gas is about 12 to 14 times as much as would be required for direct firing.

Very little consideration is required to show that as a means of producing power, the coke oven can only have a limited application. The demand for electricity in the form of light, power and heat is bound to exceed enormously the demand for coke and by-products.

It is claimed that instead of metallurgical coke, a soft smokeless fuel can be produced which is suitable for domestic purposes, and proposals have been put forward to combine an installation for producing such a fuel with a central power station, the surplus gas being employed to fire the boilers. The author is of opinion that an arrangement of this kind can only have a local and temporary application, and that the burning of fuel for domestic purposes must ultimately be superseded by electricity. To set up a process with the object of producing fuel for cooking and heating is to perpetuate a custom which all are agreed should be superseded not only for reasons for fuel economy, but also with a view to saving labour now employed in unnecessary domestic drudgery.

The author concludes with a plea for the proper grading and classification of coals and their treatment by washing and sorting.

THE FEDERATION OF BRITISH INDUSTRIES.

At the Engineers' Club, Manchester, on the 12th inst., Mr. Edmund L. Hill opened a debate on the "Federation of British Industries, its Aims and Objects." At the outset he said his heart was with the club and always would be. Out of the club grew the movement for the organisation of British engineering industry; that movement last summer joined up with the B.E.A., which had now joined the Federation of British Industries.

Mr. Hill said that the President of the B.E.A. (Mr. Wilfrid Stokes) was one of the original members of the Executive Council of the Federation, and now that they had joined them, Mr. John Thornycroft, chairman of their Executive Committee, had also been co-opted on to their Council. He hoped that every engineering firm in and around Manchester would join, and help to strengthen and take part in the councils of the B.E.A. When he left them in January last the Manchester committee had obtained some 92 new members for the B.E.A. A federation of British industries had been for some years a dream of their president's (Mr. Dudley Docker). As in thousands of other cases, the war gave him his opportunity, which he seized and had held on to with infinite patience, tact and judgment, with the result that the Federation to-day was a real live power in the world. In the history of mankind—if they left out religion, the arts, science and literature—there was one class that was of permanent use to its fellows, and that was the manufacturer and producer or "those engaged in an industry serving or providing for the needs of producers or manufacturers"; in short, those who "turn the great forces of Nature to the use and convenience of man," those who contribute to the wealth of the world. In our past political history that class had always been ignored and neglected; it had been exploited for the benefit of the merchant and middleman. The Federation was out to put that right. Its objects might be summed up briefly as the "organisation and development of industry now and after the war in co-operation with labour and in conjunction with the Government and Government Departments." It aimed at the establishment of a central organisation which could act as a focus for the industrial opinion and influence of the country, and at the same time give its members benefits and facilities such as only a powerful body with ample funds was in a position to give. Among other things, the Federation had to its credit (*a*) the establishment of a Parliamentary Committee to watch all legislation affecting industry, (*b*) a committee to deal with overseas trade (which had considered and made recommendations in regard to the improvement of the consular service), (*c*) the establishment, in conjunction with the Central Council of Associations of Controlled Firms and with the British Manufacturers' Association of an Advisory Committee to the Ministry of Munitions and to the Admiralty, to which those Departments are submitting regulations affecting manufacture, labour and raw material, before they are put into force, (*d*) the appointment of two representatives on the Priority Advisory Committee of the Ministry of Munitions, (*e*) an Education Committee to consider the improvement of education with particular regard to industry, (*f*) a Patents Committee, which was considering the proposed alterations of the Patents and Designs' Act, (*g*) a Railway Committee, which he thought would before long be called a Transport Committee, to deal with all questions affecting transport and shipments of raw materials and manufactured articles, &c. The Federation was also undertaking, on behalf of the Foreign Office the distribution to manufacturers of the commercial reports collected by the Foreign Trade Department, distributed a bulletin to members containing items of general commercial information, frequently of an exclusive nature, and was arranging the establishment in foreign countries of a system of legal advice by the best foreign experts for the benefit of members, &c. The Federation had 435 members, 59 of which were associations. They needed every association to join them because of their knowledge and experience, their members and influence, but they wanted large and small firms to join individually to give them that rapidity of decision that was vital to-day. Another point to be remembered was that any trade association got much more influence and more votes in the Federation if some half-dozen or dozen of its individual members joined the Federation as well. The Federation and the work it was doing was of world importance, and would get more so as time went on. The Federation did not wish to dominate other associations, it only wanted to help them; every association could look after its own business far better than any other body, but cases might arise when the help of such a body as the Federation would be of great value. "Wait and see" must never be our motto again. Seven weeks ago the Minister of Munitions asked his Advisory Committee to give him their considered opinion on four questions. He sent those questions to 53 trade associations—nine replied fully; four stated that they did not want to reply; 10, knowing their own inherent weakness of procrastination, did not attempt to reply, but issued the questions to their own members, many of whom replied direct most usefully; 30 had not replied at all so far. Of those who did attend to his committee's request every single one was an association of engineers or its closely allied trades. As they knew full well, it was engineering which was saving the world. It was an engineers' war, and when peace came it was engineering that would deserve and must get due recompense. There was one thing that he hoped and believed the Federation would tackle at once, and that was the regulation of the supply of raw materials. The enormous debt caused by the war could only be paid for by exports, but to export anything they must have the raw materials from which they were made, and they should take care that wherever possible those raw materials came from the British Empire.

Digitized by Google

HEATING OF DYNAMO ELECTRIC MACHINES WITH VARIOUS LOADS AND AT DIFFERENT SPEEDS.

BY PROF. MAGNUS MACLEAN, D.SC., AND D. J. MACKELLAR, B.SC.

INTRODUCTION.

The series of tests described in this Paper were carried out at the Royal Technical College, Glasgow, with the primary object of obtaining information as to the effect of armature current and armature peripheral velocity on the temperature rise of the various parts of direct-current machines.

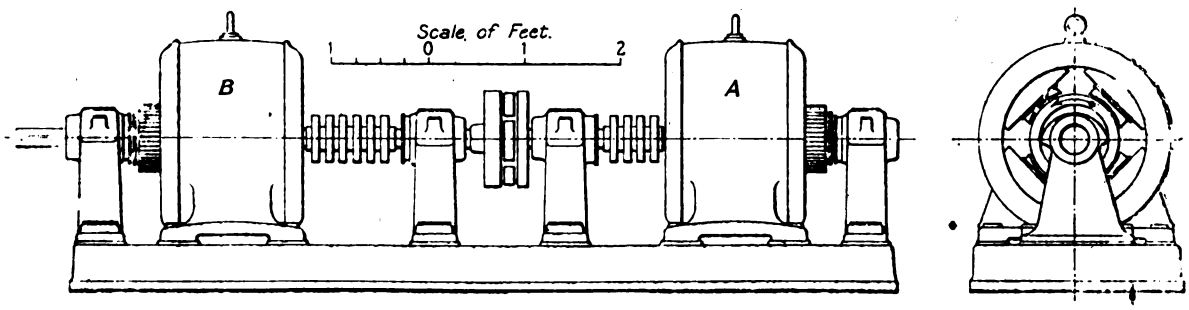


FIG. 1.

Such an investigation even for a single machine is necessarily lengthy, and in the present instance the tests have been perforce confined to the determination of temperatures and temperature rises of a field coil of a direct-current machine of the small open-type class, run at various speeds, and under different load conditions; in some cases as a motor, in others as a generator.

The results have been where possible compared with those previously obtained for a larger machine, and also with the published results of other observers.

The machine on which the tests were performed is a rotary converter having an output of 25 kw. when driven as a direct-current generator at 500 volts. This machine is mounted on a single bed-plate with a similar machine, the two machines being mechanically connected by a flexible coupling. The second machine was employed as a driving motor in those cases in which the machine under test was run as a generator.

Each machine has a sheet-iron fan mounted on the slip-ring end of the armature. The fans have each a diameter of 480 mm. There are 64 straight radial blades, having a depth of 60 mm. and a width of 25 mm. The external diameter of the armature is 292 mm. The machines are designed to run at 1,500 revs. per min. at 500 volts direct current; and at 750 revs. per min. at 250 volts direct current. The general arrangement of the machines is shown in Fig. 1.

FIELD COILS.

There are four field coils, each consisting of 5,650 turns of S.C.C. wire of 0·032 sq. cm. cross-sectional area. The coils are former wound lapped with tape and varnished.

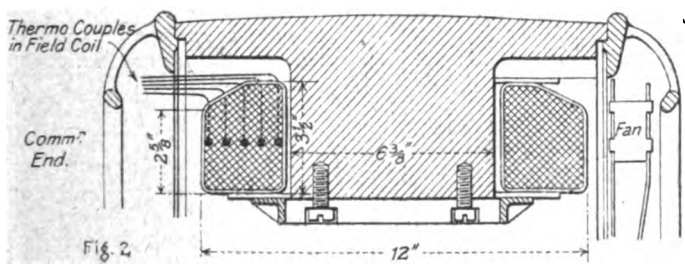


Fig. 2. Sectional Side Elevation.

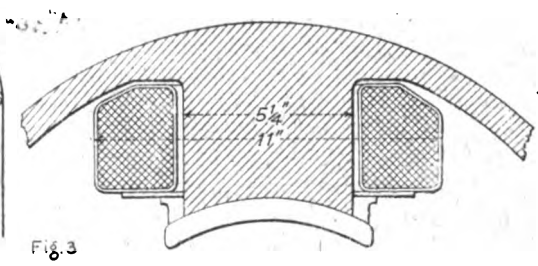


Fig. 3. Sectional End Elevation.

DETAILS OF FIELD COIL.

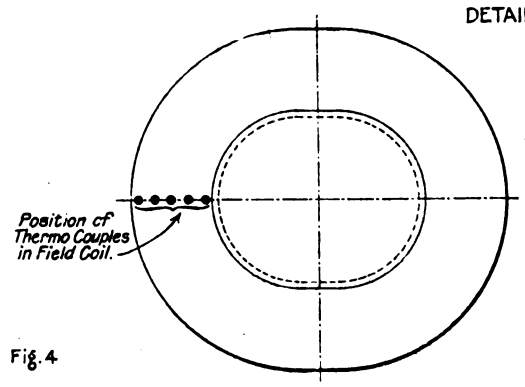


Fig. 4. Plan

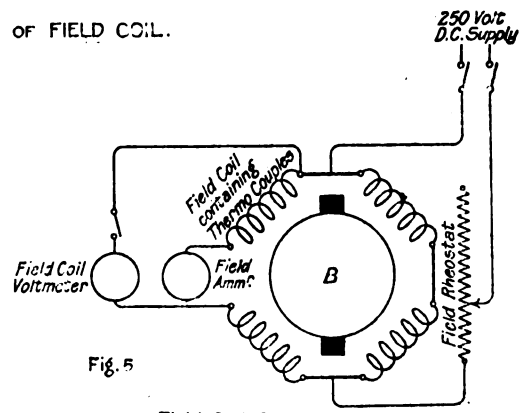


Fig. 5. Field Coil Connections.

With an excitation voltage of 500 the four coils are connected in series. By means of a change-over switch the coils can be connected two in series, in parallel with the other two in series for a 250-volt excitation.

THERMO-COUPLES.

One coil which is situated *above* the armature, and having its axis at 45 deg. to the horizontal (*see* Fig. 1), contains five copper

Digitized by Google

constantan thermo-couples arranged in one vertical and one horizontal plane as follows :—

A is at a point just under the outer layer.
B ,, ,, one quarter of distance to pole core.
C ,, ,, one-half ,, ,,
D ,, ,, three-quarters ,, ,,
E ,, ,, just before the innermost layer.

Sections of the coil giving all dimensions and showing the thermo-couples are given in Figs. 2, 3 and 4.

CALIBRATION OF THERMO-COUPLES.

The thermo-couples were used in conjunction with a sensitive moving coil mirror galvanometer and were calibrated in the following manner. Hot water was poured into a beaker, which contained the external thermo-junction, and as soon as the temperature became steady the galvanometer deflection and the reading of the thermometer were taken. By adding cold water a series of decreasing temperatures of the external couple were obtained in rapid succession, the galvanometer deflection and the thermometer reading being noted for each. For a final reading the beaker was filled with melting ice. The range of temperatures employed was from 80°C. to 0°C.

The temperature of the field coil junction was unknown, but since the calibration was performed rapidly it was assumed that this temperature remained unchanged at some value. On plotting galvanometer deflections on a base of temperatures of the external couple, the points were found to lie on a straight line. From this the deflection corresponding to 1°C. difference of temperature between the junctions was determined. This constant was found to have the value 3·26 mm. per degree centigrade.

For convenience in taking readings rapidly for the five couples the copper wire connection from each field coil junction was brought to a plug board, having brass blocks, plugs and terminals.

The common external junction was always kept at 0°C. during the tests, so that the galvanometer deflection in millimetres multiplied by the constant 3·26 in every case gave the actual temperature in degrees centigrade of the particular field coil couple then in circuit. In addition to the thermo-couple temperature measurements, readings were taken of a thermometer placed with its bulb in contact with the surface of the field coil and protected by a baize pocket.

PROCEDURE OF TESTS.

The machine *B* (Fig. 1) is the one upon which all the tests were performed. For those tests in which *B* was running as a generator the armature of *A* was connected through a starter in the ordinary way to a direct-current supply. The connections for the field coil ammeter and voltmeter are shown in Fig. 5.

In starting a test, initial readings were taken of the room temperature and of the galvanometer deflection for each of the thermo-couples. The field current was switched on, and simultaneous readings of the field coil ammeter and voltmeter were taken at once. When the machine *B* was run as a motor it was necessary for starting purposes to have maximum field current, but as soon as the starter handle had been moved to the last contact the field coil current was as rapidly as possible adjusted to the value required for the test. The field coil current was maintained as nearly as possible at this value throughout the test.

In the early part of each test sets of readings were taken at frequent intervals. As the temperature changes became less rapid these intervals were extended. Each set of readings consisted of the following :—

1. Armature current.
2. Armature volts.
3. Field coil current.
4. Field coil volts.
5. Speed of machine in revs. per min.
6. Galvanometer deflections for thermo-couples *A*, *B*, *C*, *D* and *E*.
7. Room temperature by thermometer.
8. Surface temperature by thermometer.

The general conditions of the tests performed, each lasting six hours, are given in Table I. :—

Table I.

No. of test.	Operation of machine.	Peripheral velocity of armature. Metres per sec.	Armature current. Amperes.	Field coil current. Amperes.
1	Motor, light.	10·4	6·0	0·76
2	,,	12·4	6·4	0·52
3	Motor, loaded.	10·3	17·5	0·76
4	,,	12·2	17·5	0·52
5	,,	10·0	35·0	0·76
6	,,	11·8	35·0	0·52
7	Motor, light.	20·5	8·3	0·76
8	,,	23·3	8·4	0·52
9	Motor loaded.	19·9	35·0	0·76
10	,,	23·6	35·0	0·52
11	Standstill.	...	...	0·76
12	,,	...	...	0·52
13	Generator, light	4·1	...	0·76
14	,,	10·5	...	0·76
15	,,	12·4	...	0·76
16	,,	17·1	...	0·76
17	,,	20·2	0·76*	0·76
18	,,	23·3	0·76*	0·76
19	,,	4·1	...	0·52
20	,,	17·1	...	0·52
21	,,	23·3	0·52*	0·52

For each of these tests the following curves were plotted on a time base :—

1. Actual temperature at each couple *A*, *B*, *C*, *D* and *E*.
2. Rise of temperature above the temperature of the surrounding air for each couple *A*, *B*, *C*, *D* and *E*.

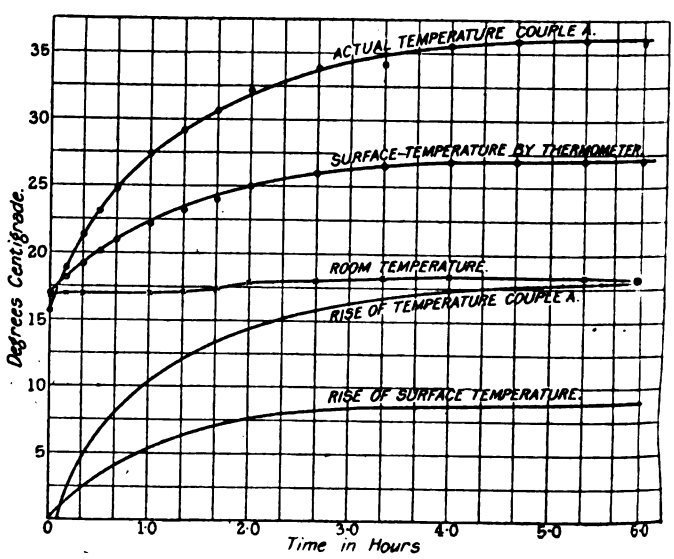


FIG. 6.—TEST NO. XVI.

3. Temperature of room.
4. Temperature of coil surface as measured by thermometer.
5. Rise of temperature of coil surface above that of the surrounding air.

In addition, curves were also plotted to show the distribution through the coil at the end of six hours, of the actual temperature and temperature rise. As an example, a set of curves for test number 16 are shown in Figs 6 and 7.

In the summary of results given in Table II. those temperature values not directly measured are obtainable from these curves; with the exception of the values for the mean temperature of the coil which were calculated from the initial and final values of the resistance of the coil obtained from the field

* In these three tests the machine was self-exciting.

Digitized by Google

Table II.

Test No.	Operation of machine.	Revs. per min.	Peripheral speed of armature. Metres/sec.	Machine measurements. Armature. Amps.	Armature. Volts.	Field coil. Amps.	Field coil. Final volts.	Field coil. Final ohms.	Field coil. Final watts.	Final room temp.	Temperature measurements, °C. Final surf. temp	Final rise of surf. temp θ	Final mean temp. by resist.	Final rise of mean temp.	Rise of temperature at the end of six hours. A	B	C	D	E	Max. temp. in coil.	Max. rise of temp. in coil.	Ratios. Max. temp. / Mean temp.	Mean temp. / Surf. temp.	$K = \frac{A\theta}{W}$
1	Motor*	680	10·4	6·0	254	0·76	98·5	129·5	74·8	16·0	26·7	10·7	45·0	29·0	20·2	32·7	38·6	38·2	33·6	55·2	39·2	1·23	1·69	88
2	,,	810	12·4	6·4	254	0·52	64·3	123·7	33·5	15·3	21·1	5·8	31·4	16·1	10·1	16·2	19·1	19·5	17·2	35·0	19·7	1·11	1·49	107
3	Motor†	670	10·3	17·5	252	0·76	98·5	129·5	74·8	15·7	26·1	10·4	43·7	28·0	20·6	33·5	39·3	39·3	34·5	55·8	40·1	1·28	1·67	86
4	,,	800	12·2	17·5	252	0·52	64·5	124·0	33·6	16·0	21·8	5·8	30·7	14·7	9·2	15·4	18·1	18·4	16·3	34·5	18·5	1·12	1·41	107
5	,,	650	10·0	35·0	250	0·76	99·1	130·3	75·3	16·8	27·8	11·0	46·4	29·6	20·4	33·4	39·0	39·2	34·4	56·5	39·7	1·22	1·67	90
6	,,	770	11·8	35·0	250	0·52	65·0	125·0	33·8	17·1	23·6	6·5	34·1	17·0	10·3	16·3	19·3	19·9	17·4	37·2	20·1	1·09	1·45	119
7	Motor*	1,340	20·5	8·3	508	0·76	98·6	129·7	75·0	16·8	26·3	9·5	44·4	27·6	16·8	30·2	36·6	37·2	32·4	54·7	37·9	1·23	1·69	78
8	,,	1,520	23·3	8·4	508	0·52	64·9	125·0	33·3	17·3	22·2	4·9	34·2	16·9	7·9	14·4	17·4	17·7	15·5	35·2	17·9	1·03	1·54	90
9	Motor†	1,300	19·9	35·0	504	0·76	100·0	131·7	76·0	18·7	29·0	10·3	47·4	28·7	17·7	30·9	37·2	37·7	32·9	56·9	38·2	1·20	1·63	84
10	,,	1,540	23·6	35·0	504	0·52	65·4	126·0	34·0	18·1	24·0	5·9	36·2	18·1	9·3	16·4	19·6	19·7	17·6	38·1	20·0	1·05	1·51	107
11	Standstill.	...	...	...	...	0·76	104·7	137·8	79·5	17·2	46·9	29·7	64·2	47·0	38·3	51·3	55·8	53·5	48·3	73·1	55·9	1·14	1·37	231
12	,,	...	...	...	...	0·52	66·3	127·5	34·5	17·2	32·0	14·8	39·1	21·9	17·9	23·3	25·1	24·3	22·0	42·4	25·2	1·08	1·22	261
13	Generator*	270	4·1	...	106	0·76	101·3	133·5	77·0	16·7	31·6	14·9	54·5	37·8	24·7	37·6	43·4	43·4	38·4	60·6	43·9	1·11	1·72	120
14	,,	685	10·5	...	254	0·76	100·3	132·0	76·3	17·1	28·1	11·0	50·0	32·9	19·1	32·5	38·4	38·8	33·8	56·5	39·4	1·13	1·78	89
15	,,	810	12·4	...	310	0·76	100·1	131·8	76·1	17·4	27·2	9·8	51·2	33·8	19·9	33·4	39·8	40·0	34·9	58·1	40·7	1·13	1·88	80
16	,,	1,120	17·1	...	430	0·76	100·0	131·7	76·0	18·2	27·1	8·9	50·4	32·2	17·7	31·6	38·5	39·2	33·8	57·0	38·8	1·13	1·86	72
17	,,	1,320	20·2	0·76‡	515	0·76	99·8	131·3	75·9	18·4	26·8	8·4	51·0	32·6	17·6	31·4	38·3	39·0	33·6	57·0	38·6	1·12	1·90	69
18	,,	1,520	23·3	0·76‡	580	0·76	99·8	131·3	75·9	18·5	26·2	7·7	49·3	30·8	16·1	29·6	36·4	37·0	31·8	56·0	37·5	1·14	1·88	63
19	,,	270	4·1	...	93	0·52	65·4	125·8	34·0	18·0	25·0	7·0	35·2	17·2	11·1	17·0	19·6	19·6	17·4	37·8	19·8	1·07	1·41	127
20	,,	1,120	17·1	...	372	0·52	64·9	124·8	33·8	17·4	22·1	4·7	33·0	15·6	7·6	13·7	16·8	17·1	14·7	34·8	17·4	1·05	1·49	86
21	,,	1,520	23·3	0·52‡	508	0·52	65·5	126·0	34·1	18·8	23·8	5·0	36·2	17·4	8·2	15·9	18·1	18·5	16·2	37·5	18·7	1·04	1·52	91

* Light. † Loaded. ‡ In these three tests the machine was self-exciting.

coil ammeter and voltmeter readings at the beginning and end of the test. The calculations were made as follows :—

Let R_1 = Resistance at beginning of test.
R_2 = Resistance at end of test.
θ_1 = Temperature of coil at beginning of test.
θ_2 = Mean temperature of coil at end of test.
R_0 = Resistance of coil at 0°C.
α = Temperature coefficient.

Then $R_1 = R_0(1+\alpha\theta_1)$.
$R_2 = R_0(1+\alpha\theta_2)$,

whence $\theta_2 = \dfrac{R_2 - R_1 + R_2\alpha\theta_1}{R_1\alpha}$.

The value taken for α is 0·004.

There are several sources of error in this method.

1. When the field current is first switched on it is assumed that the field coil has a uniform temperature θ_1, and in a practical case where no thermo-couples are placed in the coil winding it would, further, have to be assumed that this temperature is the same as that of the surrounding air.

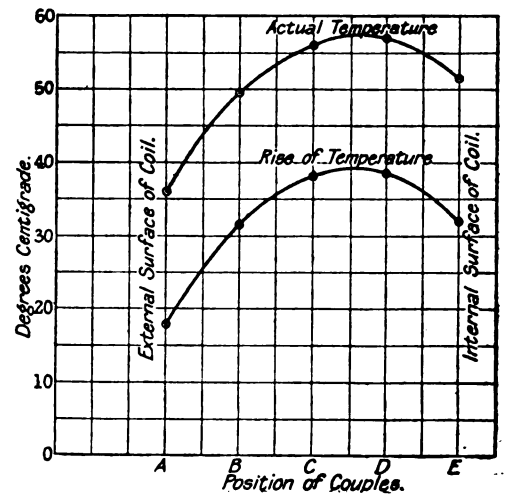


FIG. 7.—TEST NO. XVI.

The laboratory in which the tests were carried out has an exceptionally small daily range of temperature. At most the variation of temperature during 24 hours does not exceed 5°C., and yet it was found that the field coil temperature at the beginning of a test differed from the air temperature by from 1°C. to 3°C.

2. It is pointed out by Rayner * in his "Report of Temperature Tests at National Physical Laboratory," that there is the possibility of a considerable and variable amount of leakage in the coil due to moisture driven out of the cotton as the coil heats up. This reduces the apparent resistance of the coil, and in certain of his experiments the resistance was actually found to decrease with increase of temperature beyond a certain point in the tests. In several of the tests made for, but not included in, this Paper an indication of this effect was noticed.

3. It is important that the voltmeter and ammeter used in making the resistance measurements should be accurate, and that they should be carefully checked from time to time by comparison with, say, a standard Kelvin balance; since even small errors due to the instruments will produce large percentage of errors in the calculated temperature where the amount of heating is small.

(To be concluded.)

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Year Book of Wireless Telegraphy and Telephony, 1917." (London: The Wireless Press, Ltd.) Pp. lxxiv.+928. 3s. 6d. net.

* Vol. XXXIV., p. 613, "Proc." I.E.E.

Digitized by Google

The Electrician.
FRIDAY, JUNE 22nd, 1917.
Editorial and Publishing Offices:—
8, BOUVERIE STREET, LONDON, E.C. 4.
Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

THE FUTURE OF EVENING SCHOOLS.

Volume I. of the "Final Report of the Departmental Committee on Juvenile Education in Relation to Employment After the War," has recently appeared, and we feel that its publication heralds the approach of educational reforms of great importance. The report shows evidence of very careful thought, and its recommendations are based upon broad principles. The Committee seems indeed to have kept constantly in mind the words used in the introduction to its report: "We have to perfect the civilisation for which our men have shed their blood and our women their tears; to establish new standards of value in our judgment of what makes life worth living, more wholesome and more restrained ideals of behaviour and recreation, finer traditions of co-operation and kindly fellowship between class and class and between man and man. . . . We have to bring research to bear upon the processes of our manufactures, to overhaul routine and eliminate waste...."

The bare statement of the conclusions and recommendations of the report may leave a feeling of disappointment. The reforms suggested fall so far short of the ideals of the enthusiastic educational reformer as to cast doubt upon the courage, if not the earnestness, of the Committee; but we venture to hope that the complete report, not merely a summary of its conclusions, will be widely studied. It is urged in the report that educational reform will be in vain unless "the conception of the juvenile as primarily a little wage earner" be replaced by the conception of the juvenile as "primarily the workman and the citizen in training." Nothing could be more true than this, nor could any truth better bear emphasis at the present time. It is not without reason that we have been called a nation of shopkeepers, nor need we deplore the fact of our shopkeeping—since, at any rate, we have shown the world what honourable shopkeeping means—but what, indeed, we ought to deplore is our shortness of sight as shopkeepers. He is a short-sighted shopkeeper who takes his son from school to run errands; yet he is typical of a class sufficiently numerous to cripple any too daring scheme of educational reform.

The Committee's main proposals are:—

(*a*) To establish a uniform elementary school-leaving age of 14, which entails the abolition of all exemptions, total or partial, from compulsory attendance below that age.

(*b*) To require attendance for not less than eight hours a week, or 320 hours a year, at day continuation classes, between the ages of 14 and 18.

"Many," says the Report, "will feel that the system of half-time employment and half-time schooling, which has been put forward in some schemes of reform, approaches more nearly to a counsel of perfection. *But we do not believe this to be at present attainable.* . . ." The words we have put into italics define the policy of all the recommendations of the report, and one cannot but sympathise with the earnest endeavour to define a step in educational reform which, though it may seem a small one, is undoubtedly in the right direction, and will be sure of success. We would venture to hope, however, that if this scheme should be actually launched it may be labelled, and that indelibly, with the sign "Makeshift." This would remind us that the scheme was one which had been put forward in preference to much better schemes, which, at the time, seemed unattainable.

We ought to learn from the slow and painful decline which is marking the extinction of our present system of evening schools that a "Makeshift" unlabelled is apt to retard progress. It could never, we think, have been successfully contended that the evening schools system of technical education in its present form was anything more than a poor compromise, filling the unavoidable period in which the nation might grow into the readiness to accept, if not the desire to receive, something less imperfect. But the sign "Makeshift" was omitted, and so we have become accustomed to our evening schools, have borne with them, to our cost, far too patiently and too long, and now think it almost sacrilege to interfere with them.

The page of statistics contained in the Report is one of gloomy enlightenment. Of the enrolments and attendance in evening schools it says: "About 15 per cent. of the students enrolled in evening schools for 1911-12 failed to complete the absurdly small minimum of 14 hours of attendance during the session, and the average hours of attendance were no better than about 50."

The Report openly states, and boldly faces the fact, that the present system of evening schools is worn out. "It is now almost universally admitted that continuation classes, if they are to be an effective instrument of reform, must be compulsory and must be in the day-time. . . . For a very large proportion of children anything of the nature of serious schooling after a full day's labour would be not a benefit but a cruelty. We do not want any more of the waste and overstrain involved in the teaching of tired pupils by tired teachers."

We should like to touch upon the question, "What is to be the future of our evening technical schools after the abolition of the present system?" To engineers in general and to electrical engineers and physicists (for there is to-day no more important class of engineer than the physicist) in particular, the liberation of laboratory staffs and equipments from the routine work of evening classes should present an invaluable opportunity. We have, ourselves, had long experience of the work of evening technical schools, and have come to realise an important means by which the success of the engineering industry might be advanced. We refer to the provision for the small but important handful of advanced technical students at present in attendance at the evening schools, and others of like calibre who then would be attracted by facilities for specialised laboratory work. Men of the type and grade we have in mind are entrusted with the best technical work of their employers, they are keenly interested, and have got the habit of thinking things out for themselves. They have problems to solve but no laboratories in which to solve them. To give these men the means of working upon their own special problems, under the general supervision and with the advice of competent laboratory instructors, would lead with certainty to the rapid advancement of engineering knowledge.

The number of such students that might be accommodated by the laboratories of one institute might not exceed a dozen, and this dozen would employ a laboratory staff almost as numerous. By all the present rules of educational costing the scheme would be absurdly extravagant, but it is time we realised that some of the present rules of educational costing are extravagantly absurd.

Digitized by Google

INDUSTRIAL RESEARCH IN THE UNITED STATES OF AMERICA.

We have received the first of a series of Papers which are being published by the Committee of the Privy Council of Scientific and Industrial Research. The present one is by Mr. A. P. M. Fleming on "Industrial Research in the United States of America," and is published for the Department of Scientific and Industrial Research by His Majesty's Stationery Office at the price of 1s. net. We have on a previous occasion dealt with the subject as outlined by Mr. Fleming, and, therefore, it is scarcely necessary to give any extensive extracts from the present publication. The accompanying illustrations are more eloquent than much descriptive matter, and

FIG. 1.—RESEARCH BUILDING, GENERAL ELECTRIC CO.

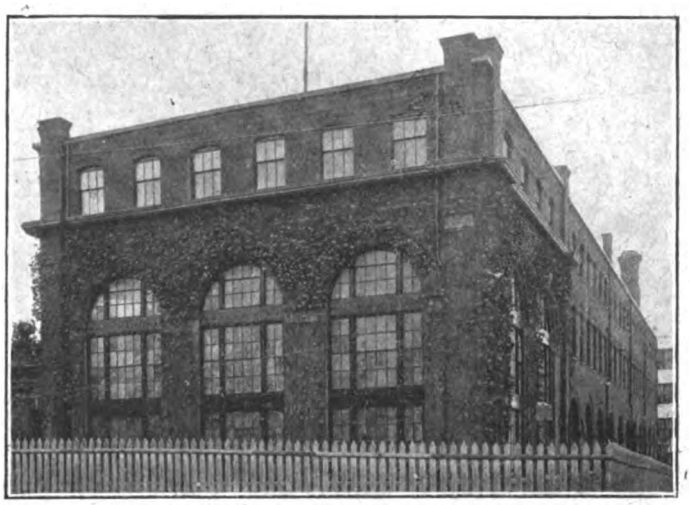


FIG. 4.—CHEMICAL LABORATORY, T. A. EDISON LABORATORIES.

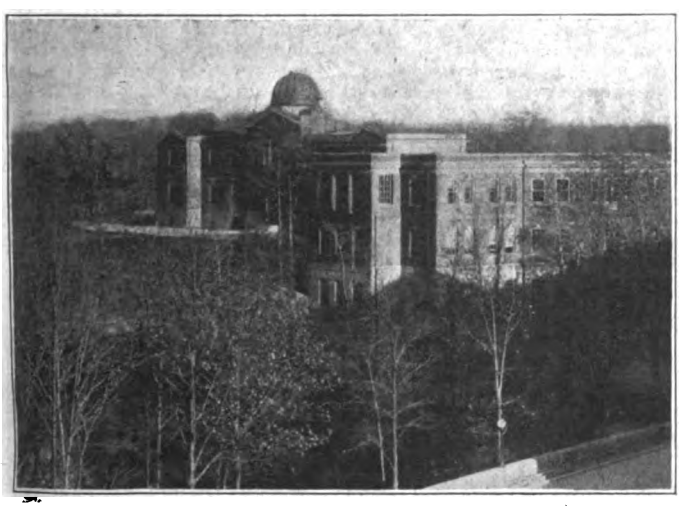


FIG. 2.—GENERAL VIEW OF LABORATORIES AND PARK, NATIONAL ELECTRIC LAMP ASSOCIATION.

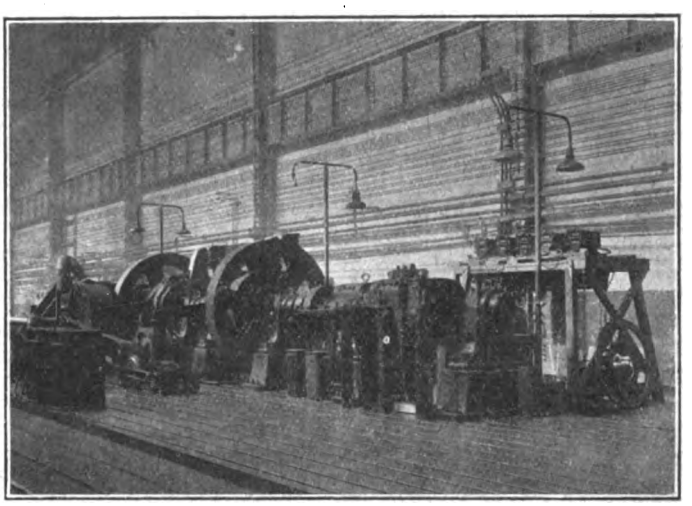


FIG. 5.—FLYWHEEL INVESTIGATIONS IN WORKS, WESTINGHOUSE CO.

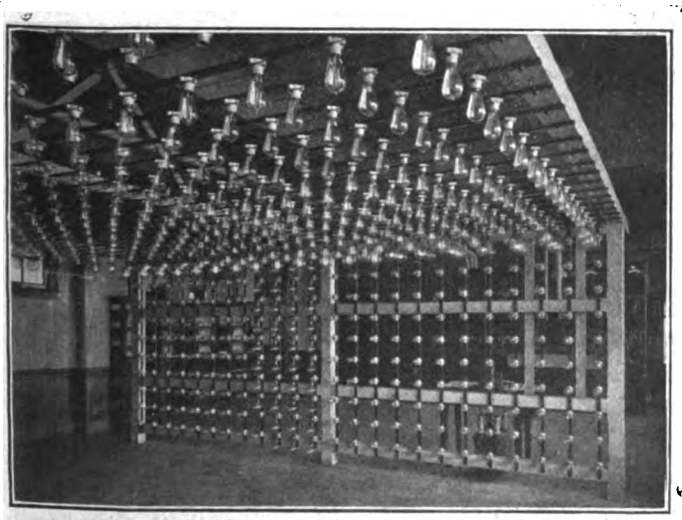


FIG. 3.—LAMP TESTING LABORATORY, PENNSYLVANIA RAILROAD CO.

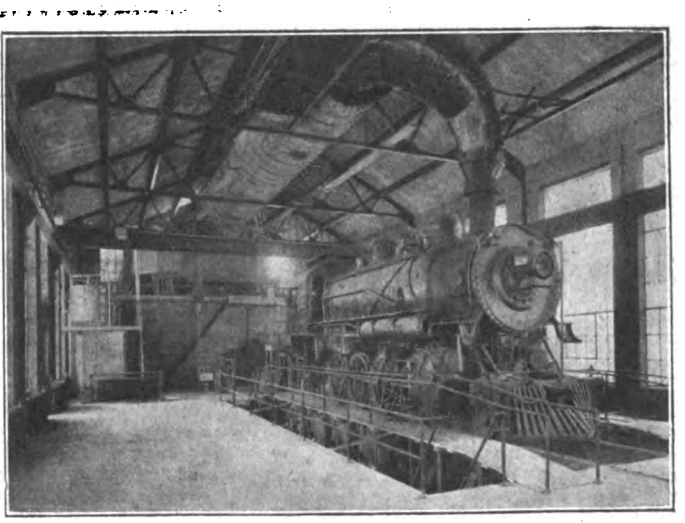


FIG. 6.—LOCOMOTIVE TESTING LABORATORY, UNIVERSITY OF ILLINOIS.

Digitized by Google

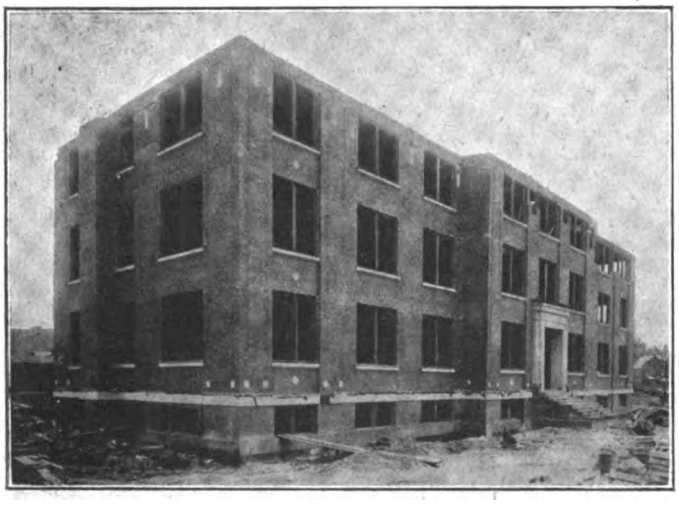


FIG. 7.—NEW RESEARCH BUILDING IN COURSE OF CONSTRUCTION, WESTINGHOUSE CO.

FIG. 8.—MELLON INSTITUTE OF INDUSTRIAL RESEARCH.

will serve to show some of the ground which is covered by the 85 illustrations in this Paper and the text which accompanies them. It should be noted that the firms with which the author deals are by no means only electrical but include other industries and also universities. We refer to this question further in our Editorial Notes.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

VOTING BY PROXY.

A special general meeting of the Institution was held on Thursday, the 14th inst., at which the resolution altering the articles of association so as to enable members to vote by proxy was confirmed.

THE PRESIDENT (Mr. C. P. Sparks), before moving the confirmation of the resolution, read a number of letters from provincial members in support of the proposal. He remarked that proxy voting would not do away with the possibility of ventilating subjects by the attendance of the President and members of the Council at local sections, by special informal meetings, or by circularising members; but it would give provincial members greater opportunity of taking part in the affairs of the Institution.

Mr. B. WELBOURN (Manchester Local Scetion), in seconding the resolution, remarked that the idea of proxies was by no means new. Mr. W. Cramp brought it forward when he was chairman of the Manchester Local Section. The resolution of the Committee of the Manchester Local Section in favour of the adoption of voting by proxy was considered by the Vice-Presidents' Committee, who co-opted Mr. McKenzie, of Manchester, and reported in favour of the scheme. The London Council were unanimous in favour of the principle, and local sections were very strongly in favour of it, and felt that provincial members ought not to be put to the trouble and expense of travelling to London in order to record their votes. So far as the provinces were concerned, there was no unhealthy agitation behind the request, and many members in the provinces felt that, by means of proxy voting, they would get a larger share and greater interest in the affairs of the Institution, and get more for their subscriptions than they had at present. He was sure that the right of proxy voting would be used very discreetly, and not for purposes of agitation.

Mr. A. C. CRAMB said he took it that all that was desired was that every member should have as far as possible an equal opportunity of having a voice in the management of the Institution, and he thought everybody would agree that that was desirable; but, as far as his experience went, proxy voting was generally associated with companies whose reputations were pretty bad and he was sorry to see the word "proxy" used in connection with the matter at all. Was it intended that the provinces should hand to the Council a certain number of votes to do with as they liked?

The PRESIDENT explained that the Institution was really in the same position as an ordinary company and for that reason the expression "proxy" was used. In the event of a special meeting being called to debate any important question, proxies, if used, would have to be deposited a certain number of hours before the meeting at the Institution's offices. If the Council felt that they should ask for proxies, they would produce at the meeting the proxies they held supporting their views.

Mr. CRAMB, continuing, said he was not satisfied by this statement whether members were going to put their votes in the hands of some other persons, who probably had not at their disposal all the information available to enable them to come to a decision. If that were the idea, he did not like it.

The PRESIDENT explained that members could depute any corporate member to vote for them if they could not attend themselves.

Mr. CRAMB felt the idea of handing over discretionary powers to someone else to use as he liked was most objectionable. Although this was done under the guise of giving other members an opportunity to take part in the proceedings, they were not actually doing so. The Government should alter the Companies Act, so that the thing could be done in a respectable and honest manner.

Mr. A. GAY asked whether the proxy paper gave any indication as to how the holder should vote?

The PRESIDENT explained that no direction could be so given. The member appointed as proxy used the power as he thought desirable

Mr. GAY stated that the officers were elected by a postal ballot, and asked whether there was anything in the Companies Acts by which this arrangement could not be extended to deal with other matters.

The PRESIDENT stated that there was no power to change the Articles in that way. To avoid having some special procedure the usual proxy method was adopted.

Mr. GAY remarked that it seemed inconceivable that Articles could not be so altered. Proxy voting appeared to him to be a very dangerous weapon, as proxies might be sprung as a surprise on a meeting. There were two methods of voting in company meetings: (1) By a show of hands and (2) by a poll. In the case of a private company, where there were no shares, he thought a vote by ballot would be equivalent to a poll. He thought that proxy voting would not carry out the desires of the provinces, because it did not represent the vote of the individual, as members would not know how the power so given might be used.

The PRESIDENT stated that there was more protection than was apparent at first sight. Supposing an isolated member started to get votes to make a drastic change, he thought the Local Sections would be a very great protection. He had absolute confidence in the Local Sections, as he was glad to say they had in him.

Mr. L. L. ROBINSON said that his association, the Municipal Electrical Engineers (Greater London), was anxious that all members should have votes, but they were practically unanimously opposed to proxy voting, and he asked whether eminent legal opinion had been taken as to the possibility of making a postal vote legal.

The PRESIDENT said they had a definite legal opinion that it could have no legal effect. They had been so advised by Messrs. Bristows, Cooke & Carpmael. He would have to refer to the correspondence before he could say whether the question of the possibility of altering the Articles so that they could have postal voting had been considered by counsel.

Mr. T. BLACKWOOD MURRAY (Glasgow) said if the motion were turned down, the Institution would be faced with wholesale resignations from the Local Sections.

Mr. LL. B. ATKINSON (Manchester) said many Manchester members had asked him to urge that proxy voting was a reasonable and proper method. He did not think they need fear wholesale resignations.

Mr. J. K. STOTHERT (Glasgow) said the whole of the Scottish Local Section supported proxy voting. The exercise of proxy voting was different in an Institution of that kind from what it was in a company run for the pursuit of money.

Mr. H. H. WRIGHT (Yorkshire Local Section) said the members of the Yorkshire section were heartily in favour of the proposal. He did not think the dangers and difficulties enumerated by other speakers were very serious.

Mr. H. W. CLOTHIER (Newcastle) also supported the motion, and said there were hundreds of men in the provinces who would be members if they felt the Institution was more a part of themselves.

Digitized by Google

The PRESIDENT said the matter had not been taken up in a hasty fashion, but had been carefully considered by the Council and by a special Committee of those who had gained during their service on the Council a special knowledge of the difficulties of running the Institution. Postal voting was favoured up to a certain extent, but such difficulties were found in obtaining any legal weight for a postal vote that the Committee advised the Council to act in the way which was now put before that meeting. They had been in the closest possible touch with the Local Sections with regard to the matter. The proposal satisfied the London Council and the Local Sections, and he hoped it would satisfy that meeting.

The President then put the motion, which was carried by 25 votes to 9.

INDIVIDUAL INTEREST IN MUNICIPAL ENTERPRISE.

The abstract of Mr. J. H. Bowden's Paper on this subject appears on p. 462 of the present issue. An animated discussion followed the reading of the Paper, and below we give some account of the views that were expressed.

Mr. D. H. LITTLER (formerly chairman of the West Ham Electricity Committee) opened the discussion. With the general principle of profit-sharing he was in entire agreement. He had found the merit of the system in giving a personal interest in the individual results of the work done, whether by the staff or workman, and it added to the prosperity of the industry, whilst it also gave an added interest to their daily occupation, which had proved highly satisfactory. But certain safeguards were necessary. Profit-sharing tended to create security of tenure, particularly in the junior staffs, and this might lead to slackness, which must be avoided. It was also essential that in any scheme the bonus should not form part of the ordinary remuneration which was due to a man, whatever his position. He hoped the author, when replying, would state how the figures quoted in his Paper for the bonus of 20 per cent. up to £6,000 and above that amount 10 per cent. were arrived at. Was it on a scientific basis, or was it an arbitrary figure, taken as a matter of convenience because of the available balance? It would be of service to those who had gone into the financial side of the question. On this point he saw the proposal was made of handing over 40 per cent. to the Finance Committee. While he had had some experience of the hungry grabbing hand of the Finance Committee, he quite admitted the ratepayers, having found the capital and guaranteed the same, should have some return made to them; but he asked whether an administrative department, when taking funds which should be used to improve the electricity department, were not already receiving a sufficient return by the added industry, the added rateable value, and the added facilities? Referring to the allocation of bonuses to staffs, Mr. Littler said he would remind Mr. Bowden of the words of a song sung by a workman that "The man who built the houses was the man who carried the hod," and with the proportion of 36 per cent. of the profits to the principal officers and 6 per cent. to the workmen, he thought the man who carried the hod would not consider the division altogether equitable. The question of the investment of the bonus was a very difficult one. The moment one touched the principle of dictating to a man what should be done with his money without his voice in the matter there would be resentment. Profit-sharing, when possible, must not be on a small scale, but a generous scale, in order to produce the best results, and for the protection of all men employed in the industry it was necessary that the bonus should be over and above a fair remuneration for services rendered. Co-partnership had been employed by certain gas companies, but he understood that labour objected to it, and that the method had not proved to be very satisfactory. He congratulated Mr. Bowden on the way he had put his case.

Mr. E. W. MUNDY (secretary of the Co-partnership Association) said any scheme of co-partnership must begin with a financial basis, but if it stopped there he had no use for it. The relationship between capital, management and labour had to be seriously considered, and especially between the two last. He was convinced that co-partnership was on the right lines, and was an attempt to bring the two parties together. He preferred the word dividend to bonus, as a man should come to look on it as something that had accrued; not as part of his wages, but as a reward for his keen personal interest. How to increase that personal interest in the business was of the first importance. In the case of the South Metropolitan Gas Co., Dr. Carpenter had found co-partnership eminently successful. He thought Dr. Carpenter could speak with more authority than Mr. Broadberry on this point. Any opposition by labour had been from the outside.

Mr. C. H. WORDINGHAM (chief electrical engineer to the Admiralty) thought a most important question was that of labour. Every man should have some direct interest in the results of what he helped to produce, and profit-sharing appealed very strongly to him. He thought, however, a workman would look with suspicion, and resent having his "allowance" spent for him or invested for him. He (the speaker) had no faith in legislation in making a man moral, honest or thrifty; and the true solution of the proper application of the profits earned by a workman was to improve his character. He questioned if much could be done with the adult, but proper education of the child as to what were his advantages and rights was the best remedy. Mr. Bowden had attempted to give the conference a solution of the question of profit-sharing, although the subject of rebates tended to be rather complicated.

Councillor BARGE, chairman of the Electricity Committee, Poplar, said, speaking in a wide sense, they might be regarded as an average Council, and as a municipal enterprise they had done their best. Their scheme was the outcome of much thought. He believed the men liked it. Work was going on better, although there was not much to complain of at any time. Half the Electricity Committees did the wrong thing because they did not know better. It was, therefore, necessary for the electrical engineer to educate Electricity Committees, who in turn would educate the Councils.

Ald. WALKER (Manchester) said much good might come out of discussion of the subject. It was an attempt to extend to the whole of the staff the method of payment by results. In some undertakings the whole of the staff was underpaid, in many a few of the staff were underpaid, and in a few undertakings the whole of the staff were well paid. Dissatisfaction must go hand in hand with inefficient service. Giving the men a stake in the ownership was for the good of the concern. The additional sum paid to men of high technical attainments was as nothing compared with the amount that could be saved in capital expenditure and operation costs. With regard to educating the members of the committees, a difficulty was that the members were ever changing. They came on with the same idea that to charge 3½d. to one consumer and 0·3d. to another meant that one was paying for all the units consumed by the other. But the idea was gradually permeating through the councils that cheap electricity was a means of increasing the rateable value of a district. He thought the contribution to the relief of rates should be based on a percentage of the outstanding debt charges. Manchester Council this year had adopted a resolution in favour of that system. Mr. Bowden was building up a debt free concern, which would be a fine asset to the locality. Mr. Bowden said the interests of the individual members of the staff should be such as to prevent them desiring to move to other positions, but a mechanical engineer would still have the desire to become a chief engineer. Any man who was worth anything would have the desire to get to the top of his profession, and he (the speaker) would not wish to eliminate that desire. He thought the distinction Mr. Bowden attempted to draw between direct rate-aid and using the profits for the purchase of material for other departments was unsound. The effect was the same whether the money was handed to, say, the Cleansing Committee or to the Finance Committee.

Ald. THOMPSON (Wolverhampton) said he predicted that the Paper would be referred to with interest over a course of years. He had at his works a profit-sharing scheme which had been in vogue for years and which had withstood war as well as peace. Making the men capitalists conduced to the success of the undertaking. It might be impossible to apply the same principles to municipal undertakings, but he would endeavour to bring his Council round to some system of profit-sharing. He had heard workmen say they had only their labour to sell and it was up to manufacturers and municipalities to see that they had something more to sell. Twenty-four years ago his father gave him the opportunity of becoming a partner in his business on condition that he saved the money to pay for his share out of the profits. The result of this kind of policy was that there were now 1,250 workmen compared with 30 when he left school. They guaranteed a minimum interest on the holdings of the men and the men received last year 12½ per cent. At the outbreak of war 300 of his men agreed to have 10 per cent. of their wages deducted every fortnight. The money had been put to a thrift fund, and his intention was that it should be invested in the business and that the men should put on the board a representative of their money. How much of the profits of municipal undertakings was to be given to the ratepayers? A remark was made that a paltry £3,000 would only take off 1½d. of the rates. If that were not enough take off £6,000. It was not only the price of electricity that induced a firm to go to a locality, but also low rates and by bringing in new men the electricity department would get more orders.

Mr. L. L. ROBINSON (Hackney) said Mr. Bowden referred to the fact that municipal trading did not allow full scope for individual interest as the only irrefutable argument against municipal trading, but many of them must feel that there were many other difficulties from which they suffered besides. One he felt acutely was the want of cohesion between municipalities in the interests of the electrical industry. That was shown by the meagre amount of support tendered to him and his Council at the present moment in the fight they were having with the Gas Light & Coke Co. He hoped members would take his words to heart and see if they could not do something better. He thought the time would come, probably very shortly, when the whole of the undertakings would be taken over by a reasonable number of large statutory companies, which would operate under Government control so far as conditions and prices were concerned. Of course, if that was done it would be their business to see that the existing interests of all concerned were properly compensated. He agreed with Mr. Bowden's general views. It was important that some scheme should be produced which would avoid labour troubles and make the association between employers and employees more comfortable. He did not agree that a higher scale of bonus should be given to the higher officials. It was likely to produce a feeling of jealousy. If a sliding scale were adopted a large part of the bonus should be paid in the boiler-house. Mr. Bowden suggested that the rate of bonus should vary inversely to the price charged. That was not easy. A large load-factor consumer would send the selling price down enormously and so increase the bonus enormously, without any particular effort of the staff. He would hand to the secretary particulars of a scheme which was before his Electricity Committee.

Mr. T. HALL (borough electrical engineer, Burton-on-Trent) gave particulars of a profit-sharing scheme which he had in operation, and which was very successful. When the total expenditure on generation and distribution was less than 1d. per unit sold the difference multiplied by 20

Digitized by Google

was taken as the rate per cent. to be added to wages and salaries. He gave the following figures :—

Year.	Total Costs.	
1914	... 0·9d. ...	1·0—0·9 =0·1 ×20=2·0 per cent.
1915	... 0·7d. ...	1·0—0·7 =0·3 ×20=6·0 per cent.
1916	... 0·66d. ...	1·0—0·66 =0·34×20=6·8 per cent.
1917	... 0·71d. ...	1·0—0·71 =0·29×20 5·8 per cent.

They had 40 to 50 workmen who received the bonus, and they were energetic canvassers for the undertaking. There was hardly a public house now which was not connected to the mains. They had also a system of collecting scrap lead, copper and brass, which was formerly put on the ash heap, and that was worth studying at the present time. He believed a municipal undertaking had no power to invest money for its workmen. Could Mr. Bowden say how th t difficulty could be got over ?

Ald. SMITH (Liverpool) said the man referred to by Mr. Littler as saying that the man who built the house was the man who carried the hod represented a very narrow view. If a ratepayer got a reduction in his rates he would see that he could increase that reduction by installing electricity in his premises. Why should we object to pay the bonus if it tended to economy and to our own interests ? It was lack of interest that produced laxity in management, and if that interest was stimulated it would be a very valuable thing.

Mr. BOWDEN, replying to the discussion, said in reference to Mr. Littler's remarks as to security of tenure producing slackness, profit-sharing rather did away with that. Unsympathetic assessment committees increased the rateable value. It should be borne in mind that, so far as a London undertaking was concerned, two-thirds of the rate had to be paid to the County Council. With regard to the purchase of motor wagons, this was an excellent advertisement for the undertaking, whereas if the money were handed over for relief of rates it was lost sight of. They did not want to eliminate the desire of a man to improve his position, but the bonus and superannuation funds would be an inducement to him to stay. When they started the profit sharing at Poplar they could not find a single undertaking doing it on similar lines. There had been profit sharing schemes for certain men in the boiler house. In reference to Mr. Hall's question, he did not think there could be any objection to the use of the money as working capital. There was a Bill in the House—or there was just before the war—which would give power to invest for the employees in a municipal undertaking.

The PRESIDENT proposed a hearty vote of thanks to Mr. Bowden, and it was carried amid applause.

FUEL ECONOMY.

The abstract of Mr. J. A. Robertson's Paper will be found on p. 464 of the present issue. In what follows we give an account of the discussion on this Paper.

Dr. S. Z. DE FERRANTI thought the interest in the Paper was that the author had dealt with the items that were really important in power generation, namely, (1) great cheapness so as to benefit the whole country, and (2) the commercial value of by-products. What was really wanted was to get more from a ton of coal. He felt we were on the border line where beyond this line electrical methods would be the only way of operation, owing to their greater efficiency. Increase of thermal efficiency was what was important. As to by-products, it was an unfortunate fact that in the cheapest methods of electric power production there was no such thing as a by-product. The advantages of any by-products were largely used up in their production. In his opinion the gas-engine suffered more from the inefficiency of gas production than its own defects. The difficulty of by-products might yet be solved, but the price of sulphate ought to be much lower (he himself took it at £8 per ton some years ago) if it was to be of real value to agriculture. A remarkable article by Sir Leo Chiozza Money appeared some time ago in which the importance of our coal was emphasised. He (Dr. Ferranti) felt that the engineer had not yet shown the way, nor had the inventor done all that was necessary. It was essential to improve the efficiency in obtaining by-products from coal. In making these remarks he did not wish to give the impression that he was not in favour of what was already being done to secure a cheap supply of electric power.

Bailie SMITH (Glasgow) said that the Glasgow electricity department had made experiments with a low temperature carbonisation plant capable of dealing with 20 tons daily. He thought that power gas for boiler firing, with recovery of by-products, could be done with low capital cost and low working expenses. They had already shown at Glasgow an advance on Mr. Robertson's figures. Where he gave a figure of £52,000 for producer plant, equipment on their lines would cost only £13,000, and at 5 per cent. interest showed a saving of £5,850 per annum. With this plant there was produced, instead of the ordinary tar, 16 gallons of a liquid per ton of coal, which could be sold at 3d. per gallon. With a low temperature plant, low grade fuel, high in ash content, could be used, and such coal was rich in ammonia and oil. In the low temperature producer plant the steam required was 1 lb. of steam per lb. of coal burned, as against 2½ lb. given in the Paper. In the liquid referred to there were resins from which direct dyes, not aniline dyes, could be obtained, and the speaker exhibited a number of specimens of materials treated with such dyes. These resins existed in the vegetation before the coal was formed, and were not destroyed by the low temperature process. He thought that the sulphate of ammonia could be sold at a price half that mentioned by Dr. Ferranti on account of these by-products. There were also great possibilities for the production of smokeless fuel by the carbonising plant, during periods of light load. When the plant was running on full-load all the coal could be gasified and the gas used for burning under the boilers. The smokeless fuel so produced was an amorphous coke, as against the graphitic coke obtained in gas manufacture, and therefore the percentage of volatile matter could be kept quite low without interfering with the free burning qualities. This coke might profitably be distributed outside the areas in which the electric service was obtainable. The distribution of such fuel would check the present bad practice in domestic circles of burning hard coal. Smokeless fuel produced in the manner referred to gave radiant heat to a greater degree than raw coal, and would be in demand for house fires. He looked forward, as the outcome of the present tendencies with fuel, to a linking-up of the gas and electrical interests.

Mr. H. DICKINSON (Liverpool) said there was little doubt that in the comparatively near future that practically all factories would be supplied with electric power, and coal correspondingly saved. With regard to electric power for domestic use much had been done in electrical cooking, and he thought the difficulty to further development was the heating of hot water required. If some scheme could be devised to obtain hot water economically then electrical cooking would make enormous strides. Many estimates of possible costs had been made in the past and it had appeared that we had a long way to go before these could be realised. Yet such estimates had been surpassed in comparatively short periods. He hoped that the author's forecast would in its turn be as quickly realised. With regard to interlinking and similar schemes, he thought they should all look upon this in the broadest possible way and not too much as individuals. They would all benefit by such changes. The author had referred to the limitations of the gas engine. He agreed that the gas engine could not be looked to for large powers on the ground that high speed was necessary, and the gas engine would not succeed until this high speed had been attained.

Mr. C. H. WORDINGHAM said the war had greatly stimulated the demand for power and necessitated a large increase in super-stations. The demand created by the sub-stations now existing would be felt confident be maintained and greatly exceeded because the attention of the general public and even the politicians had been directed to the advantages of electric power. No sane person, he believed, disputed the advantages of the super station. He felt strongly that the general power supply which we all looked forward to in the future would be best arrived at by the development of the existing undertakings. In all nature we saw growth, and he did not think any sudden cataclysm such as establishing enormous stations in districts where there was no need for them was a proper thing. The proper thing was to proceed with the linking up and with super-stations when required to link those up with the general scheme. On the whole he was in general agreement with what Mr. Robertson said. They had to consider what was the primary object in view. Was it really only the cheap production of power, or was it rather the most economical use of the nation's coal? We were not justified in throwing away any part of the coal, even though it had been cheaper not to worry about by-products. It was as though you went to Mr. Rider's late home and made bricks out of clay without troubling to pick out the diamonds. He had had bricks thrown at him for advocating the electric and gas interests, but the criticism by its nature made him more convinced that he was right in thinking it was folly to throw away the vast experience of the gas men in the proper utilisation of coal by the recovery of by-products in the production of gas and coke. We should aim at getting the maximum possible out of the coal that we had still remaining to us. Great progress would not be made unless private enterprise and municipal enterprise were concerned, or unless the schemes were made to pay. The best results were obtained by people who would benefit by the good results of their labour. It was essential that there should be some central controlling authority to which schemes would have to be submitted, a body having the necessary knowledge and experience to consider the schemes on their merits, to receive them with sympathy and to ensure that the money spent was spent in a wise manner and all extensions and all new stations put down should be parts of a well considered plan such as the author points out is desirable. Mr. Robertson compared economy of production in the factory and the central station, but the comparison ought to be made between the fuel used for producing a certain horse-power at the spot at which it is required, taking into account transmission and other losses. Mr. Robertson's views on electric heating and cooking coincided with his own.

Mr. SELVEY said it was a matter of considerable satisfaction that the Association represented 70 per cent. of electricity supply and therefore any statement from such a quarter must be received with due deference. He expressed his agreement with practically all that Mr. Robertson's Paper dealt with. Touching on the question of coal, he said much that was being drawn to-day was poorer in quality than in past years, being higher in ash content, and the price per B.T.U. tended to rise. All coal owners did not deserve the criticism made by Mr. Robertson. He knew of a case in which the various operations of a colliery had been successively electrified until finally 1s. 4d. per ton was spent on mechanical handling, but although the miner was thus relieved the output per man did not increase.

Mr. S. J. WATSON (Bury) commended the author for dealing with the subject on broad lines rather than within narrow limits. In so doing he had done a national service. He was alarmed at the figures quoted for coal production in the United States ; 83 per cent. more fuel with 32 per cent. less men at a cost of 6s. 1d. per ton, as against 9s. per ton over here. Seeing that higher wages were paid in U.S.A., the results were

Digitized by Google

startling and needed explanation. He thought that a census of the potential power supply should be taken by every engineer in his area. In Bury they were now supplying 20 per cent. of this potential demand. In other towns it was far less, but at present only the fringe of the industrial demand was being touched. Speaking of cooking and heating, he reminded the members that figures given by Mr. F. S. Grogan some years ago showed that coke heating had a thermal efficiency of 2 per cent., gas 12 per cent., and electricity 80 per cent., figures which showed that it was desirable to use electrical energy for cooking and heating. Criticising Mr. Robertson's reference to ammonium sulphate recovery, he thought that the fact that considerable outlay was needed, and extra fuel ashes and labour, would preclude the practice of such recovery in war time, when money and labour should be saved. There was also the possibility that other materials on the market would compete with these by-products.

Mr. H. S. ELLIS (South Shields) enquired what was the basis of Sir Geo. Beilby's figure of 5 lb. of coal per I.H.P. hour, and stated that in the woollen districts of Yorkshire some of the works ran on as small a consumption as 2 lb.

Mr. PORTER drew attention to the importance of the oil engine. There were large deposits of shale in this country, the only difficulty in using the oil from this shale being the sulphur content. This was being investigated by chemists and would doubtless be solved. Although linking up would reach many parts of the country, there were parts that could not be so reached, and such parts would, he thought, depend increasingly on the oil engine.

Mr. CLEGG (Accrington) said he was connected with works using large gas engines and Mond producers. Mr. Robertson said: "To obtain the highest possible efficiency in power production from the carbonisation of coal involves the employment of internal combustion engines." He agreed with that, and also with the following remarks as to large size gas engines being hardly a commercial success, and his statement that for generation on the scale required in a centralised power scheme they might be left out of account. Mr. Robertson said: "When employed for by-product recovery of sulphate was equal to about 4 per cent. of the weight of coal carbonised." This ought to read 3 per cent. Also the figure of 3 per cent. of tar (which was *very* inferior, not somewhat inferior) should be 10 per cent. He agreed with the figures on the chart showing the varying prices of sulphate, and the price was about correct at £16; but he thought those figures were coming down to about £5 per ton when atmospheric nitrogen products became common. The price of acid was quoted as £2 a ton, but he thought £3 or £3.10s. was more correct. To-day's price was £4. 10s.

Mr. ROBERTSON, in reply, referred to Mr. Ferranti's memorable address to the Institution of Electrical Engineers in 1910, which might be said to have started the subject of cheap electric power. He could not understand Bailie Smith's low figure of capital cost for recovery producer plant. Mr. Wordingham had rightly stated that what was wanted was cheap power. He (Mr. Robertson), like most engineers, had an open mind in regard to carbonisation. He did not believe in combining with gas undertakings, but if it could be shown that such a step would save fuel he would not be averse to it. It was stated recently in the "Electrical World" that 43 companies working as one concern in the U.S.A. had increased their output by more than 2,000 million units, or by more than the total output in this country. This showed the importance of combination. Mr. Selvey thought he had dealt too critically with coal owners, but so long as coal was drawn merely for dividends only the best coal would be taken from the pits. With regard to Mr. Grogan's figures of efficiency, he was in agreement with these. As to Sir George Beilby's figure of coal used per indicated-horse-power hour, this was put forward as the result of inquiries for the Royal Commission. The differences in the figures given by Mr. Clegg and Bailie Smith showed the desirability of keeping an open mind on the subject. As to the oil engine, in the smaller sizes, it was no doubt advantageous, but the available oil supplies were much smaller than the coal supplies, and would probably all be required for Admiralty purposes.

CORRESPONDENCE.

THE CHOICE OF VOLTAGE FOR RAILWAY ELECTRIFICATION ON THE DIRECT-CURRENT SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In his letter dated the 28th May, Dr. Smith appears to be reviving the old controversy between the direct-current and the single-phase alternating-current systems of railway electrification. I am sure he will excuse me if I decline to embark on an argument on this issue; certainly the article to which he refers in his letter was not intended to re-open this question.

If, however we confine our attention to what I believe to be his principal point (leaving out of account the somewhat unnecessary gibe contained in the last paragraph of his letter), I gather that Dr. Smith considers that a more satisfactory motor can be produced if arranged for working at all times with maximum field strength and graduated applied voltage for regulation of the speed than if the more usual design is adopted and speed regulation obtained by field control. He says "with field control it is not possible to use the material of the motor to the best advantage when the load is greatest."

In the first place, let me remark that the maximum output of the motor is obtained when the field is fully excited. This does not generally correspond to the highest speed: the greatest demand on the motor occurs when accelerating a heavy train up a steep gradient. Dr. Smith is evidently not very clear on this point.

In the second place, it is by no means obvious that there is any theoretical advantage in working under all circumstances with a fully excited field. Many considerations have to be taken into account such as iron losses, tendency to flashing over, motor generator or booster losses (especially when running for most of the time on light load, as in the case of the shunting locomotive) and other factors. The single point mentioned by Dr. Smith is quite insufficient as a basis to form a considered judgment. If he seriously believes that his argument is sound, let him work out an actual design for a complete equipment, and demonstrate the truth of his theorem by means of the figures as to weights, costs and working efficiencies resulting from his calculations. Until he is in a position to produce such figures I do not think too much value should be attached to his somewhat academic theory.—I am, &c.,

London, June 7. F. LYDALL.

[We regret that lack of space compelled us to hold over the above letter last week.—ED. *E.*]

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

1,271 BASTIAN, C. O. Carbon filament electric glow lamps. (26/1/16.) 105,929.

2,977 MARKS, E. C. R. (Landers, Frary & Clark.) Electric heaters. (28/2/16.) 105,936.

4,788 CHITTY, H. Dynamo-electric machines. (31/3/16.) 105,942.

4,948 FARGE, F. C. Apparatus for automatically igniting and extinguishing electric lamps. (10/7/15, addition to 24,223/12 and 4,828/16.) 100,883.

6,129 SPERRY, E. A. Method of operating electrodes for projectors. (28/4/16.) 100,781.

6,131 CURTIS, A. H. Electrical resistances. (28/4/16.) 105,946.

6,150 HALL, J., and KIRK, J. R. Method of automatically taking up shrinkage of coils of electric transformers and other electric apparatus. (29/4/16.) 105,947.

6,229 CURRUE, J. A. Apparatus for effecting endothermic gas reactions by an electric arc. (1/5/16.) 105,953.

Comprises the combination of a pair of opposed tubular electrodes having relatively wide flat annular opposed parallel arcing surfaces between which a continuous and relatively thick annular arc may be produced, means for passing gas through the arc and the electrodes, and water jackets within or on the electrodes.

6,249 STEPHENS, W. A. Reversing controller for electric motors used on petrol-electric cars and for other purposes. (2/5/16.) 105,956.

6,255 WILSON, W. H. Electrical transformers. (2/5/16.) 105,957.

6,269 RELAY AUTOMATIC TELEPHONE CO. & BYGRAVE, L. C. Electrical selectors or impulse responders. (2/5/16, addition to 9,345/15.) 105,959.

6,328 BURRELL, W. A. Automatic telephone systems. (3/5/16.) 105,966.

6,378 MESSERSCHMIDT, C. Timers or interrupters for magnetos. (12/10/15.) 101,783.

6,771 SELL, O. R. Incandescent electric lamps. (11/5/16.) 105,994.

6,859 WHITE, J. Carbon holders for electric arc lamps. (13/5/16.) 105,996.

7,712 WHITE, A. E. (Wolverine Spark Plug Co.) Sparking plugs. (31/5/16.) 106,006.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

April 4, 1917.

4,839 GARRARD & RAILING. Electric switches.

4,865 EDWARDS & LUCAS. Plug connections for electric circuits.

4,866 GRYLLS & HEAPE. Electric arc lamps.

4,882 SCHOLEY. Individual electric driving of machine tools, &c.

4,885 WADE. (Flanders.) Plates for storage batteries.

4,886 WADE. (Flanders.) Plates for storage batteries and paste therefor.

April 5, 1917.

4,901 BARR. Attachment for electric torches.

4,923 DEHN. (Electric Railway Improvement Co.) Electric welding.

4,937 MAYER. Telephone appliance.

4,946 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Circuit interrupters.

4,948 BIHELLER. Electric pocket lamps.

4,950 MARCONI'S WIRELESS TELEGRAPH CO. & EWEN. Electrical instruments.

4,954 NORSK ELEKTRISK METALINDUSTRI AKTIESELSKOP. Converting zinc powder to liquid.

4,955 NORSK ELEKTRISK METALINDUSTRI AKTIESELSKOP. Condensers for zinc vapours.

4,957 MCLENNAN. Electric interrupters for induction coils, &c.

4,963 FORBES & GELL. Electric switches.

Digitized by Google

PARLIAMENTARY INTELLIGENCE.

SHEFFIELD CORPORATION BILL.

Last week the Local Legislation Committee of the House of Commons considered this bill, which is being promoted by Sheffield Corporation to enable them to erect a new electricity generating station, &c. The Great Central Railway Co., Rotherham Corporation, Sheffield Navigation Co. and Messrs. Steel, Peech & Tozer opposed.

Mr. WEDDERBURN, K.C. (for the promoters), announced that the portion of the bill relating to the extension of the boundaries had been dropped, an arrangement having been come to with Rotherham Corporation for a rectification of the boundary. Next year Sheffield and Rotherham would bring forward a measure for a rectification of their boundaries. The contested part of the bill related to clause 16, which authorised the abstraction of water from the River Don. The clause had been modified so that not more than 500,000 gallons of water per day could be abstracted for condensing purposes. The Corporation bought the electricity undertaking in 1898 from a local company, and since that time the demand for energy for power had increased in a phenomenal manner. The output for the year ended March 25, 1914, was over 26,000,000 units, in 1915 45,000,000 units, and in 1916 78,000,000 units, while for the year ended March last 126,500,000 million units were sold. It was estimated that during the current year over 200,000,000 units would be sold. It was calculated that they ought to be in a position in 1927 to supply at least 600,000,000 units per annum. In 1916 the cost of generation was 0·44d. and the average price received 0·85d. per unit; the revenue was over £450,000, while the consumers numbered 7,500. The increased demand was mainly due to the requirements of engineering and industrial establishments. They had had assistance from Government departments in finding plant and money for extensions at Neepsend. The total capacity of the Corporation's three generating stations was over 68,000 kw. and by next winter the demand would amount to 64,000 kw., leaving an altogether inadequate margin of 4,000 kw. for reserve. At present the monthly applications for additional power averaged some 2,000 kw. to 3,000 kw., but those applications were only accepted conditionally on ability to supply. Prior to the war they had a department for educating people in the use of electrical energy for power and domestic purposes, but that had been dropped. They anticipated a considerable increase in work after the war, and the demand for electrical energy would go on increasing, as steam power was being largely superseded by electric energy, and there was also the rapid increase in the number of electric steel furnaces to be considered. It had been calculated that there was steam machinery of about 300,000 H.P. in the district, and as that became worn out it would be superseded by electric power. The Corporation intended to spend about £2,000,000 on the new station, but the first section would only cost about £500,000. Counsel referred to reports of the Board of Trade and the Local Government Board on the bill, and pointed out that committees did not always report promptly, and the Corporation could not afford to wait for departmental action to be taken. Sheffield might be described as a large economical unit, and, owing to its industrial position, it must build its station now. In a letter from the Local Government Board it was pointed out that Rotherham was extending its generating station, and there was a question whether the requirements of the city and the borough would not most economically be met by joint action of the two Councils, thus avoiding the necessity for the erection of a new generating station. He suggested that a joint committee of the two local authorities should be appointed to consider the matter and if necessary the Board would appoint an independent chairman. Mr. Wedderburn pointed out that the writer of that communication could have no idea of what the demands for electrical energy in Sheffield were, and knew nothing about the urgency of those demands. The area of the Rotherham site was 4½ acres, which might be adequate for Rotherham needs, but it was not for Sheffield. They propsed to build on a site of 35 acres, and the letter showed that the Local Government Board were in entire ignorance of the facts.

Evidence was then called, and Mr. HOBSON, chairman of William Jessop & Sons (Ltd.) and other firms, declared that the electric furnace for stock smelting was the furnace of the future. The city corporation were under an obligation not to fail to provide a cheap and abundant supply of electricity.

Other witnesses spoke to the urgency of having an adequate supply of electricity for the immediate post-war developments of Sheffield trade.

On the 13th inst. it was announced that agreements had been come to with Messrs. Steel, Peech & Tozer and with the Great Central Railway Co. Under the latter the Corporation would be enabled to lay their mains along a considerable length of railway line.

Mr. VESEY KNOX, K.C. (for Rotherham) said their case was that the abstraction of water from the Don and the returning of same at an increased temperature or in diminished quantity would be injurious to public health, and evidence was called.

Sir ALEX. KENNEDY, M.Inst.C.E., said he had been consulted by Sheffield Corporation in reference to the Bill, and, speaking generally, he was of opinion that the site chosen for the proposed new electricity generating station was a suitable one, and the works proposed to be put up were well adapted for supplying electricity to the city of Sheffield. He did not think Rotherham had any grounds for apprehension that they would be injuriously affected by the carrying out of the works. He agreed that the water returned to the river should not raise the temperature of the river beyond a certain point. He agreed that it was undesirable that the temperature of the water should be unduly raised.

At this stage the Chairman said the Committee desired him to express the view that, so far as the case had gone on the question of the temperature of the water to be discharged into the Don, Sheffield had failed to make good its case. The Committee was of opinion that Sheffield should be put under an obligation not to discharge water at so high a temperature.

Mr. JOHN HOWARTH, manager of the Sewage Disposal Department of Sheffield, gave results of his analyses of the water of the River Don for determining the presence of sewage matter. Other witnesses were also called, and the promoters' case closed.

The Committee's decision had not been given when we went to press.

BOARD OF TRADE ELECTRIC POWER COMMITTEE.

In the House of Commons last week, Mr. FINNEY asked the President of th Board of Trade whether he has receiv d a copy of a resolution passed by Stoke-on-Trent County Borough Council in regard to the composition of the committee appointed by him to consider and report on the future supply of electric power in the United Kingdom.

In reply, Sir A. STANLEY said he had received a copy of the resolution referred to and of similar resolutions passed by other local authorities, and he had decided to increase the representation of local authorities owning electrical undertakings on the committee.

Other members have since asked questions on this matter and similar replies have been given.

LEGAL INTELLIGENCE.

Dundalk U.D. Council v. Attorney-General for Ireland.

At Dublin last week Mr. Justice Barton heard plaintiffs' application for a declaration that under the Public Health Acts and the Electric Lighting Acts the Local Government Board were entitled (if they thought fit) to grant a loan to provide working capital or a working balance to enable the Council to carry on their electric light undertaking, to pay wages and meet other expenses, until the revenue could be collected. The Council had entered into a contract to supply current for power and lighting to the Great Northern Railway Co.'s works at Dundalk, and for that purpose the Council ordered two Diesel engines, but owing to the war the delivery of the engines had been delayed, and the Council had been unable for one year to carry out their contract with the railway company, thus causing them a loss of £1,800 in revenue. The estimated revenue was, in consequence, depleted, and the Council applied to the L.G. Board for sanction to a loan of £2,000, but the Board replied that they had been advised that they had no power to sanction such a loan, as it was only for permanent works and not for working capital that a loan could be granted.

Mr. Justice BARTON, in dismissing the action, said that the effect of acceding to the claim of plaintiffs would be to disregard the prohibition of the statute which forbade borrowing for any purpose other than for permanent works, which expression could not include working capital, and to ignore the direction in the Provisional Order that any deficiency in income should be charged on and payable out of the rates. He had arrived at that decision with regret, as he was satisfied that plaintiffs had done everything in a bona fide and business like manner. It did occur to him that municipal undertakings of that kind were at a disadvantage as regards working capital in comparison with commercial undertakings. He would gladly have acceded to plaintiffs' contention if he could. Their action for a declaration was fully justified, and he hoped some way out of the difficulty would be found for them.

Electric Lamp Filament Patents.

On the 12th inst. the House of Lords (the Lord Chancellor, Viscount Haldane, Lords Atkinson, Parker of Waddington, and Parmoor) commenced the hearing of an appeal by the Osram-Robertson Lamp Works (Ltd.) from a judgment of the Court of Appeal in favour of the respondents, Pope's Electric Lamp Co. (Ltd.).

A full report will appear in our next issue.

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. B. CLAY, V.D.

Orders for the week:

Officer for the week.—Platoon Commander W. J. A. Watkins.

Next for Duty.—Platoon-Commander C. Campbell.

Resignation.—Platoon-Commander Irwin Moore, Medical Officer, resigns his appointment.

Monday, June 25th.—Technical instruction for No. 3 Coy., Right Half Coy., at Regency-street; drill No. 3 Coy., Left Half Coy.; Signalling class; recruits' drill, 6.30.

Tuesday, June 26th.—Lecture, 6.30, Coy.-Commander Castell; physical drill and bayonet fighting, 7.30.

Wednesday, June 27th.—Drill, No. 1 Coy., Right Half Coy.

Thursday, June 28th.—Drill, No. 2 Coy., Right Half Coy.; ambulance class, 6.30; signalling class.

Friday, June 29th.—Technical instruction for No. 3 Coy., Left Half Coy., at Regency-street; drill, No. 3 Coy., Right Half Coy.; recruits' drill, 6.30.

Saturday, June 30th.—Commandant's parade, 2.45; uniform for drill in Hyde Park; recruits' drill, 2.30.

Sunday, July 1st.—Parade Clapham Common (Tube Rly.), 9.45 a.m. for work at bombing school; uniform; rations to be carried.

Armlets.—Members are warned that armlets must be worn at all plain clothes parades.

Musketry.—For all Companies see Notice at Headquarters.

NOTE.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street, W.).

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

British Trade Corporation. The form of declaration in regard to the Charter which the British Trade Corporation is prepared to give under its seal, together with a copy of an extract from the Minutes passed by the Board on June 8 in reference to Clause 135 of the Deed of Settlement, have been issued. The first part of the declaration is simply an announcement of policy and the second part is an interpretation of the powers conferred by the Charter. The real point appears to be whether this interpretation is the true one, and whether it would be legally binding upon the Corporation and its directors. We have the assurance of the Law Officers of the Crown that a breach of the declaration would be a cause for the withdrawal of the Charter, but we suggest that this indirect method of dealing with an important question is not a happy or a very satisfactory one.

In the declaration the Corporation declares that it has sought and accepted the charter on the footing that according to the true intent and meaning of the charter the following are provisions thereof:—

That the fundamental object for which the charter has been granted is the giving of financial assistance to British traders and manufacturers, especially in connection with overseas trade, and that the Corporation is under an obligation to give full effect to such object, and will be accessible to the business public for the purpose of consultation and otherwise; that the Corporation is not intended to be, nor will it operate as, a competing contractor, merchant, or trader, and that its enterprises shall be directed to the furtherance of its aforesaid fundamental object; that the powers and privileges given to the Corporation by the charter are intended to be and are the machinery by which the Corporation will effectuate its said fundamental object, and will be exercised for the purpose, as a means of, and with a view to the carrying out or furtherance of the same, and that nothing in the charter has the effect of conferring any exclusive privilege on the Corporation as regards access to Government information or of placing it in any preferential position as regards the representation of British trade or finance, or of conferring upon it the right of acting as Agent of the Government except upon appointment in each case or of excluding the Government from selecting other agents in cases in which they see reason for so doing.

The extract from the Minutes is as follows:—Resolved—That Clause 135 of the Deed of Settlement shall not be acted upon until it shall first have been confirmed by a majority of the votes of shareholders in general meeting, convened subsequently to the first issue of capital to the public.

In the House of Commons last week the President of the Board of Trade (Sir A. Stanley) announced that adequate provision had been made to secure that the control and management of the Corporation should be, and should always remain, British. Nobody of alien birth had subscribed in any way to the capital of the Corporation.

According to "The Times" the most important immediate outcome of the work of the Corporation will be the organisation of its projected "Bureau d'Etudes" as outlined in the report of Lord Faringdon's Committee. A good deal must depend on the new Intelligence Department which is to be associated with the Trade Bank. In the absence of information we are unable to criticise the scheme. An active energetic and up-to-date department for collecting and disseminating intelligence is badly wanted and if properly organised should benefit British merchants, manufacturers and exporters. We are not unmindful of the novercal attitude of the Foreign Office and Board of Trade towards commerce and trade in the past, and therefore we are somewhat suspicious of any scheme which may be under the control of a Government department.

* * * *

The Future of the Motor Omnibus. At a recent meeting of the Birmingham District Power & Traction Co., the chairman (Mr. C. S. B. Hilton) raised a question of great interest to motor omnibus undertakings and the motor industry in general.

Mr. Hilton pointed out that at present every motor omnibus in regular work contributes ½d. per mile, or between £50 or £60 per annum, in taxes. It was originally arranged that such taxes should be spent on road maintenance, but during the war that revenue had been diverted to other objects. Meanwhile individual road authorities were endeavouring by other means to compel omnibus owners to contribute to the repair and upkeep of the roads. He regarded that policy as very unsatisfactory from every point of view, and, if continued, it would undoubtedly have the effect of seriously crippling the development of motor transport in the public interest.

Working Expenses of Municipal Electricity Works. In our legal columns we report an interesting case which came before the High Court in Dublin last week. Dundalk Urban Council sought a declaration that the Local Government Board were empowered to grant a loan to provide working capital so as to enable them to carry on their electricity works, but the Judge decided (with regret) that he could not disregard the section of the Electric Lighting Act of 1882, which forbade borrowing except for permanent works, and working capital could not be included under that heading. Compared with companies, municipal authorities who own electric supply undertakings are at a disadvantage in regard to working capital, and though in recent years several local authorities have secured powers in their local Acts to create special funds for carrying on their business, we think that similar powers might very well be conferred on all municipal supply authorities, and thus enable them to carry on their undertakings to the best advantage.

* * * *

The London United Tramways. We are sorry to notice that a receiver has been appointed on behalf of the debenture stockholders of the London United Tramways (Ltd.).

The tramways of this company were among the first in this country to be converted to electric traction, and for some years the undertaking appeared to be quite successful. With the advent of the motor-car and the motor omnibus, however, competition became keen, passengers were lost and the receipts dropped. The company also suffered from the heavy expense involved in road widening, wayleave fines, &c., and in addition sufficient sums were not put by in the early days for renewal and maintenance purposes. Naturally, the effect of the war has been to make a difficult situation more complicated still. The company is evidently over-capitalised, as only 1 per cent. was paid on the preference shares in 1913 and ¼ per cent. in 1914, and last year it failed to earn its debenture and loan interest, while this year's prospects are worse. A re-organisation of the capital would therefore appear to be necessary in order to put matters upon a proper basis, especially as it appears that large sums must be expended for repairs and renewals.

In circulars issued by the Mercantile Investment & General Trust and the Merchants' Trust to holders of first debenture stock of the company it is stated that in consequence of the serious position disclosed it would appear necessary for debenture stockholders to take independent action to protect their interests.

The reports of the meetings of the shareholders and debenture stockholders are given in another column.

* * * *

French Industrial Reorganisation. The "Journal Officiel" of May 3 contains a draft of a law which will place at the disposal of the Ministry of Commerce, Industry and Posts and Telegraphs an additional sum for restoring some of the industries in the invaded regions in the North. It is proposed to place a credit of 250,000,000 francs at the disposal of the Ministry for the purpose of buying tools, machinery and materials which have been taken away or destroyed by the Germans. A special department of the Ministry has been constituted for carrying out this work, and 100,000,000 francs of the above sum will be voted in the Budget for the current year.

* * * *

Government Contracts. A new Defence of the Realm regulation empowers the Admiralty, Army Council and Ministry of Munitions to vary the terms of any sub-contract for Government work where it appears that the rate of profit is unreasonable or excessive by the substitution of such terms as they may think fair and reasonable, and require the sub-contractor—

(*a*) To carry out the sub-contract in whole or in part in accordance with the terms as so varied; and

(*b*) Either in addition thereto, or as an alternative therefor, to adjust the price of any goods already supplied or any services already rendered in accordance with the terms so varied.

The Order further provides that in such event the price payable to the principal contractor under the principal contract will be reduced.

* * * *

Labour Unrest. The following alterations have been made in the personnel of the Commission of Inquiry into Industrial Unrest given in our last issue:—Mr. J. W. Ogden is one of the Commissioners for the West Midlands Division, instead of Mr. A. G. Cameron, who takes the place of Mr. Ogden for the Scottish Division.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

London County Council.—On Tuesday loans of £9,187 to Hackney B.C., of £3,505 to Islington B.C., and of £5,840 to St. Pancras B.C. were sanctioned for electric supply extension purposes.

St. Anne's-on-the-Sea.—The Electricity Committee recommended the Council to acquire additional land for the extension of the electric supply works.

Wolverhampton.—A discussion arose at last week's Council meeting on the proposals of the Electricity Committee to put in additional plant at the electricity works.

Councillor HUGHES called attention to the large sums which were being asked for continually by the committee. The question was whether the large amount of plant being put down at the electricity works would be required in normal times.

Councillor THOMPSON said Wolverhampton was fortunate in having large companies which required enormous power. It was pretty well assured that after the war the demands for electric energy would be somewhere within the capacity of the power station.

GENERAL.

Beckenham.—The L.G. Board have intimated to the Council that they are unable to suspend during the war the repayment of electricity loans, and recommend as an alternative the raising of the price of electric current.

Birmingham.—The electric supply department is again troubled with breakdowns of machinery.

It is reported that a few days ago a turbine set at the Summer-lane station broke down and repairs were effected without a stoppage. On Monday night a turbine at the Nechells station also broke down and the result of the two mishaps, caused apparently by overloading, is that the department has now no spare plant.

It is believed the damage to the machine at Summer-lane may be repaired within a fortnight, but at least a month will elapse before the other turbine is again in working order.

Board of Trade Electric Power Committee.—In addition to those mentioned in previous issues the following municipalities have passed resolutions protesting against the inadequacy of the representation of municipal electricity undertakers on this committee :—

Canterbury, Carlisle, Dewsbury, Eastbourne, Exeter, Gt. Yarmouth, Grantham, Maidstone, South Shields, Weymouth and Woolwich.

Up to the present 65 local authorities have passed resolutions of protest. Twenty-eight have adopted the West Ham resolution and 35 have followed the lead of Bradford Corporation in asking that the I.M.E.A. should be consulted and also for increased representation on the committee.

Cheltenham.—The salary of the borough electrical engineer (Mr. W. J. Bache) has been increased from £450 to £550 per annum, with a further increase of £50 in two years' time.

It appeared that Mr. Bache had received an offer of an appointment in London at a commencing salary of £800 a year, and the increased salary is given to induce him to remain.

Coal for Steam Boilers.—The Controller of Coal Mines recently circulated a large number of forms asking for information regarding coal used by steam boiler owners.

Many of these have not yet been returned, and firms who have received such forms are requested to forward the particulars asked for to the Controller at once. Any firm or persons using coal for land boilers who have not yet received a copy of the form should apply to the Controller of Coal Mines, Box D.S.R., 8, Richmond-terrace, Whitehall, S.W. 1.

Dublin.—The method of collecting the accounts of the electric supply department was severely criticised at last week's meeting of the Corporation.

Mr. MORAN wished to put a stop to the payment of overtime.

Mr. P. T. DALY said the Electricity Committee ought to have the collection of their own accounts. At any rate, he objected to paying commission to men on accounts which they did not collect.

Ald. FARRELL said that an officer of the Council died recently and it was found that he owed several years' account for electric light.

Mr. O'NEILL said the widow of the officer referred to was paying in monthly instalments the amount due by him to the Corporation.

Dr. SHERLOCK said that if the gross turnover was considered it would compare favourably in the small percentage of bad debts with the best managed business in the city.

Other members agreed that the present system of collection of electricity accounts was not satisfactory and should be amended.

Increased Charges for Electrical Energy.—The charges for current at the following places are being increased :—

Shrewsbury Council is making its charges 33⅓ per cent. over pre-war rates, instead of the increase of 20 per cent. already in force.

Ealing Council has increased its charges to 8d. and 4d. for lighting on m.d. system, flat rate 6½d. (and graduated charges varying from 6d. to 2½d. per unit for large quantities), power 1½d., power, heating and cooking ½d., and supply through prepayment meters 6½d.

Marylebone (London).—The salaries of the chief assistant in the mains department (Mr. T. C. Bacon), the chief assistant to the secretary (Mr. W. Harper) and the meter superintendent (Mr. G. H. D. Evans) have been increased, while Mr. F. B. Leonard has been promoted to the position of station superintendent.

The wages of the employees, who are members of the National Amalgamated Union of Enginemen, Firemen, Mechanics, Motormen and Electrical Workers, have been increased by ½d. an hour all round. The clerical staff, women, boys and engineer's assistants are excluded and the cost of the increase will be £1,000 a year.

Mexborough.—The electrical engineer and manager of the electricity works (Mr. J. B. Feltham) has also been appointed waterworks engineer to the Urban Council.

Newport (Mon.).—The Electricity Committee has received a communication from a firm asking for certain information in connection with the establishment of new works for which a supply of electrical energy would be required.

It has been decided to carry out the tramway extension to the Alexandra Dock entrance by direct labour.

Stafford.—The salary of the electrical engineer and manager of the electricity works (Mr. Robins) has been increased from £200 to £250, rising by further instalments to £300 per annum.

Stepney (London).—On Wednesday the General Purposes Committee reported on the recent application by the Coal Controller for the loan of Mr. W. C. P. Tapper's services in dealing with the question of fuel economy at power stations, &c.

Mr. Tapper would be available for consultation on electrical matters connected with the Council's undertaking, and the Controller's Department would pay two-thirds of his salary. As the Electricity Supply Committee felt it would be the unanimous desire of the Council to allow Mr. Tapper to assist the Coal Controller, they had instructed the Town Clerk to intimate that, subject to the Council being able to call upon Mr. Tapper's services to such an extent as to ensure that the interests of their undertaking would not suffer, and to the understanding that, should unforeseen circumstances necessitate it, the arrangement could be terminated by a reasonable intimation, it would be the desire of the Council to permit Mr. Tapper to undertake the work in question.

The action of the Committee has been approved.

Tottenham.—The Fire Brigade Committee has reported that Messrs. Siemens Bros. & Co., from whom they had hitherto obtained batteries for fire alarms, &c., had intimated that they were unable to deliver any more batteries as their output had been commandeered. A supply had been obtained from another firm.

Winchester.—The Council has asked for authority to renew some of the worn-out negative plates of the storage battery at the electricity works.

Woolwich (London).—It was reported at the last meeting of the Council that, owing to the defalcations of a member of the Borough Treasurer's electricity department staff, a sum of about £500 was missing, but no exact figure could be given. A sum of £100 had been recovered on a fidelity guarantee.

The Council decided that when the exact amount had been ascertained it should be a charge on the general rate fund, and should not be a direct charge on the electricity undertaking.

LIGHTING AND INDUSTRIAL POWER.

Electricity in Tin Mines.—At the annual meeting of the Idris Hydraulic Tin (Ltd.) it was reported that the recent additions to the machinery completed their plant, and consisted chiefly of the duplication of the hydro-electric installation.

In a circular which was recently issued by the Porkellis Tin Mines (Ltd.) it is stated that the extension of the lease to 25 years from March 31 last (with the right of renewal for a further similar period) justifies certain developments set out in the circular, and it would, moreover, justify the installation of electric power, to be supplied by the Cornwall Electric Power Co., whose transmission line was only some four miles distant.

Hospital Ship Equipment.—The new Mesopotamian hospital ship which has been christened "The King's Ship" and is intended for use on the Tigris, is provided with electric lighting and power plant, electro-medical apparatus, &c.

The vessel is a complete floating hospital, with beds for 180 cot cases and accommodation for minor casualties, a fly-proof operating theatre with electric sterilising apparatus, lifts to enable serious cases to be moved from one deck to another, isolation rooms, &c. The system of ventilation is designed so as to keep the vessel cool in the maximum summer temperature and warm in the autumn and winter. For the summer, rotating electric fans have been fitted at an average of one to

Digitized by Google

every four beds, while currents of cool air are pumped through apertures in the various decks. There is a refrigerating chamber, with plants for making ice- and soda-water, distilling water, &c. The boat is oil-driven, but lighted throughout by electricity.

Textile Mill Electrification.—In reference to the article in our issue of May 18 on "Textile Mill Electrification," we are informed by Messrs. W. T. Glover & Co., of Trafford Park, Manchester, that all the cables for the installation were supplied by them.

ELECTRIC TRACTION.

Aberdeen.—Sheriff Mackenzie, K.C., has awarded that women conductors are to be paid on the same scale as men.

Birmingham.—The revised scale of tramway fares and stages came into operation on Monday.

The revision has been based on the principle of giving every passenger a ride of two miles for a penny. Many of the stages have been lengthened and none have been reduced. Only two special workmen's stages have been retained, and the return fares have been increased on all routes. It is expected that the rearrangement of the fares will amount to an increased revenue to the department of about £30,000 per annum.

Cardiff.—The Tramways and Electric Lighting Committee is considering the question of the abolition of transfer tickets.

There are 70 drivers and 121 conductors serving with the colours.

The engineer and manager (Mr. Arthur Ellis) reports that, owing to the enormous increase in the price of materials, the increase of wages and other causes, the Committee will be faced with a probable deficit this year. The revenue had increased, but not in the same ratio as the expenditure. Wheel tyres, for instance, which cost £350 before the war, now cost £1,500. The Committee was also paying £5,000 a year in allowances to employés with the colours.

A detailed report of the increased expenditure is to be prepared by Mr. Ellis before action is to be taken.

Edgware and Hampstead Railway.—The Board of Trade have extended by one year the times limited by their Acts and Orders in reference to this railway, for the construction of lines, purchase of lands, &c.

Glasgow.—As announced in our last issue, the tramway prize drawing scheme has been suspended, and the Corporation decided on Thursday last to take steps to secure authority from the Board of Trade, or other Government department, to carry on the drawing.

In the course of the discussion it appeared that the scheme had been initiated and carried out by the general manager of the tramways (Mr. J. Dalrymple), and large contributions had been handed over to various war relief funds. It was reported that the Lord Advocate has withdrawn his instructions to take proceedings against the tramways department, and ultimately (by 53 votes to 9) it was decided to take steps to obtain authority to carry on the drawing.

Metropolitan District Railway.—The Board of Trade has extended for one year from Aug. 15, 1917, the time limited for the purchase of lands and easements in Fulham and Whitechapel, authorised by the Metropolitan District Railway Act, 1913, to be acquired.

Sheffield.—The accounts of the tramways department (abstracted in another column) were adopted by the Corporation last week.

The Chairman (Sir Wm. Clegg) referred to the efficiency of the service during the last 12 months. They had been able to have an efficient and effective service, not only for the ordinary residents, but for those living outside who were coming and going to the works. The increased working expenses were £65,000, equal to 1d. per car-mile, but the increase in receipts was £69,000. The increase in the number of car-miles run was 794,286; energy was over £19,000 more, and they paid in income-tax £25,000. The average number of car rides taken per head of the population was 301—the largest of any Corporation or private tramway undertaking in the country, with the exception of Glasgow.

Southport.—The Corporation have appointed a valuer to report upon the present value of the Southport Tramway Co.'s undertaking, which they propose to purchase.

Stoke-on-Trent.—The proposal to renew the lease of the Potteries Electric Traction Co. until 1931 is being opposed by the Labour Party.

The subject stands adjourned to the meeting of the Council to be held on the 28th inst. Under the new agreement the company undertakes to carry out certain improvements in the permanent way and rolling stock, that it will not increase fares and that it will pay the Corporation £1,000 a year during the term of the lease. The North Staffordshire Trades and Labour Council is organising public meetings to protest against the renewal of the lease.

Tramway Workers' Wages.—The Committee on Production have decided, in connection with the application for a war bonus of 10s. a week made by the Amalgamated Association of Tramway Workers on behalf of employees in Lancashire and Cheshire, to grant an increase of 2s. 6d. a week on the war wages advance now being paid to made and female workers 18 years of age and over, and 1s. 3d. a week to those under 18.

The award has caused some dissatisfaction, and in Manchester and other towns fresh demands for 7s. 6d. a week have been formulated.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says the Provincial Government of Santa Fe is to issue Treasury notes equal to $330,821 (m/n) (about £29,000) in guarantee of the debt of the Santa Fe Municipality to Siemens-Schucker (Ltd.).

The Cia Italo-Argentina de Electricidad made a profit for 1916, after applying $271,677 (about £23,660) to amortisations of installations, of $246,650 (£21,448) and after provision of 5 per cent. for reserve fund and 5 per cent. for directors and syndic, $320,627 (£27,880) was carried forward. The generating plant (turbo-generators) at the Pedro Mendoza main power house now has a capacity of 18,750 k.v.a., and an order has been placed for another 12,500 k.v.a. turbo-generator, while another boiler will be provided during 1917. A 1,000 kw. converter was started at the Melo station in November. The company has 60 km. (37 miles) of h.t. and 1,077 km. (668 miles) of l.c. cable in use, besides 112 km. (69 miles) installed for third parties, and 30 km. (19 miles) of telephone cable. The units produced during the year were 16,670,000.

Imports into Argentina in 1916 were valued at£ 43,481,000 (compared with £45,378,000 in 1915).

The Director of the National Statistical Dept. states, however, that these are arbitrary values fixed by the Customs Valuation Tariff, and that the absolute values are £61,098,000 and £73,226,000 for 1915 and 1916 respectively. Of the total in 1916 the United Kingdom supplied 28 per cent. Imports of electrical goods were valued at £668,000 (against £751,000).

Berlin Electricity Works.—It is reported that the Allgemeine Elektricitäts Gesellschaft proposes to make a fresh issue of shares of 16,000,000 marks, which will be allotted to the Berliner Elektricitäts Werke as a payment for 2½ million marks of shares in the Golpa-Jessenitz Electrowerke and to repay a debt of the latter for advances of 20,000,000 marks made by the Berliner Co.

Brazil.—A British Chamber of Commerce has been formed in Brazil and the address of the Secretary is at 143, Rua da Quitanda, Rio de Janeiro.

Uruguay.—The "Journal" of the British Chamber of Commerce in Uruguay, contains suggestions to British manufacturers of hardware on the necessity of adapting their manufactures to Uruguayan and other South American needs.

It is suggested that tools, &c., should be packed in cardboard boxes, a practice adopted by German and American manufacturers, and that fully qualified men should be sent to study the markets. The majority of the Uruguayan dealers prefer British articles if obtainable, and German and other manufacturers know they can hold a considerable portion of the market by paying attention to patterns, packing and other details. In the majority of smaller hardware lines there is no need to cut prices to meet competition.

MISCELLANEOUS.

Dilution Proposals.—On Monday the Minister of Munitions (Dr. Addison) presided over a meeting of representatives of over 40 engineering, shipbuilding and kindred trade unions, and explained the proposed amendments to the Munitions of War Bill.

A statement by the Committee of the Engineering and Shipbuilding Trades was circulated among the representatives to the effect that the Bill as amended was in a form such as they could recommend. It also stated:—"In addition to safeguarding against the extension of the restrictive clauses of the Act, apart from dilution and the restoration of pre-war conditions, we have succeeded in maintaining the right to strike in such works, and in obtaining substantial amendments of the 1915-1916 Acts in their application to our members in all establishments, whether controlled or uncontrolled." The chief amendments secured are:

The total and entire abolition in all works of the leaving certificate.

The provision for restoring customs and rights which had been suspended under the Treasury Agreement prior to the Munitions of War Act.

The securing of the status and benefits (such as superannuation) due to our members who leave private employment (such as railway works) to take up munitions work elsewhere.

The extension of wages awarded by Statute to all the firms in the industry.

The right to prosecute employers in all establishments who neglect to restore any right or custom immediately on the declaration of peace, and the increase of penalties on employers in certain cases.

The taking away of the right of any employer to make any change whatever. (The change can only be made by the Minister of Munitions himself, and then only after the fullest opportunity for consultation with the men affected and their trade union representatives.)

The addition of a Schedule which now for the first time sets out the procedure to be adopted in all questions of differences, and which gives the fullest recognition to the men concerned and to the representatives of the trade union.

It is added that many other concessions have been obtained "which will do much to minimise the friction and delay in dealing with grievances and to restore confidence amongst the members whom we represent."

Digitized by Google

Dr. ADDISON said that, in addition to the outburst of special submarine activity, there was also an enormously augmented shipping programme—three times larger than the merchant shipping programme for 1916. That meant great additional demands for skilled labour in that class of work. Then there was the arming of merchant ships, the production of guns for the front, the repair of guns, railway transport, lorries, tanks, "spares," aeroplane engines and flying machines. The last straw was that they were now confronted with a demand for agricultural tractors, which had to be made for next winter's ploughing. The Ministry had examined all manner of expedients for meeting the abnormal demand, and had come to the conclusion that without killing the industries of the country which were so essential to its ordinary life, they must have a system, surrounded with all reasonable safeguards, which would enable them to draw such skilled men as could be spared from commercial and non-essential work to assist in dealing with that greatly augmented munitions programme.

Dye Controller.—In order to promote the further development of the dye-making industry the President of the Board of Trade has established a special temporary department of the Board to deal with matters relating to the encouragement, organisation and (so far as necessary) the regulation of that industry.

The department will be under the direction of Sir Evan Jones as Commissioner for Dyes. Communications on the subject should be addressed to Commissioner for Dyes, Board of Trade, 7, Whitehall-gardens, London, S.W. 1.

Forthcoming Book.—A treatise on gyrostatics and rotational motion, by Prof. A. Gray, F.R.S., is in the press, and will be published by Messrs. Macmillan & Co. as soon as possible.

Secret Wireless Apparatus.—At Hants Assizes on Monday Reg. H. Cole, dockyard draughtsman, pleaded guilty to having in his possession without permission wireless telegraph apparatus at Portsmouth capable of receiving messages nearly 400 miles.

It was not suggested that Cole had any wrong intention; he was keen about wireless telegraphy and he bore the highest character. He was bound over to come up for judgment when called upon.

Tribunal Cases.—At Eastbourne last week the local tribunal was asked to review the conditional certificates held by 12 employees of military age at the municipal electricity works.

The list included the mains engineer, three charge engineers, two electricians, two engine drivers, two stokers and two fitters. The Electricity and Street Lighting Committee claimed the men on the grounds that they were in a certified occupation, that the staff had been reduced to the lowest possible point and that they were supplying electrical energy for important public purposes. The Ministry of Munitions had been applied to for a certificate, but no definite reply had been received.

The Borough electrical engineer (Mr. J. K. Brydges) said the stokers had to adjust and look after their machines, and they also had to attend to the steam pumps. They had to perform strenuous and trying work which had to be taken in eight-hour shifts. Before the war the staff numbered 42; 14 had joined the Colours and the present total was 36. That was, in his opinion, the least he could do with. He could not understand why electric light hands should be taken and not the gas stokers. Gas undertakings were protected from one end to the other.

The Tribunal adjourned the case until a reply had been received from the Ministry of Munitions. Up to the time of going to press no reply had been received from the Ministry.

Unemployment Insurance.—The umpire has decided that contributions are payable by workmen engaged wholly or mainly in the manufacture of electric condensers.

EDUCATIONAL.

City and Guilds' Institute.—At the recent annual meeting the Earl of Halsbury, who presided, said that the continuance of the war ad still further reduced the number of students.

The entry of candidates under military age had not been materially affected, except where classes had been suspended by the enlistment of teachers or older students. The need for technical training was increasing in many directions. That was specially so in regard to manufactures concerned more particularly with chemical science. While the educational work had necessarily been curtailed, a large amount of technical work had been carried on—particularly in connection with munitions, and the investigation of engineering and chemical problems. The fact that the Institute had been able to give great assistance to the Government was an additional proof of its usefulness. He was glad to see that the Council approached the questions of the future with an open mind, instead of framing a hard and fast scheme all at once. After the introduction of so many women into commercial life, and in view of the fact that after the war many men would change their old occupations, he thought a tremendous work of usefulness lay before the Institute.

The report was adopted, and the Council re-elected.

Engineering Scholarships.—The Glasgow School Board have accepted the offer by Messrs. Barr & Stroud to institute scholarships for engineering apprentices.

The headmasters have been requested to bring the offer under the notice of their scholars, who, after consultation with their parents, should communicate with Messrs. Barr & Stroud.

TENDERS INVITED AND ACCEPTED.

Water-cooling Towers and Motor-driven Pumps.

WOLVERHAMPTON Corporation require tenders by 10 a.m. June 30 for supply and erection of water-cooling towers and motor-driven pumps at the electricity works. Specification from the Engineer and Manager.

Water-tube Boiler, Superheater, Economiser, &c.

ERITH Council require tenders by noon June 23 for supply and erection of water-tube boiler, with superheater, economiser, automatic stoker, steam valves, pipe, &c. Specifications from the Engineer and Manager.

Boiler-House Plant and E.H.T. Switchgear.

GLASGOW Corporation invite tenders for the supply of boiler-house plant and extra-high-tension switchgear (2,000 volts). Specifications and forms of tender from the engineer, Mr. W. W. Lackie, 75, Waterloo-street, Glasgow. Tenders to the town clerk, Sir John Lindsay, City Chambers, Glasgow.

Induced Draught Plant, Fuel Economiser Extensions, &c.

NEWPORT (Mon) Corporation invite tenders for induced draught plant; additions and extensions to fuel economisers; and cooling towers. Forms of tender from Mr. A. Nichols Moore, M.I.E.E., borough electrical and tramways engineer. Tenders to the town clerk, Mr. Albert A. Newman, by 10 a.m. June 30.

Electrical and General Stores.

TOXTETH PARK Guardians require tenders by noon June 25 for three months' electrical and engineers' supplies, ironmongery, &c. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

Tenders are invited for the supply of electrical appliances, oils, belting, &c., to Devon County Lunatic Asylum, EXMINSTER. Forms of tender from the Clerk. Tenders to Mr. E. B. Harbottle, County-chambers, Queen-street, Exeter, by June 23.

G.P.O.—The General Electric Co. (Ltd.) have again secured the General Post Office contract for Osram lamps until March, 1918.

SHEFFIELD.—The Council has accepted the tender of A. Reyrolle & Co., Ltd., for 25 transformer protection sets.

MARYLEBONE (LONDON).—The Electric Supply Committee recommend the acceptance of the offer of the British Westinghouse Elec. & Mfg. Co. for two sets of air pump motors, at £329; and that of Edison Accumulators (Ltd.) for a special battery for an electric vehicle, at £216 (with the right to exchange it for another type of battery made by the same company for a further £24).

STEPNEY (LONDON).—The contract with the Reason Mfg. Co. has been renewed for another 12 months upon the basis of increase of 10 per cent. for meters and 5 per cent. for demand indicators, and that of the Venner Time Switches at an increase of 10 per cent.

An order has been placed with the British Thomson-Houston Co. for three earthing switches, at £18. 10s.

CARDIFF.—The following tenders have been accepted for supplies to the electricity department:—

A. Reyrolle & Co. (£222. 8s.) and British Thomson-Houston Co. (£362 and £379) for switchgear, and British Electric Transformer Co. for a transformer (£285).

REDDITCH.—The Council have placed an order with the Brush Co. for the supply of four transformers.

WOOLWICH.—The Council has accepted the tender of Bruce Peebles & Co., at £3,825, for a motor converter.

APPOINTMENTS VACANT AND FILLED.

The Government of the Union of South Africa require an industrial adviser to the Industries Section of the Department of Mines and Industries. Salary, £2,000. Applications to the High Commissioner, 32, Victoria-street, London, S.W. 1, by July 31.

Switchboard attendants are wanted for a generating station in the Manchester district. *See advertisement.*

Redditch Urban Council advertise for two stokers for their electricity works.

Salford Corporation invite applications for the positions of assistant to station superintendent (salary £200) and secretary to the borough electrical engineer (salary £200). Applications to borough electrical engineer, Mr. J. A. Robertson, by 10 a.m. June 23.

Mr. Theodore E. Thomas has been appointed development superintendent in the traffic branch of the L.C.C. tramways dept., at £800 per annum. There were 38 applications, and nine candidates were interviewed by the Highways Committee.

Digitized by Google

Mr. F. B. Leonard, who has been acting as station superintendent during Mr. T. K. Richardson's absence on sick leave, has been appointed station superintendent at Marylebone, at £400 per annum.

Dewsbury Council have placed Mr. W. W. Firth, mains superintendent, on the permanent staff of the electricity department at £135 per annum.

Mr. Baldwin, of Bournemouth, has been appointed manager of the Exeter electric tramways, in succession to Mr. E. C. Bartlett, at £300 per annum.

BUSINESS ITEMS.

Mr. J. S. Highfield, consulting engineer, has removed his office to 36, Victoria-street, S.W. 1. He continues his connection with the Metropolitan Electric Supply Co. (Ltd.), as consulting engineer.

Messrs. Couzens & Brown, consulting engineers, are removing to 9, Old Queen-street, Queen Anne's-gate, Westminster, S.W. 1. The telegraphic address (Consonance Vic. London) and the telephone number (Victoria 5,029) remain the same as hitherto.

Messrs. Taylor, Tunnicliff & Co. (Ltd.) have removed their London offices to 110, Cannon-street, E.C. 4 (temporary telephone number, City 8,693).

John Yule and Thos. E. Nankwell (trading as J. Yule & Co.), hardware and electrical stores, 613, Manchester-road, Poplar, London, E.14, have dissolved partnership. Debts by John Yule, who continues the business.

Sale of Shares by Tender.—The Public Trustee also offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of July 12. *Further particulars are set out in an advertisement.*

Plant for Sale.—Oldham Corporation Electricity Committee advertise for sale two Willans-Siemens 740 kw. sets, shunt-wound 450-480 volts. Particulars from Mr. F. L. Ogden, joint engineer and manager.

Shoreditch (London) Borough Council advertise for sale a marine type slow speed Corliss valve engine, coupled direct to an 800 kw. a.c. generator.

The Ministry of Munitions has for disposal two Willans-Siemens generating sets, a Highfield reversible booster, &c.

British Made Magnetos.—Messrs. Vickers (Ltd.) have purchased from the Controller the goodwill, stock-in-trade, &c., of the Bosch Magneto Co.

A new subsidiary company, under the title of the British Lighting & Ignition Co. (Ltd.) has been formed for manufacturing in England magnetos of the highest grade. The name chosen for the magnetos is "B.L.I.C.," from the initials of the company. The works of the new company are in full working order, and hundreds of magnetos are being turned out weekly to meet the requirements of the authorities. Preparations are also being made to cope with the demand after the war. The offices and showrooms are at 204, Tottenham Court-road, London, W.1.

Fire.—The recent fire at the works of the Morgan Crucible Co. (Ltd.), at Battersea, which caused slight damage to an isolated building of the crucible factory, will only affect the delivery of a few special sizes of crucibles for a few weeks; the production and delivery of Morganite and Battersea carbon brushes are in no way affected.

BANKRUPTCIES, LIQUIDATIONS, &c.

The public examination of G. T. Harrap, consulting engineer, 5, Budge-row, London, E.C., was held on the 8th inst. The liabilities were put at £718. 14s. 7d.; assets nil.

An application for the discharge of Fredk. Brown, electrician (formerly a partner in the firm of Hugh Bros. & Brown), 8, Stafford-street, Llanelly, will be heard on July 6 at the Guildhall, Carmarthen.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Glasgow.—The receipts of the tramways department for the year ended May were £1,200,115, and the expenditure was £838,000.

The surplus was £422,000, out of which £160,984 will be handed over to the Common Good. The war bonuses and payments to dependents amounted to £92,000. The car-miles run were 25,786,047, an increase of 822 738. The traffic receipts per car-mile were 11·592d. (increase 0·543d.), passengers carried were 388,294,876 (increase 25,923,412), and passengers carried per car-mile 15·059 (increase 0·543). Of the passengers carried the half-penny fares represented 247,971,348 and the penny fares 100,118,754.

Grimsby.—The accounts of the electricity department for the year ended March 31, 1917, show gross capital expenditure £136,899 (increase £509), of which £75,416 is outstanding.

Revenue was £26,951 (compared with £22,144 in previous year), working and general expenses were £16,164 (£12,248), leaving gross profit £10,741 (£9,805). Capital charges were £7,955 (£7,954), and net profit was £2,787 (£1,851). The average revenue per unit was 1·95d. (1·88d.), and costs were 1·228d. (1·104d.). Units generated were 4,149,192 (3,645,213) and sold 3,154,158 (2,641,496), maximum load was 1,616 kw. (1,647 kw.), and the equivalent of 183,712 (176,476) 8 c.p. lamps is connected for private supply.

Mr. A. S. Channon, deputy electrical engineer, who reports that 1,539,382 (1,075,313) units were sold for power, and that 445 (426) motors of 2,629 H.P. (2,591 H.P.) are in use, recommends that the net surplus be placed to reserve, as was done with last year's balance. The year's capital expenditure (£509) was met out of revenue. Coal prices have increased 75 per cent., but cost of generation only 44 per cent. The cost of generation increased by £3,334, but coal consumed per unit was less than in any previous year, due to improvement in the day-load and to the use of a higher grade coal. Charges for energy were advanced as from March 31, 1916, and the revenue derived from this has balanced very closely the increased costs. The saving in current for lighting in the two summer quarters, due to the application of the "Summer Time Act," was 20 per cent., by which lighting consumers saved about £500. The increase in units for heating and cooking was 57 per cent., and additional heaters and cookers connected are equal to 205 kw. (compared with 57 kw. added in the previous year). A new development of the business has taken place by the introduction of electric vehicles. There are now six in use, and a rapid increase in the number is expected.

Leeds.—The report of the manager of the electricity department and the revenue account (an abstract of which was given in our issue of May 25) were submitted to the Electricity Committee on Monday.

The units sold were 54,992,742 (increase 22·78 per cent.), including power 40,143,880 (increase 46·59 per cent.), private lighting 6,264,784 (increase 1·87 per cent.), street lighting 76,748 (decrease 73·07 per cent.), heating 951,358 (increase 41·18 per cent.), traction 7,010,868 (decrease 29·66 per cent.) and residential bulk supplies 545,104 (increase 66·05 per cent.). The small increase in consumers (from 14,729 to 15,315) was due to Government restrictions as to cable laying. An increase of 10 per cent. in charges came into effect on April 1, 1916. Revenue increased 29·2 per cent., working expenses 45·7 per cent. Working expenses were 0·48d. per unit sold (against 0·4d.), taxes and war allowances were 0·02d. and capital charges 0·48d. (0·49d.). The profit was £17,286 (increase £196), out of which £13,125 has been contributed for permanent works, leaving £4,161 against (£8,716). Maximum load was 22,255 kw. (16,700 kw.). Towards the end of 1916 a new 6,000 kw. alternator was put into use, making the total capacity of the generating plant 32,600 kw. Gross capital expenditure is £1,662,987 (increase £139,345) and net debt is £1,046,976.

Sheffield.—The gross capital expenditure of the tramways department at March 25 was £1,216,366. The total amount of the sinking fund is £494,038, and the amount of sinking fund applied in reduction of debt is £375,604.

Revenue was £525,685 (against £455,608 in previous year), working expenses were £335,765 (£270,939), war allowances required £11,848 (£11,209), income tax £24,849 (£13,861), and interest and sinking fund £64,742 (£63,818), the net balance being £88,478 (£95,779). After placing £34,698 (£30,115) to renewals fund, £2,000 (£2,000) to special purposes fund and £1,179 (£8,049) to surplus fund, and contributing £1,174 (£601) for capital outlay, £8,381 (£8,158) for proportion of service of debt for improvements, and £946 for special expenditure on improvements, there remained £40,097 (£41,855) to devote to relief of rates. Average total revenue per car-mile was 13·058d. (12·33d.), and working expenses, including power, were 8·34d. (7·33d.). Passengers carried were 142,551,547 (123,429,410), car-miles run 9,662,012 (8,867,726) and units used 22,819,683 (19,566,818).

The total revenue of the motor omnibus section was £34,966, working expenses and war allowances absorbed £29,034, and war allowances £443 (£398), leaving gross profit £5,932. After meeting capital and other charges the net balance was £3,807.

Sunderland.—The accounts of the electricity supply department for the year ended March 31 show gross capital expenditure £494,069

Digitized by Google

(increase £3,042), of which £223,913 has been repaid and £19,438 of sinking fund remains unapplied.

Revenue was £78,291 (compared with £71,103 in previous year), working and general expenses were £48,821 (£40,467), leaving gross profit £29,470 (£30,636). Interest required £12,917 (£11,111) and sinking fund £17,421 (£17,726), and renewals and special expenditure £1,157 (£767), net result being a deficit of £2,025 (compared with a surplus of £1,032). Works costs per unit sold were 0·57d. (0·48d.), standing costs 0·13d. (0·12d.), interest and sinking fund 0·46d. (0·45d.), special expenditure 0·02d. (0·02d.) and attending public lamps 0·01d. (0·01d.), a total of 1·19d. (1·08d.). Units sold were 15,614,383 (15,056,376). Maximum load was 6,700 kw. (5,495 kw.) and load factor 26·53 (31·2) per cent. There are 1,757 (1,741) consumers connected.

Mr. A. S. Blackman, borough electrical engineer and general manager, reports that power supplies increased 3·95 per cent., traction 6·73 per cent. and on the low tension network there were an increase in sales of current for motors of 10·24 per cent. and decreases of 1·32 per cent. for lighting and heating, and 89·34 per cent. for public lighting. Compared with 1914 the following increases in costs were shown :—15 per cent. depreciation in quality of coal £3,145, increase in wages £1,283, additional income tax and insurance £2,456; total £6,884. A credit balance of £3,100 is expected for current year's working under existing tariffs, contingent upon maintenance of quality of coal received during the last few weeks and the initiation of a coal bonus to employees most concerned and upon there being no further general increase and no serious mishap to plant. Mr. Blackman suggests that 15 men should share in the coal bonus and that £100 be divided equally between them, provided the coal used per unit sold be not more than 3·25 lb., with a further £100 for a further reduction of $\frac{1}{16}$lb. During the year a 7,500 kw. turbo-generator was ordered from Messrs. Willans & Robinson.

COMPANIES' MEETINGS AND REPORTS.

United River Plate Telephone Co. (Ltd.)

The thirty-first annual ordinary general meeting was held last week, Sir John Gavey, C.B., the chairman, presiding.

The SECRETARY (Mr. A. H. Dawborn) having read the notice convening the meeting,

The CHAIRMAN, after a feeling reference to the deaths of Sir Geo. Franklin and Mr. Geo. Keith, said that the board had elected to the casual vacancies which had arisen Mr. J. E. Kingsbury and Mr. Albert Anns, two gentlemen who had the widest possible experience of telephony in its various branches. You will, I think, all agree that the accounts presented for the year ended Dec. 31, 1916, are extremely satisfactory, notwithstanding the very difficult times through which we have been passing. Our rate of progress, as measured by subscribers' stations, shows a distinct improvement over 1915, the figures being 3,986 for 1916, as against 2,714 for the previous year, making the total number of stations connected to our system 60,568. We have not, of course, reached the annual rate of increase which we had attained before the war commenced (6,466 for 1913), but when you consider all the circumstances the progress made must be considered as satisfactory. You will see from the profit and loss account that the gross earnings for the year amounted to £709,226, compared with £641 581 in 1915; that maintenance and other expenses of management in the Argentine and London have absorbed £477,370, compared with £447,810; and that the net profit for the year before deducting debenture interest, is £231,855, compared with £193,771 in the preceding year. Included in the expenses is the usual provision for the renewal of plant, which item for the year amounts to £145,624. The London expenses (including income-tax) have amounted to £44,412, as compared with £37,802. The balance-sheet items are in the customary form, and again reflect the conditions under which we are working. Expenditure on plant, £87,627, compares with £121,646 in 1915—a decrease of £34,019, due to the difficulty of obtaining materials, which has prevented much work from being carried out. The expenditure on real estate, £7,978, compares with £5,476 in 1915, and is principally in respect of a new exchange building we have had to erect at Belgrano, in Buenos Aires. Securities, £48,615, show a reduction of £60,140, compared with 1915, due to the sale of most of our investments. As you are aware, all gilt-edged stocks have depreciated very considerably during the past three years, and your board came to the conclusion that the best policy would be to realise, as everything seemed to indicate that values would still further depreciate. We consequently sold, and I am glad to say that our policy has been justified, as to-day prices are considerably below those we obtained, the difference between the latter and the original cost having been written off to the securities depreciation reserve formed in the previous year. Further, our money is liquid, and is earning more in interest than the old investments. Stocks of materials, £115,534, show a reduction from the previous year of £15,588, due largely to circumstances making it necessary for us to draw on our stocks to a greater extent than usual, combined with the difficulty of replacement. Bills and cash, £322,063, show a position which is very satisfactory, as it gives us liquid resources available for development as and when occasion arises. Since the beginning of the year many of the bills have matured and the proceeds have been invested in the 5 per cent. War Loan, our application being for £100,000. (Cheers.) On the liability side of the balance-sheet there is little to comment upon. The reserve fund, with the appropriation now recommended, amounts to £386,138, and the reserve for renewal of plant to £717,971. These funds put the company in a very strong position. Such a position is very necessary in these troublous times, when replacement and development work has had to be largely postponed until happier days. The appropriation statement shows the final dividend of 5s. per share, free of income-tax, £81,000; staff provident fund, £2,000; reserve fund account, £50,000; reserve (war contingencies) fund, £26,000; balance to be carried forward, £6,989. Our capital expenditure during 1916 is appreciably less than in the previous year, a large amount of work having to be held over owing to the non-arrival of material, and some even may not be in our hands this year. Our trunk line system giving connection to the city of Buenos Aires remains as at the outbreak of the war. Small exchanges have been opened at Bernal, Ituzaingo, Castelli, Fisherton and Dionisia, and the common battery switchboard installation in the la Plata exchange has been brought into service with good results. A considerable amount of underground plant has been laid in Buenos Aires, as well as in Mar del Plata, the Argentine Brighton, and we have also completed an aerial cable scheme in Rio Cuarto, an important town in the province of Cordoba, which has greatly improved the service. In Buenos Aires only two exchanges remain to be converted to the common battery system. For one of these (Belgrano) the new building is now practically completed, the switchboard is in course of manufacture, and we hope early next year, if all goes well, to have the exchange working. For the other and last exchange (Barracas) we have recently purchased a site for the new building at a favourable price, but it will not be possible to proceed with the manufacture of the switchboard until after the war. When these are completed the city of Buenos Aires will be wholly provided with telephone plant equal in efficiency to that of any other great city in the world, but, of course, the general development to meet the anticipated growth of subscribers that would have taken place in normal conditions has been arrested. Careful surveys made in Buenos Aires in the years 1912-13 and fully studied by the board in personal communication with the general manager, the engineer-in-chief and the consulting engineers, had shown the need for at least three large additional exchanges to meet the anticipated requirements between the years 1918-22, and the site for one had been actually purchased when the war broke out. Owing to the lack of materials the proposals originally agreed to have had to be deferred, due to the fact that subsequently to the year 1914 manufacturers of the plant we use became increasingly and, finally, wholly engaged on war work, so that great difficulty was experienced in obtaining stores even for maintenance and renewal purposes. Fortunately, the ample provision made for growth in the shape of spare plant, which must always be provided in a progressive telephone service, has enabled the company to meet the increase of subscribers up to now, although, should the war last for a considerable period, much difficulty may be experienced later. The chairman gave some particulars of the commercial conditions in the Argentine, and said he thought, considering the facts, the results shown by the company's accounts were quite good. As to the future, it was generally unwise to prophesy, but, so far, the results for the current year promised to be as good as those before them Sir John Gavey paid a tribute to the good work done by the local committee in Argentina and by the general manager and staff. The war had made a sad inroad into the numbers of their London staff, which were now reduced to Mr. Dawborn, two men and two women clerks. He could speak personally on the untiring energy with which, under Mr. Dawborn's able direction, they had carried out their duties. Two of the members of their staff who left to join the Army had been awarded the Military Cross—namely, Lieut. W. G. T. Pope (from Buenos Aires) and Second-Lieut. R. E. Petley (from the London office).

Sir FREDK. GREEN seconded the resolution which, after a brief discussion, was unanimously adopted.

The CHAIRMAN, in answer to a question, stated that the automatic service fully answered the expectations of the directors, and, what was still more important, the inhabitants of Cordoba and Rosario, from all he could hear, were thoroughly satisfied with the working of the system.

The retiring directors (Major Eustace Quilter and Mr. Albert Anns) and the auditors (Messrs. Walton and Bond) were then re-elected.

The proceedings terminated with cordial votes of thanks to the local committee, the general manager and staff in the Argentine, and the staff in London, and to the chairman and directors.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—The gross income for 1916 was £93,578 (against £81,923 for previous year), of which operating management and general charges absorbed £59,252 (against £51,577). The gross profit was £31,598 (against £27,886). After payment of income tax, providing for debenture interest and sinking fund, &c., writing £2,500 off value of investments and adding £10,000 to renewals fund, the amount available (including £4,409 brought forward) is £15,838. In November an interim dividend of 3 per cent. was paid, and the directors now recommend a further dividend of 3 per cent. (less tax), making a total distribution of 6 per cent. for the year, and leaving £6,838 to be carried forward. The profit was adversely affected by a further fall in the value of the Portuguese currency, the actual loss on remittances being about £16,000, an increase of £6,000 over previous year. In view of the continued expansion of the business and in anticipation of the time when Treasury sanction may be obtained for a new issue, it is considered desirable to authorise an increase in the capital to £200,000.

At the meeting last week the chairman (Mr. Herbert Allen) said that the managing director (Mr. Kerr) had been compelled to go to Lisbon on business of the company. In 1916 they did a record business; they added a larger number of subscribers than in any previous year; they passed a record number of messages and they had a record income and profit. Their gross income was £11,655 more than in 1915 and the net

Digitized by Google

profit had increased by £2,493. They were paying a 6 per cent. dividend (against 8 per cent.) but they were carrying forward £2,430 more than in 1915. The directors thought it would be well to be on the safe side and to husband their cash resources; that was the principal reason for recommending a curtailment in the dividend. Last year they lost over £16,000 on their remittances, the exchange averaging only 34 3/16d. per escudo. Every penny rise in the exchange on London meant a loss of about £1,000 to the company. They were continually incurring fresh capital expenditure; last year it was £15,000, in 1915 £12,000 and in 1914 £27,000. He saw no reason to suppose that the expenditure would be less in the future. The continuous expansion in their business was sufficient testimony to the efficiency of their service. Apart from the automatic element he believed there was no more up-to-date telephone system in the world than that at Lisbon, and but for the temporary obstacles to raising new capital they would now be bringing their Oporto system up to date. However, the building of a new exchange in that city was the next important capital work they would undertake, and that would no doubt be followed by a third exchange at Lisbon, although it was only three years since they opened the second one there with an ultimate capacity of 6,000 lines.

ARROL-JOHNSTON (LTD.)—The profit for 1916, after making provision for taxation, depreciation, debenture stock interest, &c., and after deducting interim dividend, is £16,846, making, with £20,485 brought forward, £37,331. The directors recommend a final dividend of 10 per cent. (tax free), £23,099 being carried forward.

BARNSLEY & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The accounts for 1916 show an available sum, after providing for debenture and loan interest, setting £4,500 aside to renewals fund and including £166 brought forward of £4,678. After placing £1,143 to reserve a dividend of 6 per cent. was declared, compared with 5 per cent. for the previous 12 months, leaving £1,014 to be carried forward.

CALCUTTA TRAMWAYS CO. (LTD.)—Sir Henry Kimber, Bart., who presided over the recent meeting, explained that the greater part of the past year's capital expenditure (£7,405) was spent in purchasing land for the extension of the upper circular road car shed, and the balance of the cost of five new motor-cars. The receipts amounted to £238,546, an increase of 6 per cent. over those of 1915. The freight, the commerce and trades of Calcutta were not affected to any great extent, the principal industries of jute, tea and coal having done exceptionally well. The total revenue for the year was £241,124. Indian working expenses increased by £2,484, but power expenses showed a decrease of £1,488, due to the operation of the new generating and sub-station plant; traffic expenses were £842 more owing to the increased mileage run and maintenance and repairs an increase of £3,708, due to the enhanced cost of materials. With the London expenditure, the total working expenses were £120,512, leaving a gross balance of £120,612. Deducting charges for debenture, preference and loan interest and income-tax, the available balance was £77,602, and they proposed to pay a final dividend of 6s. 6d. per share (making 9½ per cent. for year), to transfer £20,000 and £2,000 to reserve funds for general depreciation and for depreciation of investments respectively, and to carry forward the balance (£9,595), subject to excess profits duty. As there seems to be a general desire by shareholders that the company should revert to the practice of paying the dividend on the ordinary shares free of tax, it was proposed to do so after payment of the final dividend.

CHINA & JAPAN TELEPHONE & ELECTRIC CO.—The net revenue for 1916 shows, after providing for excess profits duty and including £20,658 brought down, £35,698, out of which a dividend of 10 per cent. (tax free) has been declared, and £26,736 has been transferred to reserve, leaving £3,938 to be carried forward.

CITY OF SAO PAULO IMPROVEMENTS & FREEHOLD LAND CO.—In their report for 1916 the directors state that considerable progress has been made with the installation of the electric light, gas and water power services in the Garden City Estate, Villa America.

LIMA LIGHT POWER & TRAMWAY CO.—The accounts for 1916 show a profit of £p.194,873, against £p.183,715. The net profit was £p.128,799, against £p.101,318. The board has made the following deductions: Dividends distributed on share capital £p.26,997; transferred to general amortisation fund, £p.40,000; reserves for bad and doubtful debts, £p.15,000; cost of new works and extraordinary repairs, £p.25,000; leaving £p.93,742 to carry forward, against £p.80,396.

LISBON ELECTRIC TRAMWAYS (LTD.)—Mr. L. Breitmeyer stated at the recent meeting that their difficulties had been accentuated during 1916. The only gratifying feature was the expansion of the traffic revenue. The number of passengers carried was 76,620,194, earning Es.2,324,655$58,5, against 67,101,249 passengers and Es.2,022,142 $93,5, an increase on the preceding year of 9,518,945 passengers and of Es.302,512$65, or approximately £24,000. Unfortunately, that appreciable increase had been swallowed up entirely by the expenditure, which had grown at a more rapid rate than their income, the working costs having exceeded those of the preceding year by no less than £36,000. Those conditions were quite beyond their control and were due to the greatly enhanced cost of coal and all other supplies, and also to the advance of wages all round. In normal times rails which cost about £6 per ton were now five times as much. Rails could be economised, and one need not build new lines, but it was a different matter with coal. The price of coal delivered in their power house was from 21s. to 22s. per ton in pre-war times, against £6 10s. per ton about a month ago, and at present coal was not procurable under £10 per ton, and that with difficulty if at all. In other words, the dividend was evaporating in the smoke stack. The instability of the Portuguese exchange, which averaged only 33·73d., against 35·97d. in 1915, militiated further against them. In consequence of all those adverse factors, the working profit showed a falling off over the previous year of £15,033 10s. 8d. out of the available balance of £59,756 17s. 3d. The usual preference dividend had been paid and £25,000 had been transferred to depreciation reserve, the balance of £9,223 13s. 7d. having been carried forward. The schedule of fares (except season tickets) was governed by their concession, and, short of raising the tariff, there were no other means of counterbalancing the abnormal high working costs. For the two years since the outbreak of war the company struggled on and continued its excellent service at the old fares, but in June last year the management felt itself compelled to raise the price of season tickets from 50 to 60 escudos. That perfectly legitimate step met with a stormy protest by the municipality, and even the public were incited against them without any justification whatever. Under the interference and earnest solicitations of the Government, and for the sake of preserving peace, they agreed to drop that advance for the time being. But they did not intend to sit still under that injustice.

LONDON & SUBURBAN TRACTION CO. (LTD.)—Lord Stewart of Wortley, who presided over the meeting last week, said that the gross tramway receipts of their subsidiary companies had all gone up during the war, but the omnibus receipts had all shown a decrease. The gross receipts were £1,306,335, against £1,303,912, and they had carried 254,968,619 passengers compared with 246,831,117 in 1914. The rise in expenditure had more than swallowed up the increased receipts, owing to the bonus paid to the employees and the rise in the price of all materials. The conditions due to the war had seriously affected the prosperity of their companies, but it was doubtful whether, even if there had been no war, the expectations of the net revenue derivable from the London United Tramways could have been realised. The cost of the maintenance and repair of the permanent way and rolling stock had been greater than expected and the elimination of competition had not been carried out to the extent hoped for. Discussions between themselves and the Underground Electric Railways Co., with a view to the improved co-ordination of the traffic facilities in Greater London, would probably lead to a better understanding and would result in increased profits. The unfortunate results of the past year's working of the London United lines, were entirely due to the increased cost of working owing to the war. The abnormal increase in the cost of operating their various enterprises had caused the Board to devote their efforts to increasing, wherever possible, the price of those commodities which they sold to the public, and in the case of the tramways they were considering proposals for a general increase of fares.

LONDON UNITED TRAMWAYS (LTD.)—The chairman (Mr. W. M. Acworth) explained at the meeting last week that owing to the increased cost of materials and labour the result of the past year's working was an adverse balance of £2,583, which would be carried forward, and it was evident that the net results of the current year's operation would be even less favourable. In the circumstances proceedings had been taken for the appointment of a receiver for the debenture stockholders.

A committee of the debenture holders of the company was appointed last week in order to investigate the company's affairs. The committee consists of Messrs. D. A. Bevan, R. H. Benson, J. C. L. Coward, M. W. Mattinson and A. G. Scott, and it will report at a meeting of the debenture holders on July 25. Lord Revelstoke, who presided over the debenture holders' meeting, explained that a receiver only, and not a receiver and manager, had been appointed and the appointment of a committee was, therefore, advisable to protect their interests. The concern was much over capitalised. Its gross receipts last year were less than 10 per cent. of the capital employed and the shareholders must resign themselves to a drastic cutting down of the nominal value of their investments before the company was placed in a position to earn dividends. The debenture holders had approved of the arrangement with the London County Council for the sale of the company's lines in Hammersmith under which the company would receive about £245,000 12 months after the war.

NEW GENERAL TRACTION CO. (LTD.)—The revenue for year ended March 31 £10,649; with £7,901 brought forward, the available total is £18,550. The directors recommend a dividend of 4 per cent. (less tax), and carry forward £8,070. The Norwich Electric Tramways Co. paid a dividend of 3 per cent., being same rate as for the previous year. The Douglas Southern Electric Tramways system is still closed down on account of the war. The income received from the Darby, Media & Chester Street Railway Co. (Philadelphia) amounted to £14,063.

PETERBOROUGH ELECTRIC TRACTION CO. (LTD.)—The accounts for 1916 show that, after providing £3,304 for repairs and maintenance, £1,950 for renewals and paying the dividend on the preference shares for year ended March 31, 1912, the credit balance of £422 brought down was increased to £742 which has been carried forward.

RANGOON ELECTRIC TRAMWAYS & SUPPLY CO. (LTD).—The gross profits for 1916 were £65,829, which with transfer fees and interest on deposits, &c., made £68,653. Deducting interest on debentures, depreciation, income-tax, &c., the net profit was £22,199, which, with amount brought forward, makes £24,983. After deducting preference dividend to Dec. 31 last the balance is £9,983. The directors recommend a dividend on the ordinary shares of 4 per cent. for the year (tax free), which will leave £2,903 to be carried forward.

RICHARDSONS, WESTGARTH & CO. (LTD.)—The accounts for 1916 show after an expenditure of £37,198 in maintaining buildings and fixed and loose plant a profit has been made of £119,377. After providing for

Digitized by Google

interest on the 4½ per cent. perpetual debenture stock on the year (£15,750), directors' fees (£1,700), depreciation (£35,000), and £16,701 being portion of capital expenditure in 1916 (excess over pre-war cost) written off, the credit balance is £50,227, and with £4,058 brought forward from 1915 the available total is £54,284. In order to meet the great demands made on the manufacturing capacity of the company, considerable capital expenditure has been necessary during the year. The wear and tear on the entire plant has also been so excessive that the directors are very strongly of opinion that a special provision out of profits should be made to meet the exceptional deterioration. The depreciation attributable to 1916 (exclusive of any accumulated arrears) has, therefore, been in part provided out of the manufacturing profits for the year. The directors believe, however, that the Government authorities with whom the decision lies will meet the company adequately with regard to the allowances which are claimed as essential. The question of re-construction has engaged the earnest and anxious attention of the directors, who are of opinion that the position can only be met by a reduction of capital.

SINGAPORE ELECTRIC TRAMWAYS CO. (LTD.)—At the meeting on Tuesday it was reported that the profit for 1916, after providing for debenture interest, depreciation and royalty to the municipality, was £9,913. The dividend paid in July absorbed £5,000, and £3,000 was placed to depreciation reserve, and £7,964 carried forward.

SOUTHERN BRAZIL ELECTRIC CO. (LTD.)—The report states that difficulties in obtaining materials from abroad and shipping restrictions have interfered with the working of their undertakings. Satisfactory progress has been made, however, the gross revenue being 16 per cent. and the net revenue 14 per cent. higher than the previous year. The electric lighting revenue increased by 5 per cent., electric power by 34 per cent; and electric tramways increased by 19 per cent. After deduction of all charges in London and Brazil and of interest on debentures and loans to Dec. 31, 1916, the balance was £1,198, and, with £3,072 brought forward, the total was £4,271, which the directors proposed to carry forward.

WAYGOOD-OTIS (LTD.)—The profit for the past year amounts to £23,501, and, with balance of last year's account (£671), the total is £24,173. Of this sum depreciation of plant, &c., absorbs £4,212; chairman and managing directors' remuneration, salaries of directors managing departments and directors' fees, £6,310; National Service grants to dependents of employees, £1,028; leaving £12,622. Out of this sum the directors paid a dividend on the preference shares for the half-year to July 15, 1915, leaving £8,122, out of which they recommend that six months' preference dividends be paid on July 15, the balance being carried forward.

WINNIPEG ELECTRIC RAILWAY CO. (LTD.)—The gross earnings for 1916 were $3,311,169 and operating charges $1,939,041. The net operating revenue was $1,372,123 and net income $445,251, a decrease of $36,742). The directors regret that owing to very substantial increases in the cost of materials and to the serious competition of the "jitneys," the results have been disappointing. For these and other reasons very careful consideration was given to the question of continuing the payment of any dividends on the capital stock. It was felt that due to financial conditions and the impossibility of disposing of long term securities at satisfactory prices to retire temporary loans, a discontinuance of dividends for the time being would strengthen the financial position and more quickly guarantee an earlier date for the resumption of such dividends. No dividend was, therefore, declared during the year.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

APEX ELECTRIC ACCUMULATOR SYND. (LTD.) (147,516).—Private company, reg. May 21, capital £25,000 in £1 shares (10,000 pref.), electrical and mechanical engineers, manufacturers of electric accumulators and other appliances, &c. Reg. office: 65, London Wall, E.C.

GEO. W. BAKER (LTD.) (9,866.)—Private company; reg. in Edinburgh May 30. Capital £2,000 in £1 shares, to carry on business as electrical engineers and manufacturers, &c. First directors are G. W. Baker and Jas. Smith. Reg. office, 19, Blythswood-square, Glasgow.

JOHN BARNSLEY & SONS (LTD.) (147,643.)—Private company; reg. June 4, capital £20,000 in £1 shares (9,000 6 per cent. cumulative preference), to take over the business carried on as "John Barnsley & Sons," and to carry on the business of manufacturers of and dealers in hydraulic, pneumatic, electrica, steam and general engineering products, gauges, machine tools, cranes, pulley blocks, &c. First directors are A. Barnsley, J. W. Barnsley, J. T. Barnsley, W. G. Barnsley and P. G. Barnsley. Reg. office, Gradley-road, Netherton, Worcs.

BRITISH BARIMAR-THERMIT WELDING CO. (LTD.) (147,739.)—Private company. Reg. June 15, capital £5,000 in £1 shares, welders, annealers, metal founders, wire drawers, tube makers, boiler makers, electrical engineers, motor vehicle manufacturers and repairers, &c. First directors are H. A. Blackwell, C. W. Brett, H. E. Lamplough and W. L. Turner.

CATHODES (LTD.) (147,620.)—Private company, reg. June 1. Capital £10,000 in £1 shares. Manufacturers and repairers of copper water jackets for internal combustion engines, fuses and other parts of shells, &c., by electrolytic deposition, engineers, metallurgists, &c. Agreements (1) with C. E. Peczenik, (2) with N. Bosanquet, and (3) between Alastair-Houston-Boswell-Preston and T. Hamilton-Adams. First directors are T. Hamilton-Adams, N. Bosanquet, Sherard Cowper Coles, Alastair-Houston-Boswall-Preston and G. Houston-Boswall-Preston. Reg. office, 11, Arundel-street, W. C. 2.

ELECTRIC HOLDINGS (LTD.) (147,558.)—Private company, reg. May 24, capital £300,000 in £1 shares (200,000 6 per cent. cumulative preference), to subscribe for, purchase or otherwise acquire all or any of the debenture stock and preference and ordinary shares of the British Westinghouse Electric & Mfg. Co. (Ltd.), and in particular to purchase all such debenture stock and shares now held by the Westinghouse Electric & Mfg. Co. and its nominees, and to enter into agreements with the said American company, the British company and the Metropolitan Carriage, Wagon & Finance Co. First directors are L. C. Docker, E. V. Hiley and H. Walker.

C. E. FALCONBRIDGE (LTD.) (147,691.)—Private company; reg. June 9, capital £2,000 in £1 shares, to carry on the business of electrical engineers and contractors, suppliers of electricity, &c., agreement with C. E. Falconbridge, of 114, Mansfield-road, Nottingham.

GEORGE N. POTTER (LTD.) (147,588.)—Private company, reg. May 26. Capital £3,000 in £1 shares, to take over business of a brass founder, metal worker, machinist and factor carried on by G. C., H. A. and F. N. Potter as George N. Potter, at Birmingham, also to carry on the business of electrician and mechanical engineers, &c. First directors are G. C. Potter, H. A. Potter and F. N. Potter.

E. B. MAGNETOS (LTD.) (147,542).—Private company, reg. May 23, capital £8,000 in 6,000 preference shares of £1 each and 8,000 ordinary shares of 5s. each, manufacturers of and dealers in magnetos, dynamos, accumulators, coils, speedometers, accessories, engines, &c. Reg. office: 16, Howick-place, Victoria-street, S.W.

RENEW ELECTRIC LAMP CO. (LTD.) (147,598.)—Private company, reg. May 31. Capital £10,000 in 10s. shares (10,000 5 per cent. cumulative preference). To take over the business carried on as the Renew Electric Lamp Co., with F. Harrison and others. First directors are R. G. M. Delpech (and one other to be nominated by him) and F. Harrison.

SHEPPEY MOTOR TRANSPORT CO. (LTD.) (147,552).—Private company, reg, May 23, capital £20,000 in £1 shares, to take over the business carried on in the Isle of Sheppey by the Sheerness & District Electric Power & Traction Co. and T. Standen & Sons; and to carry on the business of pier, motor car, steam and motor boat, &c., proprietors, &c. First directors are G. J. Somerville (chairman), A. Charlton, W. A. Standen and A. F. Standen. Reg. office: 1, Kingsway, W.C. 2.

SOUTHPORT ELECTRIC SUPPLY CO. (LTD.)—(147,492) Private company. Reg. May 17, capital £1,000 in £1 shares. Objects as title. First directors are T. Lawyer, S. Stroud, E. Stafford and J. Bennett. Reg. office: 99B, Eastbank-street, Southport.

SUPERSIGNS (LTD.) (147,666.)—Private company; reg. June 6, capital £2,000 in £1 shares (1,000 10 per cent. preference), to acquire any invention relating to advertising signs, &c. Managing directors are S. G. Couldrey and H. V. Dodd. Reg. office, 5, Southwark-street, S.E.

TULLITE (LTD.) (147,746.)—Private company. Reg. June 15, capital £5,400 in 2s. shares, manufacturers of refractory materials and articles capable of being made therefrom or used therewith, electricians, electric and general engineers, &c. First directors are C. B. Tully and W. M. Edwards. Reg. office, 39, Victoria-street, S.W.

VERITY'S (FOUNDERS) (LTD.) (147,638.)—Private company; reg. June 2, capital £100,000 in £1 shares, to acquire all or any part of the deferred ordinary shares of Veritys (Ltd.). Agreement with G. Verity, J. F. Lister, B. C. Evans and T. I'ons. First directors are: G. Verity J. F. Lister, B. C. Evans and T. I'ons.

ROBERT WALKER & SON (MANCHESTER) (LTD.) (147,512).—Private company. Reg. May. 17, capital £5,000 in £1 shares, to take over the business carried on as Robert Walker & Son and to carry on the business of mechanical, electrical, gas and oil engineers, tool makers, &c.

MORTGAGES AND CHARGES.

L. WEEKES (LTD.)—Particulars of £3,000 debentures created May 26, 1917, have been filed, whole amount being now issued. Property charged, company's undertaking and property, present and future.

CITY NOTES.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—A quarterly dividend of 1¼ per cent. has been declared on the cumulative preference shares.

BRUNNER, MOND & CO. (LTD.)—The directors announce a dividend at rate of 30 per cent. per annum, making 27½ per cent. for the year ended March 31 last. £100,000 has been placed to suspense, £2,600 written off patents and £216,000 carried forward.

CANADIAN GENERAL ELECTRIC CO. (LTD.)—The directors have declared a quarterly dividend of 2 per cent. on the common stock for the three months to June 30.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended March 31 last of 3s. per share (tax free), payable on the 14th prox. The hare register will be closed from July 6 to 13, inclusive.

HEENAN & FROUDE (LTD. & REDUCED).—A petition for confirming a resolution reducing the capital of this company from £200,000 to £100,500 will be heard at the Assize Courts, Manchester, on July 3.

JAMES KEITH & BLACKMAN CO. (LTD.)—The net profit for the past year was £33,699. A dividend of 10 per cent. (tax free) is proposed on the ordinary shares, after adding £20,000 to reserve. £14,102 is carried forward, compared with £10,515 brought in.

Digitized by Google

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—"The Electric Vehicle," June, contains an advertisement in which the most prominent headline reads :—

"Cylinders and Crank Cases Brass and Copper worn parts built and turned up."

* * * *

BON MOT OF THE WEEK.—

"I look across the ebbless tide of Time
With the clear vision of a prophecy,"

and I see the Federation which I have the honour to serve growing in numbers, wealth, power, influence and wisdom—wisdom which it will learn partly through its mistakes, until it becomes what Tennyson so gloriously and nobly described as "the Parliament of men, the Federation of the world."—EDMUND HILL on the Federation of British Industries before the Manchester Engineers' Club.

* * * *

I am disappointed on looking through Mr. F. M. Long's Presidential I.M.E.A. address that there is no reference to the electro-culture of canaries or the maintenance of the electric service during "flood time."

* * * *

"Dip the joint into the liquid solder until a sufficient quantity has been absorbed, and then wipe it with a rag. Wash the joint with water to remove the stains of the flux, dry and serve with india-rubber tyre solution."

The editor of "The Healthy Life" quotes the above from an Army Manual, and aptly remarks, in the light of the present food situation, "chew slowly to rag time music."

* * * *

Motto for the I.M.E.A. : "Why burn gas at the end of a pipe in your house when you can more efficiently allow it to be burned under boilers to raise steam for electricity generation ?" Why indeed ?

* * * *

A London correspondent kindly draws my attention to the following :—

WOMEN AND ELECTRICITY.

When a woman is sulky and will not speak	*Exciter.*
If she gets too excited	*Controller.*
If she talks too long	*Interrupter.*
If her way of thinking is not yours	*Converter.*
If she is willing to come half way	*Meter.*
If she will come all the way	*Receiver.*
If she wants to go further	*Conductor.*
If she would go still further	*Dispatcher.*
If she wants to be an angel	*Transformer.*
If you think she is unfaithful	*Detector.*
If she is unfaithful	*Lever.*
If she proves your fears are wrong	*Compensator.*
If she goes up in the air	*Condenser.*
If she wants chocolates	*Feeder.*

—*Selected.*

To all of which I may add : If she likes champagne, "choker" (off it) ; if she takes to cycling, "balancer" ; if she's run down, "booster" ; and, finally, if she breaks down, "megger."

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, June 19, 1880.]

UTILISATION OF SOLAR HEAT.—M. Mouchet, whose name will be remembered in connection with this subject, is carrying on his experiments under the clear sky of Algeria. He is working with a mirror 3·8 m. in diameter, mounted so as to withstand the effect of the most violent wind, and concentrating the heat of the sun on a boiler 5 mm. in thickness, within which a pressure of 8 atmospheres can be obtained in one hour. We should be glad to ascertain whether the power developed by this means would be sufficient to work a dynamo-electric machine of moderate size. The work hitherto done by M. Mouchet includes the sublimation of benzoic acid, the distillation of essences, and the concentration of syrups, the boiling of linseed oil, the carbonisation of wood, &c. It is probable that he may shortly take up the question of the generation of an electric current.

When a candidate enters upon a competitive examination, he is, to some extent, forewarned of a "catch," just as the schoolboy, home for his holidays, suspects a fraud in the floorer which the family doctor is always ready to discharge upon him. After solving the recondite problem as to the connection between the cost of shovel and tongs, and what the coals will "come to," he is prepared to be sceptical about the differing weights of a pound of lead and a similar pound of feathers. Examiners are nowadays driven to such straits that their papers always embrace questions even as fatuous as these ; and all that can be said for them is that they exercise, and are to some extent a test of, the ingenuity of the candidate. Whether this is the object primarily aimed at, and whether, for example, a student's knowledge of electrical laws can be estimated by his skill in seeing through the superfine trickiness of the examiner is another matter. At present the real competition lies mainly between the professional coach and the professional framer of questions ; when these belligerents are fairly exhausted perhaps the turn of the peaceful student may come.

Australasia.—The municipalities of Lyttelton and Wairoa (N.Z.) have been authorised to supply electrical energy for all purposes.

It is reported that a large deposit of low-grade molybdenite ore has been discovered at Yetholme, near Bathurst (N.S.W.), and work has been commenced upon the properties. There are to be electric drills, current being supplied by a 90 kw. set, and the plant will be increased as the work of development proceeds. It is stated that over 20,000,000 tons of molybdenite ore occurs within a square mile and near the surface.

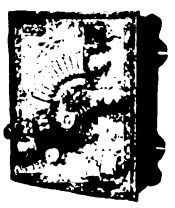
The Amalgamated Zinc (De Bevay's) (Ltd.), which has been established for the production of zinc electrolytically and for manufacturing high-grade spelter in Tasmania, has decided to establish works near Hobart for the electrolytic treatment of zinc concentrates. The State Hydro-Electric Department will supply the company with power aggregating 50,000 H.P. from the Great Lake plant, of which not more than 40,000 H.P. is to be utilised in the production of electrolytic zinc ; the remainder to be used in electro-chemical industries.

The request of the Victorian Hydro-Electric Co. for permission to divert water from the Kiewa River for generating electricity, has been referred by the Victorian Cabinet to the sub-committee which is investigating the possible use of brown coal for electrical generation.

The Victorian Institute of Industries recently reported on the question of utilising Morwell brown coal for the production of electrical energy. The Government were recommended to confirm the estimates as to public power requirements, and to arrange that expert estimates be obtained of the cost of the most approved plant at Morwell and of similar plant at Altona to generate 50,000 kw. of electrical energy, which would be transmitted to the metropolitan area and localities contiguous to the transmission line, &c. The Technical Committee of the Institute, dealing with the subject is satisfied that Morwell brown coal can be placed on rails at the mine or delivered at a near-by power station at 2s. 3d. a ton. The coal was found (in tests made by the Railways Dept.) to have 41·6 per cent. of the heat value of Newcastle (N.S.W.) coal, which meant that 5s. 5d. worth of brown coal would generate as much electrical energy at Morwell as 20s. worth of Newcastle coal at Melbourne. If Altona coal were placed in a near-by power station at 5s. 6d. a ton current could be delivered in Melbourne at less than three-fourths of the fuel cost of current from Newcastle slack.

Canadian Exhibition.—The Canadian National Exhibition will be held at Toronto this year from Aug. 25 to Sept. 10.

The United States, Mexico, the West Indies and the United Kingdom are represented amongst the exhibitors. There will be a machinery hall and electrical building designed for heavy machinery and machinery in operation and supplied with ample steam power and shafting ; a transportation building (for motor cars, &c.), and an industrial and process of manufacture building. Particulars from Dr. J. O. Orr, general manager, 36, King-street, East, Toronto.



IGRANIC

SPEED REGULATORS

and Motor Starters operated by one handle.

No. 200.—Combined Starter and Interlocked Shunt Field Regulator to increase motor speed from normal. Protective features prevent incorrect operation.

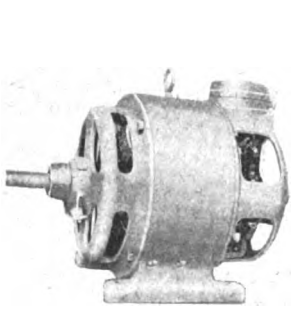
No. 220.—Combined Starter with Shunt and Series Regulation. Permits wide speed range above and below normal motor speed.

IGRANIC ELECTRIC Co LTD 147, Queen Victoria Street, London.

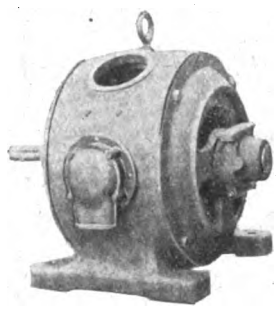
Digitized by Google

SIEMENS

STANDARD ELECTRIC MOTORS



For Direct Current.



For Three-phase Current.

for

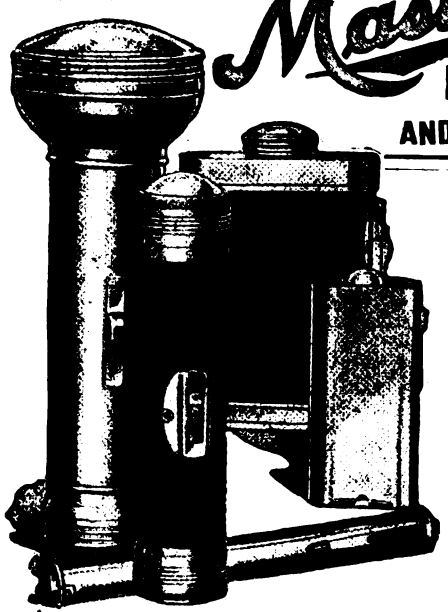
ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."

HOME BRANCH ADDRESSES:

BIRMINGHAM—Central Ho., New St.
BRISTOL—30, Bridge Street.
CARDIFF—89, St. Mary Street.
GLASGOW—66, Waterloo Street.
MANCHESTER—196, Deansgate.
NEWCASTLE—64-68, Collingwood Bldgs.
SHEFFIELD—22, High St.
SOUTHAMPTON—46, High Street.

Branches in Principal Towns Abroad.



Master BATTERIES AND FLASHLIGHTS.

Build up a better battery business by stocking the MASTER Line for Fall. Flashlight Cases are unique and beautiful.

MASTER Tungsten-Light Batteries are made in every standard size, to fit foreign or domestic cases.

Each battery guaranteed not to depreciate over 10 per cent. in a specified number of months and then to give a certain number of hours' burning-service. Request our catalogue and attractive quotations on direct importations from the U.S. or delivery from large London stock.

THE RIVER PLATE COMMERCIAL COMPANY
EXPORT ORDER DEPARTMENT.

UNITED BATTERY CORPORATION.

MANSION HOUSE—15, GEORGE ST.—LONDON, E.C.

SHOULD SUPPLY UNDERTAKINGS WIRE HOUSES?

In the United States there appears to be a controversy, somewhat similar to our vexed question of "municipal wiring," as to whether central stations should undertake the wiring of houses. In order to collect opinions upon the subject Mr. E. L. Whitehorne sent out a number of letters of inquiry to a number of stations, and in a recent issue of the "Electrical World" he gives a digest of the replies. Some of these are interesting, and we quote the following :—

Naturally the advocates of central station wiring are very definite in their reasons. "We believe we are justified in having a wiring department," says an Indiana company. "Before we established this department there were very few new houses wired, and as for old houses they were at a minimum, which was entirely due to the fact that the contractors, having no competition, exacted exorbitant prices for the work. Since establishing this department every new home has been wired complete and the number of old houses wired has been very satisfactory" A Wisconsin company wrote : "In our judgment, we should go after this business energetically and maintain an organisation to that end for the same reason that in the operation of our gas department we solicit house piping work in competition with the plumbers. Possibly some little feeling is stirred up in connection with central stations and gas departments doing this class of work, but still the utility is held responsible for the results at all events, and for that reason, if for no other, should handle this business." Another Western man believed central station wiring to be essential until the territory is well saturated, but not beyond that point. He says : "The central station should maintain house-wiring departments and do the work as reasonably as possible until the connected load is developed and a very large majority of the old houses on the lines are wired up. I have in mind one town where we were forced to do house wiring. The contractors had maintained a very high price for such work and, repeated efforts on my part to have them reduce these prices being unavailing, it forced us into the house-wiring game. Up to that time about the only thing that was being connected to our lines were new houses. We established a house-wiring department, wiring houses at a small cost, our per cent. of profit being from 15 to 20. In two years we had wired and connected to our lines more than 600 houses in a town of approximately 10,000 people. On the other hand, I could name several other towns under my jurisdiction where we do not wire houses and the matter is handled entirely by the contractors, where the development is very, very slow. Therefore, I am very much in favour of the central station maintaining a house-wiring department and doing the work as reasonably as possible up to the point where the lines are fairly well saturated."

However, a general manager in a state a little farther west said : "As long as conditions in this town, or any other, as regards the saturation point of electric light users, are as at present, I believe a company can get along quite as well in the matter of increasing its number of customers without being in the wiring business as it could if it did maintain a wiring department. Whenever such a point is reached, however, where new customers are difficult to get, the entire matter hinges on the prospect's being able to get his wiring done at a low price. Then there is nothing for a company to do but to embark in the business, since an electric lighting company is the only person or corporation that can afford to do wiring without charging a percentage to cover all overhead in connection with the wiring business, and to make only a small per cent. on the capital tied up in stock of supplies."

The testimony of another medium-sized Western city is : "In our situation we consider it both profitable and necessary to continue this department. There are a large number of small, one-story houses here which are occupied mostly by the foreign element, and we have put a flat rate into effect which enables our salesmen to quote prices for wiring these houses without first getting an estimate. The average price of wiring a house of this character amounts to $16 (excluding fixtures, and it has been our experience that the local contractor will not try to get this business for the reason that there is not sufficient profit to pay him to spend any time in promoting the sale. Our increase in meters last year amounted to about 700, and of this increase we estimate that fully 150 meters were secured from the small houses tenanted mostly by the foreign element. If we were to discontinue house wiring I estimate we would lose at least 100 new consumers per year. Therefore, although we do compete with the local contractors, it is a fair competition and there exists the best of feeling between the contractors and the company."

The same condition affects a good many cities, and seems to have caused the institution of a large number of central station wiring departments, while in some cases the active competition of the gas company is given as the reason. But by far the most numerous among these letters is the statement that the central station competition protects the standard of the work done in that town. It is expressed by one manager this way : "We believe there is justification for the central station wiring department because it ensures wiring installations at a cost not excessive. We bid on all wiring jobs, but are not disappointed when outside men secure the contract. In this way we can give our personal attention to a great many cases where the installation would not be properly made except for the supervising jurisdiction exercised by bidding on each wiring job."

In a Kansas city the sales manager wrote : "It is my opinion that this business should all be turned over to the contractors, providing they are members of a contractor's association, and are recognised as able to do the proper kind of work. We have tried both systems in the various companies with which I have been connected in the past four years, and there is only one successful plan, and that is to co-operate with the contractors, providing they are desirous of working with the

Digitized by Google

J. P. DEVINE CO., BUFFALO.

MANUFACTURERS OF

Vacuum Drying and Impregnating Plant.

(PASSBURG SYSTEM.)

The Devine Co. are well known in the United States and Canada as the leading manufacturers and experts in Vacuum Drying and Impregnating Plant and have over 1,500 such plants in successful operation.

AIR PUMPS, COMPRESSORS,
VULCANISERS,
CONDENSING PLANT.

Solvent Recovery and Derisinating Plant a Speciality.

Sole Representative:

JAMES LIVINGSTON, LTD.,

IMPERIAL HOUSE, KINGSWAY, W.C.

Telegrams and Cables: "CINERARY, LONDON." *Telephone:* GERRARD 2366.

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite—Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

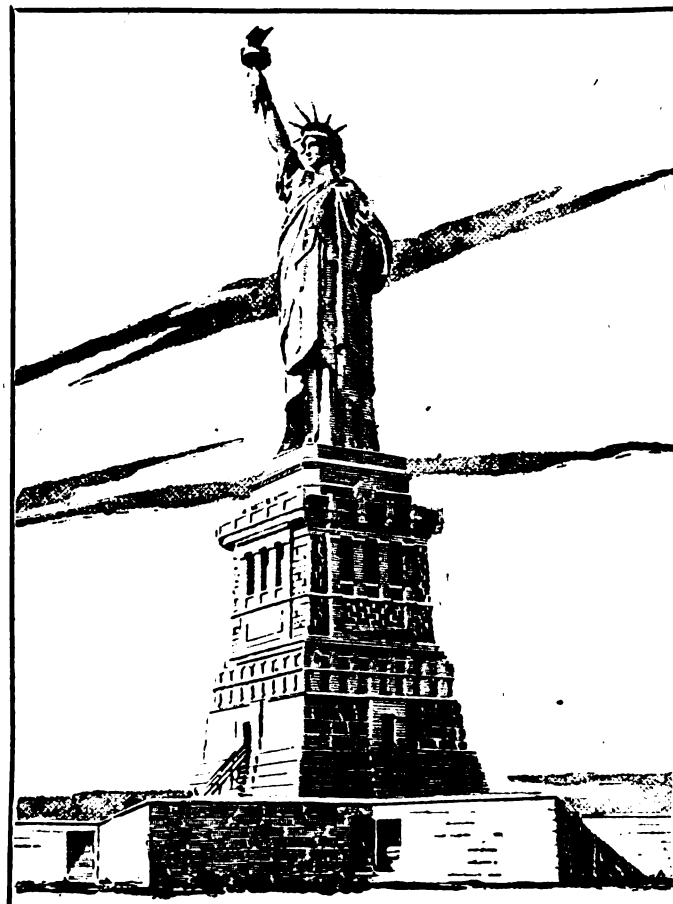
WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1912 to 1917.

ATTWATER & SONS,

Telegrams: Attwaters, Preston. Telephone No. 1045 (2 lines).

Hopwood St. Mills, PRESTON.

Established 1868. Codes: 5th Edition A B C & Western Union.



LIBERTY AND FREEDOM.

It has been well said that the price of Liberty is eternal vigilance.

The price of Freedom from troubles in the erection and use of Electrical Conductors is the current price of Simplex Conduits Fittings and Accessories.

That Freedom also is purchased by the same eternal vigilance in all the processes of manufacture.

The price includes not only value in material things, but the added value that is contained in 20 years of experience in the selection of the fittest, and the elimination of the "good enough."

SIMPLEX CONDUITS LIMITED

GARRISON LANE, BIRMINGHAM.

LONDON— 113-117, Charing Cross Rd, W.C.
MANCHESTER— 16, Corporation Street.
GLASGOW— 72a, Waterloo Street.
NEWCASTLE— 61, High Bridge.
BRISTOL— 10 & 11, Denmark Street.
LIVERPOOL— 96, Whitechapel.
LEEDS— 6, White Horse Street.
SWANSEA— 14, Heathfield Street.
CARDIFF— 4, Westgate Street.
ABERDEEN— 1, Crimon Place.
SHEFFIELD—281-3, Attercliffe Common.

Digitized by Google

LOAD AND EXPERIMENTAL

RESISTANCES

MADE TO ANY SPECIFICATION.

Particulars of Standard Types will be found in our List, to be had on application.

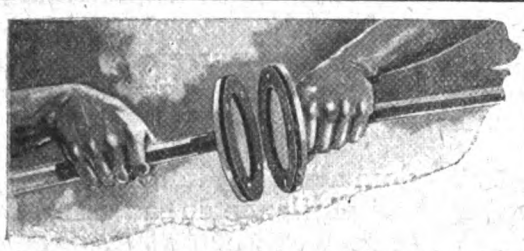
RAPID DELIVERIES GUARANTEED.

ISENTHAL & CO., Ltd.,

(DEPARTMENT 4)

Denzil Works, Willesden, London, N.W. 10.

Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster General, etc.



Perfect Transmission

You'll have perfect transmission *always* once you adopt Ferodo friction surfaces. "Idle moments" will be reduced to a minimum—output will be greatly increased.

No slipping—no "seizing" with Ferodo Fabrics—perfect engagement even when soaked with oil. Discard leather-lined disc clutches—fit Ferodo friction surfaces and *double your output.*

FERODO

FRICTION SURFACES.

Contractors to the War Office and Admiralty, London General Omnibus Co., and Underground Electric Railways of London and Paris. List "X" from—

The HERBERT FRODO CO., Ltd.,

Works: CHAPEL-EN-LE-FRITH.

Depots at London, Birmingham, Belfast, Bristol, Cardiff, Edinburgh, Glasgow, Liverpool, Manchester, and Newcastle.

central station. We find that we cannot depend on them to sell or push the sale of appliances, but we derive considerable benefit from turning over all wiring business to them, and carrying the accounts." A manager in Arkansas said: "My experience teaches me that it is absurd for a central station to do wiring, for the central station can co-operate with contractors and thus ensure that only a reasonable profit be earned and first-class work done. And there are many advantages in having good live contractors in the field, for more business will be secured and a live contractor is practically as good as, and sometimes better than, a salesman employed by the central station. If you encourage him he will certainly get the business."

The bad influence on public opinion of a lack of harmony in the local electrical family is dwelt upon by many companies in discussing the question. The manager of a large Illinois company wrote: "It has been my experience that in such towns where we have maintained an interior wiring department that the company not only has alienated the contractor's affections, but created a false field of competition and public prejudice. I find that in towns where central stations maintain the wiring department that the company itself has secured more contracts than in towns where no such department exists, but that in such towns the number of contracts secured by both the outside companies and the central station is less than where all of the wiring is done by the outside contractors. We have actual figures embracing several years that prove this condition in several of our towns." "Among other things," says another man in Illinois, "if the light company is asked to submit bids on a job, it will naturally figure on the best material possible and of sufficient capacity to take care of the expected increase in heating appliances, whereas the local contractor will figure to make as much as he can and still get by. The result is that the light company's figures are largely in excess of those submitted by the local man and the local man gets the job and the light company adds another item to the charge that it tries to hold up the customer." Others stated that central station wiring departments were usually an actual source of expense because of the wasted labour, the cost of supervision and through the losses in collection, &c.

It is pointed out that the opponents of central station wiring are quite as decided and as specific as its advocates, but in the majority of the letters the dominating factor was the local conditions—caused unquestionably to some considerable degree by the very policy of the central station itself. A Georgia man said: "This is a matter which should be governed entirely by local conditions. If satisfactory conditions cannot be obtained from the contractors, then it is the duty of the central station, in justice to itself and its customers, to go into the wiring business." A Kansas manager said: "I believe that there are two causes which may force a central station to do wiring. First: If the central station finds it impossible to make a fair increase without taking wiring and fixture contracts, then it is certainly up to it to do this work, regardless of the effect on the contractor. Second: If it becomes necessary, in order to take on more consumers, to install wiring on a monthly instalment basis the central station may be forced to finance and operate the entire campaign. Often the contractors in smaller cities and towns have no or very little competition. They have all they can attend to without spending any time rustling business, and this naturally causes them to pick the plums and charge a very high figure for their installations. The increase of the number of electrical consumers is thus greatly minimised especially residential consumers. In a case of this kind it is up to the central station to induce another contractor to come in or get into the business itself. On the other hand, if there are plenty of contractors in a town I can see no reason why the central station should get into the business."

For Effective Impregnation use "LACWATT"

Black or Golden Brown.

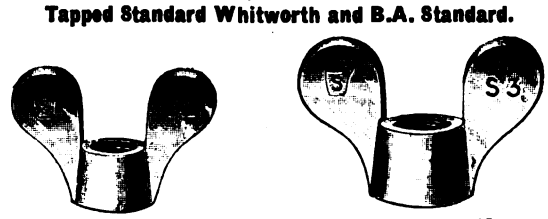
JENSON & NICHOLSON, Ltd., Insulating Varnish Department, Goswell Works, Stratford, E.15.

E. SHOWELL & SONS, LTD.,

STIROHLEY, BIRMINGHAM.

SOLID FORGED BRASS WING NUTS.

Tapped Standard Whitworth and B.A. Standard.



Made from No. 1 tapped ¼" to No. 9 tapped ½".

Sole Agent for the Electrical Trade:—

LIONEL ROBINSON, 3, STAPLE INN, LONDON, W.C.

TELEPHONE: Holborn 6282.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

It is better to be good than beautiful.

It is best to be both.

Like our Loop Type Insulators, which, while handsome in appearance, are insulators through and through, and are designed to maintain their alignment in use.

D.4411. For Frog Pulls and light Pull-offs.

D.4412. For heavier wires.

Delivery from stock.

BRITISH INSULATED & HELSBY CABLES.

LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED **SECOND HAND**

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.

Phone: Victoria 4026. Grams: Viemaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh. *See Illustrated Advt. inside front cover.*

Digitized by Google

ELECTRICAL PROGRESS IN BELFAST.

A visit was recently paid by the members of the Belfast Association of Engineers and their friends to the East Bridge-street electricity works.

Mr. Stanley Johnston, president of the association, proposed a vote of thanks to Mr. T. W. Bloxam, the Electricity Committee and Ald. Tyrrell, the chairman, and said when one looked round a museum such as the Corporation electricity station, he was sure they would admire some of the antique examples in No. 1 house. No doubt those were the last word in electrical science when they were installed, but when one saw the more modern machines in No. 2 house they could realise the very great development that had taken place in electricity supply. These later machines were now somewhat out of date, and it showed how quickly things changed in that branch of engineering. Some of the latest turbo-electric machines at work were double the capacity of the entire station, and he hoped the present committee would not be led into some other corner without looking well into the future. That was the second attempt at a station, and he hoped the third would prove the charm. The mills and factories, situated as they were within such a small area, should all be running from one central station, but the committee had allowed all that business to slip through their fingers. Contractors pushed all the business in electricity. The committee never helped them in any way. Even now, when he told them that one mill was contemplating large extensions and new power plant the Corporation was not in a position to say to them: "We will give you all the power you want at a competitive price." Who would ever give the question a second consideration? The city would be free of all the dirty, smoky chimneys belching out soot and dirt all over the place. He hoped before long to see an electric generating station worthy of the name, supplying power to all the many industrial concerns in and around the city, at the same time making a good revenue towards the relief of the rates. That was no idle dream. If the matter was in the hands of a business concern they would not allow those golden opportunities to slip by. Mr. Johnston complimented Mr. Bloxam on having made £17,000 out of the station last year, considering the inefficient plant he had to work upon.

Ald. Tyrrell and Mr. Bloxam replied to the vote of thanks. Ald. Tyrrell, in replying, said he thought it was proper that the builders of industry and commerce should come and see in motion the result of their own handiwork. He also thought it would be well if the citizens could come and get a more adequate idea of what was being done in their interest. He had always been a strong advocate of putting up a new plant for the generation of electricity. He hoped that the next time the members came to visit them it would be at the new one at the Harbour. He held the view that, with a modern station, properly equipped, Belfast would take its place amongst the foremost cities of the kingdom in the matter of supplying electricity at a low rate, and thus give a great impetus to industrial progress.

THE TELEPHONE IN RAILWAY WORK.

The telephone is (according to the "Railway News") to be used instead of the telegraph for despatching trains on the whole of the Southern Railway system between Washington and Atlanta, 649 miles. Between Washington and Spencer (N.C.), the telephone is now in use, and authority has just been given for the construction of two copper telephone circuits between Spencer and Atlanta (314 miles).

When this work is completed the Southern will have continuous train despatching and message circuits between Washington and Atlanta, and these two circuits will also provide a third or phantom circuit for talking purposes, and a simplex telegraph circuit between the offices at Washington, Atlanta, Charlotte and important division and junction points, such as Monroe, Va., Greensboro, N.C. Spencer N.C., Hayne, S.C., and Greenville, S.C. The telephone has several advantages over the telegraph. Service is quicker and it is easier to guard against errors. The despatcher writes the order as he send it, spelling out all figures such as train numbers, engine numbers and time. The receiver writes the message as he receives it, and then repeats it to the despatcher, spelling out all figures. The telephone brings the sender and receiver into close touch, and the despatcher, should occasion arise, can talk personally to the conductor or engineer of any train on his division.

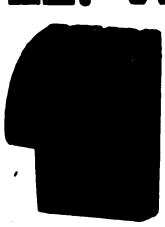
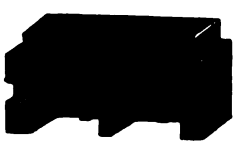
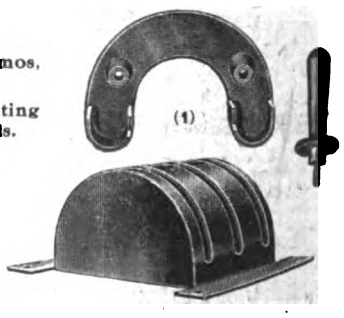
LEAD OUTPUT OF THE U.S.A.

According to the "Iron Age," the production of primary refined lead in the United States in 1916 was 571,134 net tons, compared with 550,050 net tons in 1915, which is stated to be a record output. The primary lead available for consumption was 477,384 tons, an increase of 12 per cent. over 1915, which is also a record. The exports of domestic lead in 1916 were 100,565 tons, against 87,306 tons in 1915 and 58,722 tons in 1914.

FOR
High and Low Tension
SWITCHGEAR
THE
NEW SWITCHGEAR CONSTRUCTION CO., Ltd.
SUTTON, SURREY, ENGLAND.
ABC Code 5th Edition. Telephone: Sutton 773.

Electrical Engineers and Manufacturers
The House for Electric Heating.
Special Offer of "Quead" and "Ensign" Fires from Stock.
Be Patriotic and Save Coal.
Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.
Telephone: Gerrard 7601 (2 lines)

Petrol Engine Sets,
Manufactured in sizes from 2 kw. to 20 kw.
Quotation for larger sizes on application.
F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON

H. Weidmann, Ltd., Rapperswil, Switzerland.
MAKERS OF PRESSPAN AND INSULATING MATERIAL.

Pressboard (Presspan) in Sheets, Rolls and Tapes, Oiled Presspan, Black Presspan, Presspan Tubes and Stampings.
Amianite (Vulcanised Asbestos) Coil Frames, Spools for Apparatus, Dynamos, Motors and Transformers. Insulating Blocks, Tubes, Plates, Boxes, &c.
Bakelite & Cornite (high tension material) Handles of Switchgear and Heating Apparatus, Controller Insulation, Moulded Pieces, Terminal Covers of all kinds.
Asbestos-Cement in Plates, Arc Shields for Controllers, &c.

Mica and Substitutes, Insulating Pearls, Transformer Spools.
Japanese Felt and Paper in rolls and tapes.
Oil-Varnished Linen, Diagonal Tapes, Oil-Varnished Silk & Paper.
Artificial Leather Discs for Friction Drive.
Insulators for Electric Furnaces, Tramways, &c.

(1)

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,041. [Vol. LXXIX. No. 13] FRIDAY, JUNE 29, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES	495
Arrangements for the Week	497
Current Density in Copper Refining. By Lawrence Addicks. Illus.	498
Heating of Dynamo Electric Machines With Various Loads and at Different Speeds. By Prof. Magnus MacLean, D.Sc., and D. J. MacKellar, B.Sc. Illustrated.—*Concluded*	500
Incorporated Municipal Electrical Association	502
The Electrical Properties of Gases. Illustrated.—*Concluded*	505
Decimal Coinage	507
PERSONAL INTEREST IN MUNICIPAL ENTERPRISE	508
National Physical Laboratory	511
Control of Motors for Industrial Work	512
Ferguson, Pailin & Co.'s Truck Type Switchboard. Illustrated	512
CORRESPONDENCE	513
Physical Society	514
LEGAL INTELLIGENCE	515
PARLIAMENTARY INTELLIGENCE	516
Volunteer Notices	516
Patent Record	516
COMMERCIAL AND INDUSTRIAL SECTION	519
Electricity Supply	520
Tenders Invited and Accepted	522
Financial Matters	523

NOTES.

The Miners' Output.

ONE of the most striking points brought out by Mr. J. A. ROBERTSON in his Paper on "Fuel Economy" before the Incorporated Municipal Electrical Association was the output of coal per annum per person employed in the coal industry in Great Britain. This quantity shows a fairly steady decrease during the last few years, notwithstanding mechanical aids for the miner. Perhaps there is some consolation in the fact that the output in Germany has been generally less than in this country, but it now shows a tendency to increase, and has become higher than our record. The downward tendency in this country may be partly due to the greater difficulty in winning coal as time goes on and as the workings become deeper. The idea, however, that this is sufficient explanation is not borne out by the results obtained in the United States of America. Here the output has increased more or less satisfactorily; and not only so, but the difference in the figures between the two countries is now very marked. In 1912 the output per person per annum was only 260 tons for Great Britain, whereas in the United States the figure had risen to 660 tons. The result of this is that the cost of production rose to 9s. per ton in Great Britain in 1912, whereas in the United States the cost showed a tendency to fall and was 6s. 1d. in 1912, notwithstanding the fact that the cost of labour is much higher than over here. We fear that such figures indicate restriction of output. This view is supported by the remarks of Mr. SELVEY in the discussion on this Paper, who stated that in a case within his knowledge the total electrification of a colliery had failed to produce any increase in output.

Fuel Economy.

WHATEVER the cause of these unsatisfactory results may be there is ample reason for economy in fuel, which was the main subject of Mr. ROBERTSON's Paper. Whenever this subject is approached in connection with the electricity works of this country we think that every reader must feel that most of these works are hopelessly inefficient. The idea of anything like the necessity of 5 lb. of coal per kilowatt hour is something of a reflection upon our engineers. We notice that Mr. ROBERTSON states a far higher standard, namely, 1·45 lb. of coal per kilowatt hour sold, with coal having a calorific value of 12,500 B.Th.U. (presumably as fired), which is equivalent to about 18,000 B.Th.U. per kilowatt hour sold. We are inclined to think that Mr. ROBERTSON is a little too ambitious with this figure when it comes to day in and day out running, but it is well to have a high standard before us. With regard to the much larger question of carbonisation of coal, Mr. ROBERTSON really touched only very lightly upon this subject, for he referred mainly to recovery producer plant. But if every advantage is to be secured that is possible with raw coal we must go much farther than this. The experiments at Glasgow on low temperature carbonisation appear to be extremely important, and we hope that much more will be published about them in due course. So far very little of an authoritative kind has been heard of this work. We trust that those responsible will not consider that generalities are sufficient for the average engineer, but will proceed to give us something more solid.

The Motor Omnibus as an Aid to Tramways.

THE days have passed since the motor omnibus was looked upon merely as a competitor of the electric tramway. At the present time there are electric omnibuses as well as those operated by means of petrol, and in many ways such vehicles are able to be of very considerable service to electric tramways in outlying districts. It is not surprising, therefore, that Mr. EMILE GARCKE should have referred to the subject at the general meeting of the British Electric Traction Co. Mr. GARCKE expressed the view that the motor omnibus business had not received from the Government the recognition which it deserved, and that there is continual difficulty in satisfying the requirements of local authorities. This difficulty is partly due to the fact that an omnibus route may traverse the districts of a number of authorities, all of which may make different stipulations. Then, again, there is, of course, the vexed question of road maintenance. Mr. GARCKE pointed out that an omnibus in regular service contributed from £50 to £60 per annum in petrol tax. Originally this tax went towards the maintenance of the roads, but since the outbreak of war it has been used for national purposes, and consequently demands have been made by local authorities that the omnibus should make a further contribution to road maintenance. It is undoubtedly unsatisfactory that any attempt should be made to impose a double tax. The position has given rise to discontent on the part of motor omnibus proprietors for some time past, and although we can scarcely expect a point of this kind to be settled during war time, we hope that some satisfactory solution of the difficulty will be found when peace returns. It is only reasonable that some contribution should be made to road maintenance by this class of traffic. The only difficulty is to determine what is reasonable and the most practical form in which it may be applied.

Digitized by Google

A Decimal System of Coinage.

THE Institute of Bankers has now issued in pamphlet form the report of the Committee appointed to enquire into the adoption of a decimal coinage and the metric system of weights and measures. The Committee agrees that the existing system of weights and measures is an obstacle to the extension of foreign trade, but it appears to favour, in the first instance, the adoption of a decimal coinage as a step more easily taken, which may serve as a preliminary towards the more ambitious project of introduction of the metric system in regard to weights and measures. The conviction is expressed that the bankers of this country could not see their way to adopt any system of decimal coinage which is not based on the pound sterling as the primary unit. It is accordingly suggested that the pound sterling should be divided into 1,000 parts, called "mils." The half-sovereign would thus be 500 mils, and the silver coinage would comprise the double florin of 200 mils, the florin of 100 mils, the half-florin of 50 mils and the quarter florin of 25 mils; 100 mils is thus equivalent to two shillings, and 25 mils to sixpence. It is further proposed that there should be a 10 mil piece of nickel or other appropriate alloy, and bronze coinage of 4, 2, and 1 mil respectively (equivalent roughly to the penny, half-penny and farthing). The advocates of the decimal money system, as our readers know, are divided into two camps, one in favour of the pound sterling as the unit, the other in favour of the shilling. It is interesting to know that the bankers are strongly in favour of retaining the pound. It appears to us that this is essentiallly a question for those people who are engaged in finance. The metric system of weights and measures is a more difficult question to decide. There is u doubtedly very much to be said in its favour. On the other hand, many engineers in the United States strongly oppose its compulsory adoption. Whatever is done we hope that a decision will not be reached merely through pressure of popular opinion, but will be due to those who have a full knowledge of the advantages and disadvantages of any system that is proposed.

Société de Chimie Industrielle.—This is the title of a new society formed to organise and assist in the development of the chemical manufacturing industries of France. Its offices are at 49, Rue des Mathurins, Paris.

Royal Society.—At the meeting of the Royal Society yesterday a Paper was read by Sir Robert Hadfield, F.R.S., Ch. Chéneveau and Ch. Géneau on "The Study of the Magnetic Properties of Manganese and of Some Special Manganese Steels."

Glasgow Memorial to Sir Wm. Ramsay.—A memorial tablet, with a medallion portrait of the late Sir Wm. Ramsay is to be erected in the University of Glasgow. The memorial which will be to the design of Sir John Burnet, will be placed at the entrance to the Bute Hall.

Miners' Electric Safety Lamps.—In Part II. of the Mines and Quarries Report for 1915 the numbers of the various electric safety lamps in use at the end of the year were as follows :—

Bristol, 107; Ceag, 52,684; Float, 111; Gray-Sussmann, 5,887; Joel-Fors, 423; Oldham, 29,717; Pearson, 1,122; Thomson-Rothwell, 28; Wolf, 5,088.

Reinforced Concrete for Railway Work.—In view of the shortage of timber the use of reinforced concrete in place of timber is being considered for many purposes. Concrete is being tried for ship-building, and for smaller vessels for inland transport, especially, seems likely to give good results. On the railways even sleepers of ferro-concrete are being experimented with, although according to the "Railway Gazette" they have not yet been introduced on main lines. One difficulty appears to be that they are apt to get chipped if packed in the usual way. For posts of all kinds concrete is eminently fitted.

Automotive Electric Association.—This is the title of a new organisation of manufacturers of automotive electric accessories, which was recently formed at Atlantic City, New Jersey. The purposes of the organisation are to improve and develop this branch of electric accessories' business through standardisation and by friendly interchange of experience with reference to design and manufacture.

Hardening Steel Gauges.—We have received from the Westminster Electrical Testing Laboratory particulars of some hardness tests carried out by the National Physical Laboratory for the Hardness Tests Research Committee of the Institution of Mechanical Engineers. These show the advantages of the Wild-Barfield process of hardening. In this laboratory screw gauges are being hardened in large quantities, and these gauges change so little in their dimensions by this process as only occasionally to require lapping.

Depreciation of Diesel Engines.—The Diesel Engine Users' Association announces that the Inland Revenue Authorities have now agreed to increase the rate of depreciation upon Diesel engines to 10 per cent. per annum. It has also been agreed that the increased allowance shall remain in force for three years after cessation of the war, when either party may claim a revision.

The subject was taken up by the Association at their meeting on June 22, 1915, and in March the secretary (Mr. Percy Still) attended with Mr. A. D. Bird (of Messrs. Humphreys-Davies & Co.), at Somerset House to urge the claims for a more generous allowance, for an allowance of at least 15 per cent., for depreciation of Diesel engines. Although the authorities have not conceded the demand of 15 per cent. per annum on the diminished capital value, members of the Association will no doubt consider that the concession of a 10 per cent. allowance is of great importance.

Standard Marine Engines.—An important step towards standardising the engines of cargo vessels has recently been taken by the North East Coast Institution of Engineers and Shipbuilders. A committee appointed by the council of the Institution in 1916 has prepared a specification embodying the best practice of the leading makers on the North-east Coast. The specification will, it is hoped, be adopted throughout the industry. The first ship-owners to avail themselves of this new departure are Messrs. Furness, Withy & Co., Ltd., and their lead will doubtless be followed by others.

Electroculture.—Considerable interest was shown last week in the electroculture apparatus which was exhibited in the basement of the Institution of Civil Engineers by Messrs. H. W. Cox & Co., in connection with the Convention of the I.M.E.A. The equipment which was designed for farm conditions, and is being practically used, consists of a transformer with mercury break for continuous-current, the equipment being housed in a small weatherproof hut which is easily portable. The transformer is provided with an adjustable spark gap, and the high-tension lead is taken out through a substantial porcelain insulator, so as to give an 8 in. clearance all round. This insulator is protected from rain. On the occasion of the demonstration the high-tension side was connected to a Lodge valve and thence to the overhead wires.

Board of Trade Electric Power Supply Committee.—It was announced by Mr. G. Roberts in the House of Commons on Monday that the Chairman of this Committee, Mr. F. Huth Jackson, had resigned on the advice of his doctor. Steps were being taken to appoint a new chairman, and also to increase the representation on the committee of local authorities owning electric supply undertakings. It was hoped that the names of the new members would be announced in the course of a few days. Mr. Roberts was unable to say when the committee would be in a position to make a report.

In reply to an earlier question, Mr. Roberts stated that it had been decided to give increased representation to local authorities owning electricity undertakings on the committee, and he was in communication with the Secretary for Scotland with a view to appointing a representative of the interests of the Scottish local authorities concerned.

Resolutions of protest against the composition of the committee continue to be passed by local authorities, and Hammersmith (London) Borough Council, while concurring in the spirit of the resolutions passed by West Ham and Bradford Corporations, is of opinion that all elec-

Digitized by Google

tricity committees should combine to demand that the present committee should be dissolved, and that a new one, consisting of a small number of competent unbiassed persons, not directly interested in electrical matters, should be constituted in lieu thereof.

Conjoint Board of Scientific Societies.—The fourth meeting of the Conjoint Board of Scientific Societies was held at the Royal Society on June 13, Sir Joseph Thomson, O.M., President R.S., in the chair, to receive the report of the Executive Committee on the work of the previous six months.

As the report indicates, a number of important questions of scientific and industrial importance have occupied the attention of the board. Various bodies are at present interested in the formation of a census of mineral resources of the Empire. It was agreed to enter into communication with these bodies, and to make suggestions with a view to the publication of information in a form useful to the general community. Interim reports were received and approved on the necessity for an anthropological survey of the British people, on the best methods for carrying on the international catalogue of scientific literature, and on an inquiry into the desirability or otherwise of the adoption of the metric system throughout the British Isles.

The Sub-committee on National Instruction in Technical Optics reported that a scheme approved by the Board of Education had now come into operation. Under the ægis of the Imperial College of Science and Technology an Advisory and Administrative Committee had been formed to organise instruction, and Mr. F. J. Cheshire, a member of the sub-committee of the Board, has been appointed Director of Studies in Technical Optics. Although the President of the Board of Education did not see his way to adopting the suggestions of the sub-committee, the Board heard with satisfaction that a promising effort had been made to solve a question of considerable national importance.

A sub-committee, having considered special cases of magnetic disturbances revealed by a magnetic survey of the British Isles, and their possible connection with the occurrence of iron ores, recommended a detailed investigation of two test areas, in order to ascertain how far, under the conditions of the British iron ores, the magnetic survey was likely to prove of economic value. Arrangements for carrying out the investigation are in progress.

An Agricultural Sub-committee, with the Earl of Portsmouth as chairman, reported that it is at present devoting itself mainly to engineering questions. It is engaged in collecting information with regard to the transport of raw materials to farms and agricultural products from them, to the power required for this purpose, and for seasonal operations on the land, with a view to comparing the relative advantages and costs of steam or internal combustion engines and electrically-operated machines. It is dealing also with the possibility of co-operation in repairs and skilled labour, and is considering the various types of tractor most suitable to large and chiefly arable farms, and to moderate sized mixed farms, having regard to the different local circumstances and requirements.

A sub-committee was nominated to report on what is at present being done to ascertain the amount and distribution of water power in the British Empire. A complete report of the first year's work of the Board will be published in due course.

Electric Vehicle Committee of Great Britain.—The annual report for the year ended March 31 states that the constitution of the committee has been broadened by including representatives of the Society of Motor Manufacturers and Traders, the Royal Automobile Club, the Institute of Cleansing Superintendents, the British Rubber Tyre Manufacturers' Association and the Institution of Automobile Engineers.

The committee's journal, the "Electric Vehicle," has been published each quarter, and continues to gain in popularity. The honorary editorship of the journal is being temporarily undertaken by the hon. secretary (Mr. F. Ayton), who has dealt with many inquiries for information concerning electric vehicles. Negotiations with the Car & General Insurance Corpn. has resulted in certain alterations being made in that company's special electric vehicle policy, thus bringing it into line with the committee's views.

Charging Plug and Receptacle.—In regard to the British Standard charging plug and receptacle, the specification of which was published during 1916, it was decided, as the result of experience with the same fitting in the United States, to suggest to the Engineering Standards Committee that the length of the encasing shell of the receptacle should be increased by 11/16 in. (18 mm.). This alteration does not entail any change in the dimensions of the contacts or insulating shield, nor will it prevent the receptacle with the increased dimension receiving the plug as at present standardised. As a result of a search made for the committee by Messrs. Lloyd Wise & Co., that firm was able to advise that the design was not covered by any patent; consequently any manufacturer in this country is now at liberty to make it.

Government Regulations, &c.—The Committee has paid close attention to such orders and regulations as have been issued by Government departments affecting the manufacture and employment of motor vehicles, and where the prospects of the electric vehicle have appeared to be jeopardised or adversely affected, the matter has been taken up with the particular department concerned. The Committee have had under consideration the short loan periods recently granted by the L.C.C. Board for the purchase of motor vehicles, and a communication was sent to the Board expressing the hope that upon the termination of the war the latter would be prepared to consider evidence showing that the actual useful life of the electric vehicle was such as to justify a considerably longer period than five years. Through the courtesy of the Society of Motor Manufacturers and Traders, the Committee now has a representative (Mr. E. W. Curtis) upon the Tyre and Roadwear Research Committee that has been formed by the society.

Charging Facilities.—A list of charging stations in England, Scotland and Wales has recently been compiled. The list contains the names of over 200 stations where the batteries of electric vehicles may be charged, and gives particulars as to maximum charging current available, hours during which charging can be done, tariff, &c. The list appears as a supplement to the June issue of the "Electric Vehicle," and it is also published in the Handbook of the Commercial Motor Users' Association.

Miscellaneous.—The Committee will be known in future as "The Electric Vehicle Committee of Great Britain; formed under the auspices of the Incorporated Municipal Electrical Association." In view of the many difficulties incidental to war conditions, the progress in the adoption and employment of electric vehicles during the year is not other than satisfactory, the total number recorded as in use or on order at the end of March, 1917, being 914, compared with 680 in the previous year. In view of the probable demand for electric vehicles after the termination of the war, the Committee sent to all automobile manufacturers in Great Britain a circular letter suggesting that the manufacture of electric vehicles should be given consideration as a branch line to the manufacture of petrol vehicles. A somewhat similar letter was addressed to electrical manufacturers suggesting the advisability of producing after the war the electrical equipments for electric vehicles. The Committee place on record their appreciation of the kindness and courtesy shown to them by the Electric Vehicle section of the National Electric Light Association of America, and also their appreciation of the voluntary service of its hon. secretary, Mr. F. Ayton. His devotion to the cause of the electric vehicle has been unremitting during the 12 months under review, notwithstanding the extra calls upon his time by reason of war conditions.

OBITUARY.

DEATHS ON ACTIVE SERVICE.—The following are reported to have died on active service:—

Corpl Wm. Bates (R.F.A.), aged 28, formerly employed on the Bolton tramways, is reported killed.

Cleveland & Durham Electric Power (Ltd.) inform us that the following employees have laid down their lives for their country: Second-Lieut. E. J. Rapp (2nd Yorks), junior engineer; Corp. A. Barnes (Durham L.I.), junior engineer; Gunner W. Cadman (H.R. Heavy Battery), junior engineer; Corpl. Woodward (Durham L.I.), linesman; Acting P.O. T. Hodgins (R.N. Div.), fireman: Pte. W. Bracegirdle (R.N. Div.), Sergt. T. Lewis (Northumberland Fusiliers), Pte. J. Rowlands (Durham L.I.) and Pte. W. Tague (Durham L.I.).

PERSONAL.

We are glad to learn that Mr. A. C. Cramb, Borough Electrical Engineer of Croydon, who recently underwent an operation for appendicitis, is making satisfactory progress.

MILITARY HONOURS.—The following honours have been earned by former employés of Cleveland & Durham Electric Power (Ltd.):—

Second-Lieut. T. Walton, Albert Medal (2nd class); Sergt. C. Hindle, Military Medal.

Other recipients of Military Honours are the following:—

Temp. Sec.-Lieut. H. E. Davis (R.F.C.) has been awarded the Military Cross. Prior to obtaining his commission he spent two years in the engineering section of Birmingham Corporation Tramways department.

Mr. L. W. Caston (First Class Mechanic, R.N.A.S.) has been awarded a D.S.M. He was formerly in the service of the General Electric Co.

Lce.-Corp. Oliver Kerby (R.E.), of Cardiff, who has been awarded the Military Medal, is engaged in a Wireless Section of the Royal Engineers.

Mr. A. E. Shorter (First Class Mechanic, R.N.A.S.), who was formerly a telegraphist in the London office of the "Liverpool Courier," has been awarded a D.S.M.

Sergt.-Maj. A. Mitchell (R.B.), formerly in the rubber department of the India Rubber Co., has been awarded the Military Medal.

MILITARY CASUALTIES.—The following casualties are reported:—

Second-Lieut. W. Gentle (R.F.A.), who is wounded, was formerly science master in the George Heriot School, Edinburgh.

Second-Lieut. George A. M. Leatham (R. Irish Rifles), who was formerly on the staff of Belfast electricity supply department, was slightly wounded in the left arm on the 7th inst. He had only returned to duty, after leave, on the 1st inst.

Corpl. E. Randle (M.G.B.), formerly in the general office of the India Rubber Co., Silvertown, has been wounded.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, June 29th (to-day).

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

3 p.m. At the Institution of Civil Engineers, Great George-street, S.W. Ninth Annual Congress. Paper to be read on "The Manufacture, Life and Maintenance of Tramway Car Tyres," by Mr. Arthur Norton, A.M.Inst.C.E. Subjects for discussion, "Return Fares," by Mr. A. V. Mason, M.I.E.E.; "Standardisation of Conditions of Labour and Rates of Pay," by Mr. E. H. Edwardes, A.M.I.E.E.; "Women Drivers," by Mr. A. Robertson, and "Traffic on Highways," by Mr. C. D. Stanley, A.M.I.E.E.

Digitized by Google

CURRENT DENSITY IN COPPER REFINING.*

BY LAWRENCE ADDICKS.

Summary.—The Author discusses the effect of current density on various factors in copper refining, notably the temperature of the solution and conditions affected thereby. The desirability of supplementing electric energy by live or exhaust steam is also discussed. Tables and diagrams are presented illustrating the effect of current density on age of cathodes, power costs and total operating costs in practice

The current density (amperes per square foot of active cathode surface) is the chief factor upon which the design and operation of an electrolytic plant depends; the cost per pound of cathodes recovered, first cost of plant and metallurgical purity of product being largely influenced thereby. There is a limit to the density employed, imposed by the temperature of the electrolyte. By far the larger part of the electrical energy is converted into heat in overcoming the ohmic resistance of the cells. Further at about 150°F. a liquid will begin to steam sufficiently to make a tank room too foggy for comfort or for efficient inspection.

Temperature of Electrolyte.—In ordinary practice with moderate densities the electrical energy is supplemented by either live or exhaust steam to obtain the desired temperature of operation generally in the neighbourhood of 130°F. This requires a balancing of the cost of heating against the gains resulting.

The writer has shown that the chief elements in the total tank resistance are the electrolyte (55·1 per cent.), conductor bars (10·5 per cent.) and the anode and cathode contacts (in all about 14 per cent.).

Increasing the temperature of the electrolyte will lower its resistance by an amount proportionate to the increase and to its temperature coefficient of about 0·5 per cent. per degree F. It will increase the resistance of the various metallic resistances and contacts which it can affect. But we may safely assume that the total change in these minor resistances with change in temperature of the electrolyte is very small.

We may, therefore, consider the temperature coefficient as approximately minus 0·5 per cent. per degree F. at high temperatures and a larger figure at low temperatures due to the added change in "transfer" resistance. An actual test recently gave 0·54 per cent.

When running at about 16 amperes per square foot of cathode surface without the use of any steam for heating, the electrolyte in an average system will run about 25°F. above the temperature of the atmosphere in the tank room, which latter is generally around 70°F. and very humid unless an adequate system of forced ventilation is employed.

This temperature coefficient of 0·54 per cent. per degree F. is so large that it at once becomes apparent that the application of direct heat to the electrolyte should be considered. Some interesting tests were carried out at another plant by measuring the temperature of the electrolyte, amperes and voltage from anode ear to cathode loop, for different current densities without direct heat. These led to the relation:—

$$\text{Watts per tank} = 20{\cdot}8 \times (\text{°F. liquor} - \text{°F. atmosphere})^{1{\cdot}45}.$$

This formula only applies to the conditions at the particular tank-house where the tests were conducted. At a room temperature of 70°F. this formula would give our practical limit temperature of 150°F. in the electrolyte with 12,000 watts per tank.

Under the conditions of this set of tests the internal tank resistance would be about 0·00003 ohm and 12,000 watts would correspond to a current of 20,000 amperes and a current density of 64 amperes per square foot. This is far above any density ever likely to be applied in practice unless marked changes in the general arrangement of the process develop.

With a density of 45 amperes per square foot the electrolyte would probably run about 120°F., and the use of steam for heating would hardly be justified. At lower densities we have the usual case of heating in the solution wells by steam.

Another result of heating the electrolyte is to increase the growth of copper in solution due to the oxidising effect of the liquor. Copper is not ordinarily considered soluble in dilute sulphuric acid, but when the solution is aerated by passing from tank to tank the oxygen dissolved brings about slow solution. This action may or may not be desirable according to circumstances.

Where quite pure anodes are being refined the excess copper builds up in the electrolyte and is usually removed by means of insoluble anode or "liberating" tanks. As these operate at from 2·0 to 2·3 volts or some seven times as much as ordinary depositing tanks require, this power tends to offset the resistance saving due to hot electrolyte.

When, on the other hand, the anodes carry considerable percentages of nickel, cobalt, &c., a proportion of the current is employed dissolving these substances electrochemically at the anode while depositing an equivalent quantity of copper at the cathode, so that the nickel, &c., will grow in the electrolyte which is at the same time depleted in copper. Then the addition of copper by chemical corrosion is very welcome; in fact, in extreme cases this effect has to be artificially increased by the use of towers of shot copper or similar means.

The final and really controlling reason for the use of warm electrolyte is the greatly improved metallurgical conditions resulting therefrom. Not only is the cathode smoother and denser, but the conditions at the dissolving surface of the anode are greatly benefited.

The increased temperature brings about a local circulation which assists in removing the dense solution of copper sulphate from the face of the anode and in preventing stratification in the tank.

When current is passed through a cold cell without any circulation of the electrolyte, conditions soon become so unbalanced that the electrodes will gas, the voltage show violent fluctuations and the anode slimes be stirred up and carried in suspension, thereby fouling the cathode.

When the electrolyte is systematically circulated these bad effects are counteracted, but the rate of circulation which can be employed is limited by the eventual stirring up of the slimes mechanically.

There is also a current density for this limiting circulation which begins to bring about a return of the undesirable gassing, and for a cold liquor and an impure anode this density is so slow as to require an abnormally large plant investment.

When the electrolyte is heated this density limit is greatly raised.

In general, therefore, (1) the temperature of the electrolyte should be carried well up toward the practical limit of 150°F. in order to be able to employ as high a current density as may be desirable from the point of view of cost of operation; (2) unless a very high density permitted by very unusual conditions is employed, heating in the solution will be required to maintain this temperature; (3) with proper exhaust steam design this heating will be practically free of direct expense.

Power.—Assume a tank resistance of 0·0000766 ohm, a counter E.M.F. of 0·010 volt per tank, 24 pairs of 2 ft. × 3 ft. anodes and cathodes, making 288 sq. ft. of surface and 90 per cent. current efficiency.

The power cost per pound of copper rises in such a case nearly in proportion to the current density employed.

It is true that we have assumed a constant tank resistance due to maintaining the electrolyte at a constant temperature by means of steam.

As the current density is raised the electrical heat dissipated in the tanks will increase, as previously discussed, and this will mean that less heating steam will be required and this saving will give some credit to be applied against the power cost.

It is evident that the cost of producing a kilowatt-hour will have a great deal to do with the question; in fact, it is possible to plot the power cost at various plants against the current density used and obtain quite a smooth curve.

First Cost of Plant.—Assume that the tank-house equipment in the example taken amounts to an investment of $300 a tank and that the power plant costs $80 a kilowatt. As the former will vary with the output of cathodes per tank-day and the latter with the kilowatt demand, both of which depend upon the current density, we can ascertain the joint influence of these two factors, which has been done in Table I.

Labour Cost.—The main labour items in operating a tank house are for inspection work to maintain current efficiency and for inserting and drawing the electrodes as the copper moves through the process.

The higher the current density the more difficult is it to maintain the efficiency on account of the increased number of short circuits caused by rough deposits on the cathodes.

After the circulation of the electrolyte has been raised to the highest rate which will not stir up slimes, and addition agents have been added to control the character of the deposit as much as possible, the only ways to maintain efficiency are either to steadily increase the inspection labour or to decrease the life of the cathodes.

Actually as the density rises the efficiency in practice is sacrificed a little, the labour is increased and the age of the cathodes decreased until a balance is struck.

* Abstract of an Article in "Metallurgical and Chemical Engineering."

Digitized by Google

Table I.—*Relation Between Current Density and Cost of Plant.*

Current density.	Lbs. copper per tank-day.	Tank investment per lb. copper per day.	Watt-hours per lb. copper.	Watts per lb. copper per day.	Power plant Investment.	Total investment per lb. copper per day.
5	81	$3.60	52	2·16	0·17	$3.77
10	162	1.85	99	4·12	0·33	2.18
15	243	1.23	145	6·04	0·48	1.71
20	324	0.92	193	8·06	0·65	1.57
25	405	0.74	240	10.00	0·80	1.54
30	486	0.62	287	11.90	0·95	1.57
35	567	0.53	335	13·90	1·11	1.64
40	648	0.46	381	15·80	1·26	1.72

Table II.—*Relation Between Current Density and Age of Cathodes.*

Current density.	Lbs. per tank-day	Lbs. per cathode day.	Cathode age in days.	Lbs. per cathode.	Cathodes per ton.	Total per ton.
5	81	3·4	100·0	340	5·9	0·18
10	162	6·7	37·0	247	8·1	0·24
15	243	10·1	15·2	154	13·0	0·39
20	324	13·5	9·6	130	15·3	0·46
25	405	16·9	6·8	115	17·4	0·52
30	486	20·2	5·2	105	19·0	0·57
35	567	23·7	4·0	95	21·1	0·63
40	648	27·0	3·2	86	23·3	0·70

The cost of making starting sheets in the multiple process also enters if the weight of the individual cathode is changed. We shall confine ourselves to an inquiry into the effect of age of electrodes upon the labour cost.

Age of Electrodes.—The age of the anodes and the proportion of anode scrap made have but little connection with the current density, except that four anodes which give heavy scrap will work at increasing disadvantage as the density is increased.

In the case of cathodes we may observe a general relation between age and density as shown by the practice at different plants and given in Fig. 1.

Taking this curve as a basis and assuming that a starting sheet costs one cent to make and that it costs two cents a cathode to handle sheets in and cathodes out of the tanks, making a total of three cents, we can figure as in Table II. the cost of changing age with density.

Metallurgical Effects of Current Density.—A high-current density will always give trouble at the anode when treating foul material and usually bring about abnormally high-voltage conditions. But even where normally pure anodes are refined the disturbance of the slimes is greater as the density is raised, due partly to the necessarily somewhat increased mechanical circulation and partly to local gassing or heat disturbances at the face of the anode.

This relation can be clearly traced in the purity of the cathode, and while it is ordinarily not sufficient in magnitude to affect the commercial purity of the copper as such, it can be clearly felt in the silver and gold losses carried away in the cathodes.

Financing Metals in Process.—In a previous article ("The Metal Tie-Up in Electrolytic Refining," Sept. 15, 1916) it was shown that the copper, silver and gold are tied up in the tank-house an equivalent of 25 days in ordinary eastern practice, which means a current density of about 20 amperes per square foot. It is evident that this time will vary with any change in the density, and for simplicity's sake we shall assume that this variation will be in straight inverse proportion.

Taking copper at an ante-bellum price of 15 cents a pound and silver and gold values of varying amounts and interest at 6 per cent. per annum, it is easy to work out data on this point.

Summary.—The first step in a design after determining the desired capacity of the proposed plant and the probable cost of power per kilowatt hour is to combine the data given under the various preceding headings and determine the approximate current density, thereby settling the size of the tank-house and power plant.

We will assume that the gain from released heat just offsets the loss from decreased current efficiency as the density is raised; that the gain from interest and depreciation on the tank-house and power plant shall be 20 per cent. per annum; that the silver and gold values in the anodes amount to $100 a ton; and that we are interested in five locations where the probable power cost is estimated at ⅒c., ¼c., ½c., ¾c., and 1c. per kilowatt-hour respectively, and other conditions are equal.

These assumptions are combined with the data from the several tables and diagrams in Table III.

The figures worked out for total costs are not the actual costs of refining, but simply totals which vary as the actual costs will when the density is varied. In order to find the density which will give the minimum cost for each power cost these results are plotted in Fig. 2, while Fig. 3 shows the minima so determined.

It will be observed that the two curves for theory and practice agree well except at the lower power costs where practice runs at a higher current density than would be expected from our discussion.

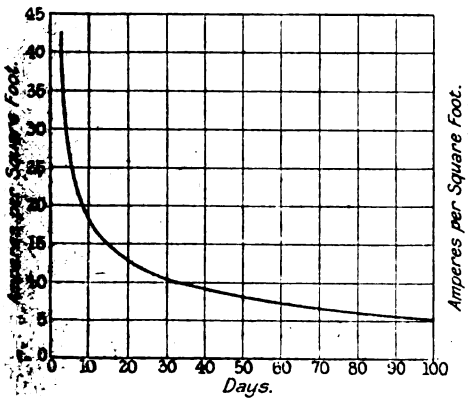


FIG. 1.—CURRENT DENSITY *v.* AGE OF CATHODES IN PRACTICE.

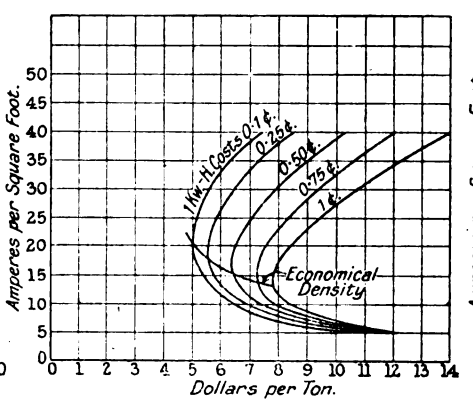


FIG. 2.—CURRENT DENSITY *v.* VARIATION IN TOTAL OPERATING COSTS.

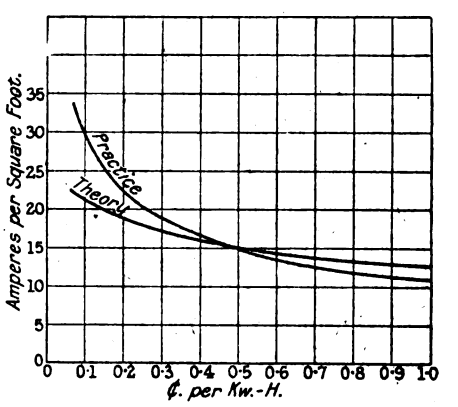


FIG. 3.—CURRENT DENSITY *v.* POWER COST, IN THEORY AND PRACTICE.

Table III.—*General Relation Between Current Density and Cost.*

Current density.	Kw.-hour per ton.	Dollar Investment per ton-day.	Cost in dollars per ton.									Dollars per ton.				
			Interest and depreciation.	Metal interest.	Metal loss.	Labour.	Power.					Total operating cost.				
							⅒c.	¼c.	½c.	¾c.	1c.	⅒c.	¼c.	½c.	¾c.	1c.
5	1·04	7,540	4·19	6·67	0·09	0·18	0·10	0·26	0·52	0·78	1·04	11·23	11·39	11·65	11·91	12·17
10	1·98	4,360	2·42	3·34	0·25	0·24	0·20	0·50	0·99	1·49	1·98	6·45	6·75	7·24	7·74	8·23
15	2·90	3,420	1·90	2·22	0·48	0·39	0·29	0·73	1·45	2·18	2·90	5·28	5·72	6·44	7·17	7·89
20	3·86	3,140	1·74	1·67	0·75	0·46	0·39	0·97	1·93	2·90	3·86	5·01	5·59	6·55	7·52	8·48
25	4·80	3,080	1·71	1·33	1·12	0·52	0·48	1·20	2·40	3·60	4·80	5·16	5·88	7·08	8·28	9·48
30	5·74	3,140	1·74	1·11	1·60	0·57	·57	1·44	2·87	4·31	5·74	5·59	6·46	7·89	9·33	10·76
35	6·70	3,280	1·82	0·95	2·25	0·63	0·67	1·68	3·35	5·03	6·70	6·32	7·33	9·00	10·68	12·35
40	7·62	3,420	1·90	0·83	3·00	0·70	0·76	1·91	3·81	5·72	7·62	7·19	8·34	10·24	12·15	14·05

Digitized by Google

HEATING OF DYNAMO ELECTRIC MACHINES WITH VARIOUS LOADS AND AT DIFFERENT SPEEDS.

BY PROF. MAGNUS MACLEAN, D.SC., AND D. J. MACKELLAR, B.SC.

(*Concluded from p.* 467.)

THE HEATING COEFFICIENT.

The heating coefficient has been calculated from the equation :—

$$K = A\theta/W,$$

where—

θ = Rise of surface temperature in degrees centigrade.

A = Cooling surface in square centimetres.

W = Watts dissipated in coil at end of the test.

The cooling surface A has been taken as the area of the outer cylindrical surface of the field coil, no allowance being made for the ends of the coil nor for the inner cylindrical surface. This area for the coil tested is 618 square cm. Most observers have pointed out the inaccuracy of surface temperature measurements by thermometer, but the surface temperature rise obtained in this way has been retained here, since up to the present it is the method used commercially. Also it has been pointed out above that mean temperature rise calculated by resistance is not necessarily free from error.

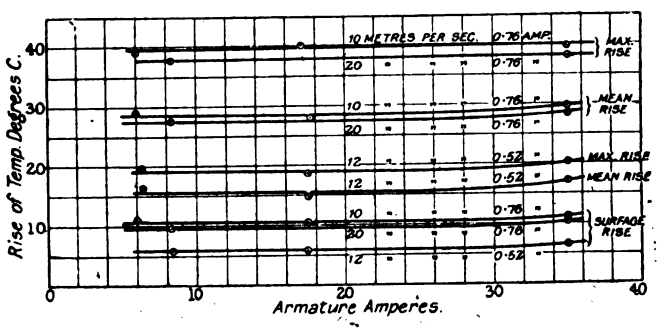


FIG. 8.

EFFECT OF ARMATURE CURRENT.

(*a*) *On Temperature Rises.*—The effect of the armature heating on the field coil temperature rises is very slight, as will be seen from the curves in Fig. 8. At 35 amperes armature current the armature and the commutator became very warm, but the increase in the field-coil temperature rises is very small indeed. This is no doubt due to the efficient ventilation of the machine by the air current from the fan.

(*b*) *On Temperature Ratios.*—The effect on the ratios maximum temperature/mean temperature, and mean temperature/surface temperature was nil. On plotting values, Fig. 9, a series of horizontal straight lines were obtained.

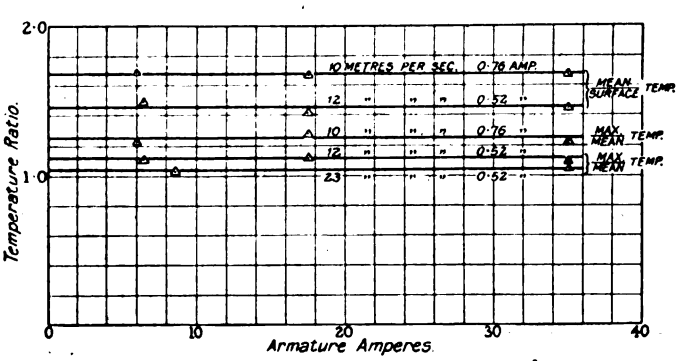


FIG. 9.

(*c*) *On Value of Heating Coefficient K.*—The value of the heating coefficient rises as the armature current is increased, but only at the higher armature currents does the increase become prominent. From the curves (Fig. 10) it will be seen that the rise in K with armature current is much more pronounced in the case of the lower field current, and therefore lower surface temperature rise,

EFFECT OF PERIPHERAL SPEED.

(*a*) *On Temperature Rises.*—It will be seen from the curves, Fig. 11, that the temperature rises become rapidly less as the peripheral velocity of the armature is increased from zero to about 5 metres per second. Above this speed the decrease is much less marked. As might be expected, the greater cooling effect at the higher peripheral velocities is most apparent in the case of the surface temperature rise. The maximum and mean temperature rises are affected to a much smaller extent.

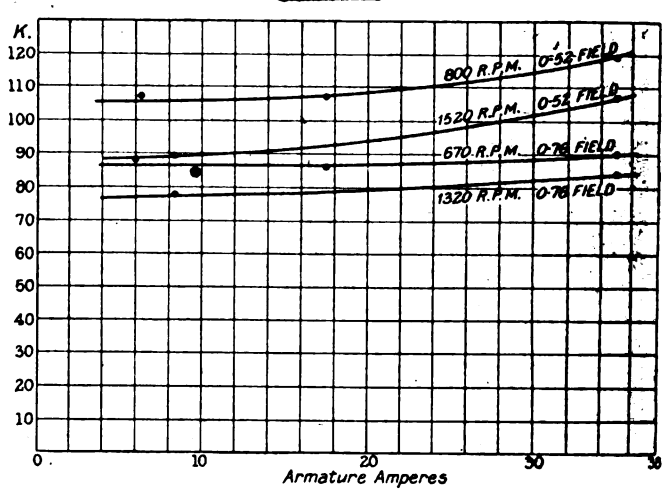


FIG. 10.

The curves of surface temperature rise are apparently represented by an equation of the form—

$$\theta = \theta_s/(1+b(v)^n),$$

where θ_s is the surface temperature rise when the armature is stationary.

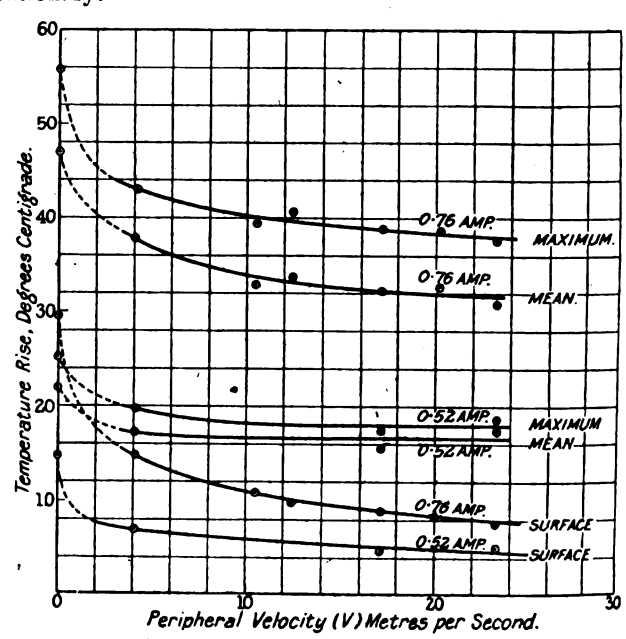


FIG. 11.

Thus, for the field current 0·76 ampere, the equation

$$\theta = 29{\cdot}7/(1+0{\cdot}451v^{0{\cdot}58})$$

satisfies the exeprimental curve from end to end ; and for the field current 0·52 ampere, the equation

$$\theta = 14{\cdot}8/(1+0{\cdot}644v^{0{\cdot}89})$$

satisfies the experimental curve.

Digitized by Google

(*b*) *On Temperature Ratios.*—The value of the ratio maximum temperature/mean temperature is practically independent of the peripheral velocity of the armature, as will be seen from the graphs, Fig. 12. For the lower field current the value of the ratio decreases slightly as the armature speed is increased, but the total decrease is only 0·04 from standstill up to a peripheral velocity of 23 metres per second. The cooling effects of the air currents apparently alters the maximum and mean temperatures in practically the same proportion.

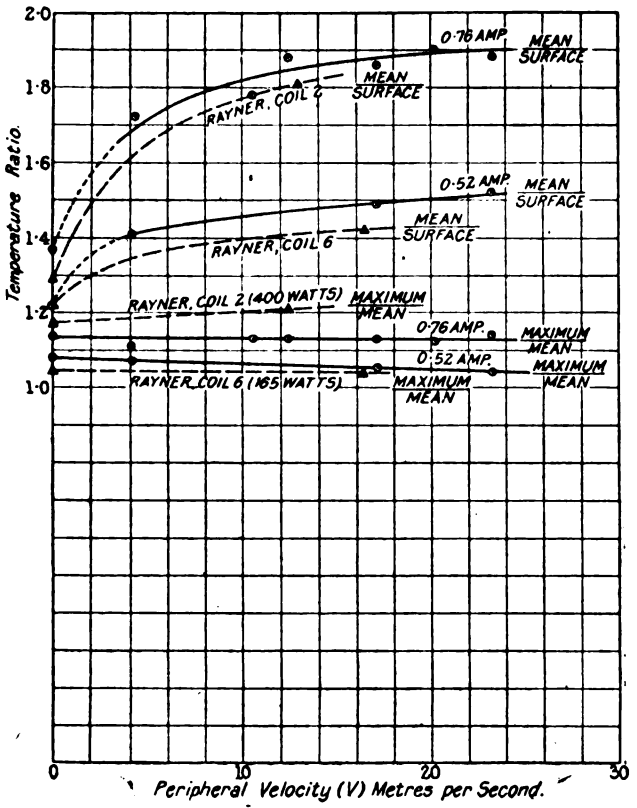


FIG. 12.

The variation of the ratio mean temperature/surface temperature, however, is very marked. The air currents from the armature and fan reduce the surface temperature very considerably while the mean temperature is only affected to a small extent, consequently the value of the ratio rises rapidly as the peripheral velocity of the armature is increased from standstill, although at the higher speeds the increase becomes less rapid.

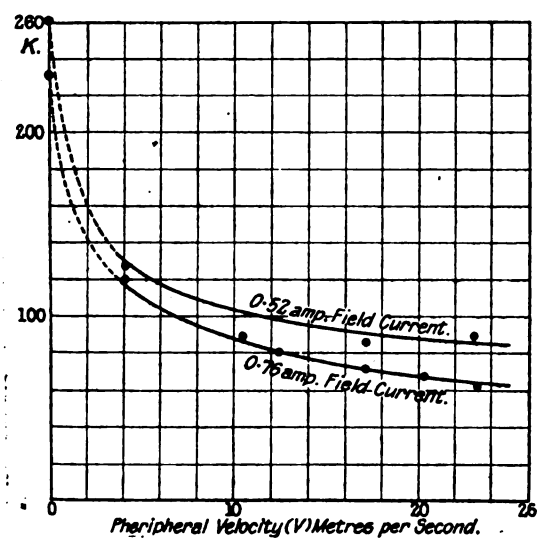


FIG. 13.

(*c*) *On the Coefficient K.*—Referring to Fig. 13, the curves show a very rapid fall in *K* as the armature peripheral velocity is increased from zero to about 10 metres per second. After this speed has been reached the fall in *K* is much less rapid.

The curves agree closely with an equation of the form—

$$K = K_s/(1+bv^n),$$

where K_s is value of temperature coefficient when the armature is stationary, and b and n are constants for each curve. For the field coil on which these tests were made the constants have the following values :—

0·76 ampere field $\begin{cases} b = 0{\cdot}464 \\ n = 0{\cdot}55 \end{cases}$

0·52 ampere field $\begin{cases} b = 0{\cdot}59 \\ n = 0{\cdot}4. \end{cases}$

COMPARISON WITH THE RESULTS OF PREVIOUS OBSERVERS.

(*a*) *The Ratio Maximum Temperature/Mean Temperature.*—Referring to Rayner's "Report on Temperature Experiments at the National Physical Laboratory," the coil No. 2 gives both at standstill and at a speed of 12·4 metres per second higher values for this ratio than any obtained in the tests described above. Also the ratio increases slightly as the peripheral velocity is increased.

For convenience of comparison the values have been plotted in Fig. 12. The coil No. 6 gives much lower values for the ratio, and the ratio decreases very slightly with increase of peripheral velocity.

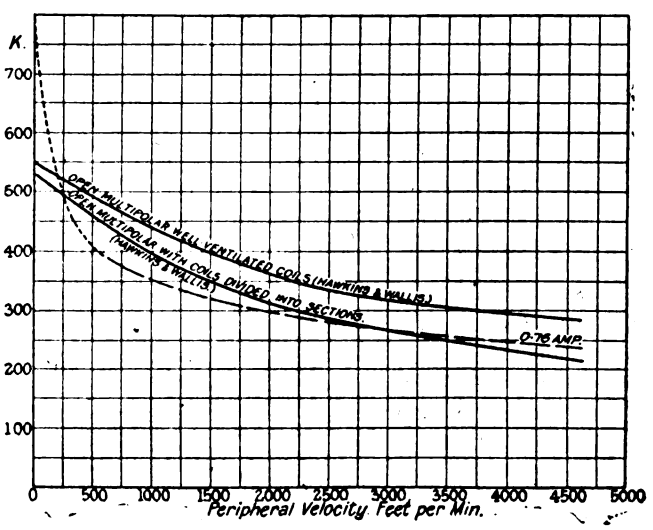


FIG. 14.

Both these effects may probably be traced to the fact that the coil No. 2 was run to a much higher final temperature rise than coil No. 6. From the present tests it may be noted that at the lower field current a decrease in the value of the ratio takes place as the peripheral velocity is increased, while at the higher field current the ratio is practically unaffected by armature speed.

Evidently for a taped coil of fair depth it may safely be assumed that for the practical range of surface temperature rise, the ratio maximum temperature/mean temperature will in no case exceed 1·2.

(*b*) *The Ratio Mean Temperature/Surface Temperature.*—For the Rayner coil No. 2 (*see* Fig. 12) this ratio varies (for the same variation in armature velocity) practically in the same proportion as in the case of the 0·76 ampere field current for the present tests. This indicates a similar efficiency of ventilation in the machine to which coil No. 2 belonged, as in the machine used for the present tests.

The machine to which coil No. 6 belonged evidently had a less efficient ventilation. Although the ratios have the same value at standstill, at a peripheral velocity of 16·4 metres per second the coil No. 6 shows a much lower value for the ratio.

(*c*) *The Coefficient K.*—Lister, in a Paper on the heating coefficient of magnet coils, has collected and compared the

Digitized by Google

Table III.—*Summary of Values of Heating Coefficients.*

Observer.	Type of machine.	Output.	Speed.	Covering of coil.	Conditions of test.	*K.*
E Brown	Two-pole motor	7½ kw.	1,250 revs. per min.	Nil.	Full-load.	1,025
Rayner, Coil 2	Six-pole motor	75 kw.	13·5 metres per sec.	Two layers of tape.	Full-load.	1,190
Lister	Medium size machine	..	..	Plain coil.	Standstill	1,750
,,	Open-type machine	50 kw.	...	...	Full-load.	1,250
,,	,, ,,	24 kw.	...	Partly-bound tape and string	Standstill	1,190*
Maclean	Open-type	120 kw.	12·3 metres per sec.	...	Running light.	1,460
,,	,,	,,	,,	...	Half-load.	1,825
,,	,,	25 kw.	10·4 metres per sec.	Varnished tape.	Running light.	850†
,,	,,	,,	10·0 metres per sec.	,,	Three-quarter load.	860†
,,	,,	,,	...	,,	Standstill.	1,300†

* Taken from curve, p. 407, Vol. XXXVIII., "Proc." Inst. Elec. Eng. † For normal field current 0·76 ampere.

heating coefficient as given by a number of observers. Advantage will be taken of his Table No. III.,* giving a summary of these values. Lister takes as a common basis for comparison *mean* temperature rise and *total* surface of coil.

In order to compare the results set forth in this Paper with those mentioned above it is necessary to multiply them by—

1. Ratio mean rise/surface rise.
2. Ratio, total surface/outer cylindrical surface.

The ratio (1) is variable and dependent on the conditions of the test. From Table II. of this Paper the values of mean and surface rise are taken, and the ratio is thus obtained corresponding to each case inserted in Table III.

The total surface of the coil is 2,200 square centimetres, and the outer cylindrical surface is 618 square centimetres, giving a ratio of 3·56.

It will be noted that the values from the present tests, for the machine running light, and at three-quarter load, are very much lower than any others given in the table. This is no doubt due to the extra cooling produced by the current of air from the fan. In this connection it would be interesting to carry out a similar series of tests with the fan removed.

A further indication of the effect of the fan is found on comparing the curve of K plotted on a peripheral velocity of the armature base with similar curves given in "The Dynamo" (Hawkins and Wallis).*

These curves have been plotted in Fig. 14, the curve (0·76 ampere field current) from the present tests being converted to the Hawkins and Wallis basis by multiplying by the ratio total surface/outer cylindrical surface=3·56.

At standstill the value of K is greater than that given by Hawkins and Wallis; and yet due to the effect of the fan this value has dropped even at the low peripheral velocity of 500 ft. per minute, below the Hawkins and Wallis values. At a medium speed the author's value for K corresponds with that given by Hawkins and Wallis for open multipolar machines, with the coils divided into sections.

* P. 412, Vol. XXXVIII., "Proc." I.E.E.

* Vol. II., p. 701.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

ANNUAL GENERAL MEETING.

The annual general meeting of the I.M.E.A. was held last Friday, when the chair was taken by the President, Mr. F. M. LONG. Early in the proceedings Mr. Guy Calthrop (Controller of Coal Mines) attended and addressed the meeting on the subject of coal supplies.

Mr. CALTHROP said he was glad of the opportunity to come there and appeal to the members for their assistance in his task. He did not ask for his position, and he could not achieve the best results unless he had the assistance of everybody concerned in the consumption of coal. He was not an expert in the production of coal, but he knew something about transport. The object of the control of coal was not to interfere with any business or industry unless it was absolutely essential in the nation's interest. They wanted to co-ordinate the efforts of everybody who was a consumer of coal, in the nation's interest. At this particular time there were two particularly difficult problems to face—first, the supply of London, so that everybody should have their reasonable requirements for next winter, and when it was realised that the population of Greater London was about one-seventh of the population of the United Kingdom, and that London was remote from coalfields, it would be seen that it was a pretty difficult problem. Another important subject he had to face was the transport of coal. This was largely a war of transport. He had the assistance of Mr. Wilson and Mr. Wright, who were experts, and with them he had got out a scheme, and hoped to get it into operation in about six weeks or two months, with the object of getting the coal consumed as near as possible to its point of origin, and by that means to save transport. They could save seven million ton-miles on the railways if they achieved all they had set out to do. It might happen that certain industries might not be able to get the same class of coal as formerly. The coal used in electrical supply, tramway and electric railway undertakings in Great Britain during the year was just short of seven million tons. That might not seem a very large thing, out of a production of 240 million tons, but every little helped, and if anything could be done as regarded the consumption of a less quantity or even as regarded obtaining coal from a nearer source of supply he was sure he could rely upon their help. Electrical undertakings represented the most efficient users of coal in the country. During the summer he would be glad if they would economise in the use of coal to save it for the winter. If the war were over to-morrow the transport business would not cease this winter. The difficulties in this country would be accentuated next winter, but he hoped they would be able to supply everybody with a sufficient supply of coal for essential purposes. He was aware of the difficulties imposed by the Ministry of Munitions and other departments due to the war, and he knew the responsibility rested upon him to see they had what was absolutely necessary in the way of coal. But he hoped they would try to get a stock of their own during the summer months which would help to tide over next winter. We had had an extraordinary winter, more coal having been consumed in April this year than had been known for many years. He expected they had an interest in prices, and, until the Government directed otherwise, and as far as he was able to do it, he intended to see the Coal (Limitation of Prices) Act carried out, and if they had troubles in that respect and they laid them before the Controller or his department they could rely upon his assistance. He congratulated the members on the able and careful way in which they had made the returns for which his department had asked.

Mr. RUSSELL TAYLOR (chairman of Liverpool Tramways Committee) said his department could only make a contract for a considerably less quantity of coal than they had last year, and they had to buy small lots and the majority of it came from a distance. Was there any hope that they might secure sufficient coal from collieries near at hand?

Mr. J. D. PEMBER (Dartford) said he usually got a fair amount of coal from Yorkshire of good calorific value, but they had had to go elsewhere and pay 5s. a ton more. Would the Government make up the difference in price?

Mr. H. S. ELLIS (South Shields) asked whether Mr. Calthrop could do anything to assist them in getting plant such as would enable them to make use of an inferior quality of coal. He had used coal for two years which was mined 60 years ago, mixing with it 25 per cent. of coke breeze, and had been getting 800 kw. to 900 kw. out of boilers designed to do 1,000 kw. Next year he anticipated a bigger load, and wanted more boilers of a type which would enable him to burn the coal he had been using. He went to the Ministry of Munitions and asked for two more boilers, and was told he could not have them unless there was a risk of shutting down munition works. By using the cheaper coal, costing 11s. a ton compared with fresh wrought, unscreened coal at £1 a ton, and by using 15 or 20 per cent. more of it they could get through next winter.

Digitized by Google

Would the Coal Controller assist him to get plant which would enable him to save coal? It ought not to be left to the Ministry of Munitions.

Mr. C. H. YEAMAN (Stoke-on-Trent) asked whether the Coal Controller could tell them that he intended to see the prices of coal in the Coal (Limitation of Prices) Act were adhered to. How would he deal with a case like his? Last year and the year before coal was obtained from a local colliery, but they were now told it could not be supplied, and that the Local Committee would arrange for another supply, and that through a middleman. The particular supply which they were recommended by the district Local Committee to take was not at the price of the contract, or within the limit set within the Coal (Limitation of Prices) Act, but about 5s. more. Last year they paid £2,000 odd more than they should have done, and this year they would pay about £500 more than that. The calorific value was less and the ash was greater. This also involved increased cost of transport and labour. The action taken in that case nullified the benefit of the Coal (Limitation of Prices) Act.

Mr. F. W. PURSE (Carlisle) associated himself with Mr. Ellis's remarks, and said he had to get a lot of Scotch Duff, which was dirtier than the coal previously used. They required assistance of the Ministry and the Coal Controller to give them plant which would burn the poorer quality coal.

Mr. F. AYTON (Ipswich) asked whether Mr. Calthrop could do anything to get them cleaner coal. That was an important point. The poor coal took more room and required more labour and more haulage, and it reduced the capacity of the boilers. At Ipswich they would be put into a very serious position next winter with their continually growing load for power purposes unless they got a cleaner coal. They had coal with an ash content of 17 per cent. to 20 per cent.; the same coal prior to the war had an ash content of 7 to 10 per cent., and therefore the same capacity could not be got out of the boilers now.

Mr. J. A. CROWTHER (Wallasey) asked how the Coal Prices Limitation Act would be applied in renewing contracts if they had to go to another colliery of which they did not know the price a year ago.

Mr. T. D. CLOTHIER (Bootle) said that in the case of an appeal placed before the Board of Trade on the limitation of coal prices he got a decision with which he did not agree. Were those matters to be closed by the new Coal Control Committee, or could they be opened again? The Board of Trade decision did not bring the prices within the Coal (Limitation of Prices) Act.

Mr. C. F. MCINNES (Gravesend) asked whether the Controller would deal with sea-borne coal or only with railway transported coal.

Mr. CALTHROP said sea-borne coal came under his control as much as railway borne or canal borne coal. In regard to contracts and the difficulty of not getting the quantity required, if there were cases where contracts had not been renewed, he would be glad to have information in regard to them. If there was a necessity for coal, and if there was any difficulty in obtaining it, he would be glad to help in that direction also. Mr. Pember apparently wanted him to assist him financially, but he thought the Coal Controller had enough to do in other directions. With regard to Mr. Ellis's questions, he was quite willing to assist anybody in regard to plant who was prepared to make out a real case of economy in coal consumption, or if they said they would not take any coal out of the pits, having it lying by them. The case which Mr. Yeaman mentioned was one of which the details should be brought to his notice. with regard to obtaining cleaner coal, he would assist them in dealing with complaints of that nature if he could get the names of the collieries from which dirtier coal came. It was easier to deal with a real case than with a general question.

A vote of thanks to Mr. Calthrop was then passed.

The President then moved the adoption of the report of the Council, and in reference to the paragraphs on "Model General Conditions of Contract," moved that the resolution of the General Meeting of 1913 referred to therein be rescinded.

Mr. AYTON seconded.

Mr. PURSE moved an amendment that the resolution be referred back, subject to no action being taken until the matter had been referred to the Association again in full meeting.

Mr. A. W. BARHAM (Watford) seconded, and the amendment was carried.

Mr. S. E. FEDDEN (Sheffield) asked whether the President could give them any later news with regard to the Board of Trade Committee referred to in the report under "British Trade after the War."

Mr. H. FARADAY PROCTOR (Hon. Secretary) said their work had been divided into two Board of Trade Committees. The Board of Trade Committee referred to in the report was the first Committee appointed to deal with electrical trade after the war The Association gave evidence before that Committee, and at a later stage the Board of Trade appointed another Committee, now generally referred to as the Power Committee, which he believed was appointed more or less at the instance of the former one, and was especially prohibited from touching upon municipal trading. With regard to the new Committee the Council was not satisfied with the representation. The members of the Association had been circularised, asking that a resolution should be passed by their respective municipalities requesting the Board of Trade to give more adequate representation, to municipalities and many of them had done so. The President of the Board of Trade had agreed to give an increase of three municipal representatives. Their Hon. Secretary would presently put forward a resolution which the Council had passed that morning with reference to that representation. The Secretary of the new Board of Trade Committee had requested the Association to submit the names of a witness or witnesses to give evidence before them, but within the last two or three days they had altered their request and said that owing to their desire not to duplicate evidence they thought it would suffice if one witness was forthcoming to give evidence before them, and they would advise on the particular points on which they wanted evidence. The last letter seemed to indicate that there was only one point on which they wanted evidence.

Ald. PEARSON (Hon. Solicitor) said this matter had been discussed several times, and the Council had passed the following resolution, which he moved on their behalf:—

> "That the Incorporated Municipal Electrical Association in Annual Meeting assembled desired to request the President of the Board of Trade to accept the recommendation of this Association in conjunction with the Association of Municipal Corporations in regard to the three additional members he has undertaken shall be added to the recently appointed Board of Trade Committee on Electric Power Supply."

It was perhaps unwise to ask that they should have the right to suggest all the names that should be added to the Committee. The Association of Municipal Corporations were no doubt deeply interested in the subject as well as themselves, and the Council thought it would be better if they associated themselves with the other Association so that they could have the benefit of their support in any pressure they desired to bring on the President of the Board of Trade.

Mr. J. H. CLOTHIER (St. Anne's-on-the-Sea) said the Urban District Councils Association had sent out a letter, he presumed to all members of their association, in which they asked for suggestions of names of gentlemen for appointment on the committee. Had they not better add the name of the Urban District Councils Association to the resolution as well?

Mr. PURSE said he knew a gentleman who was chairman of a district council, and was an engineer as well, who had been asked to consent to be nominated. He thought he was a suitable representative.

Mr. A. H. SHAW (Ilford) said he agreed that the Urban District Councils Association should be included in the resolution.

Mr. BARHAM (Watford) said his committee had had a similar letter, and they had nominated a candidate from the Council.

Mr. H. R. BARGE (chairman of the Poplar Electricity Committee) said they must be represented on the committee and not by the people the Board of Trade chose, who might be selected because they were associated with big companies. He had opposed the inclusion of the Association of Municipal Corporations in the resolution, but the main thing was to save themselves from private undertakings being against them. He thought the meeting would do well to take the resolution as the committee left it. They should get the power to nominate three representatives and fight out the matter afterwards with the Association of Municipal Corporations as to who had the two or the one, and he thought they would come to a more or less amicable agreement.

Ald. PEARSON said if there was any strong feeling in favour of bringing in the Urban District Councils Association he did not think any objection would be raised by the Council.

Mr. T. ROLES (Bradford) said in the event of the Board of Trade declining to agree to the Council's request he suggested that the Council should consider whether any evidence should be placed before the committee. If three so-called municipal representatives were on that committee who were not heart and soul municipalisers the position of the municipalities would be worse than if there was only one municipal representative. Could the President say whether the Association of Municipal Corporations was going to put in any engineering evidence given by a municipal engineer? If so he thought it was time the I.M.E.A. took strong action. If their Association could not represent the engineering side of that matter it was time it shut up shop altogether.

Ald. WALKER (Manchester) said he had brought forward a proposal similar to Mr. Roles' but after consideration the Council decided upon the resolution now before the meeting. He thought they had the right to take note of what had occurred with regard to the evidence to be given. Originally they were asked to provide "witnesses." Now that had been watered down to "a witness," and the committee asked that the name of the witness should be furnished to them, and said they would indicate to him the points on which they desired him to give evidence. That was not the right way to go about getting evidence. They should have left it to some extent within the control of that association. In the event of a refusal to allow the nominations to go forward he would be prepared to recommend that consideration be given to the advisability of refusing to tender any evidence, but it was for the municipalities to see to it that their representatives and evidence were given a predominating position. He could not conceive of the legal department of any city council taking upon it to represent the electricity department before the committee. If it happened in any public authority of which he was a member there would be serious trouble. The legal and electricity departments could formulate in consultation a policy, as recommended by the Association, which could be put as an ultimatum to the Board of Trade.

Ald. PEARSON said he sincerely hoped nothing in the nature of a threat would be added to the resolution. They could make trouble without threatening it beforehand. In the event of their not getting proper representation they should call a meeting and take instructions as to what should be done. If it was desired that the Urban District Councils Association should be brought in he suggested that an amendment to that effect should be moved.

Ald. J. P. SMITH (Barrow-in-Furness) said this was a pure question of power supply, and he could not see why the Association of Municipal Corporations should come into the question. As far as the working of that association with them was concerned their experience had been unfortunate. They would get better representation if they acted alone. He thought their Association should appoint at least two out of the three representatives, and that they should be engineering members. The committee should give the Association information as to what points

Digitized by Google

they wanted dealt with and the Association should select the right man as a witness. He agreed that they should not add any threat to the resolution.

Mr. PURSE said he would move an amendment to the resolution to include the Urban District Councils Association. That Association had been asked to nominate a gentlemen, to give evidence he thought. That gentleman appeared before the Association on the previous day and was questioned as to his capabilities for giving evidence. He was a Chairman and also an engineer.

The HON. SECRETARY said the Association of Municipal Corporations had been asked to give evidence. They had decided that it was desirable that evidence should be forthcoming on their behalf from a large town, a town of middle size and a small town, and the Council had presumably adopted a proposal that representatives should be put forward from Leeds, Blackburn and Sutton Coldfield. He believed one of those gentlemen was an engineer.

Ald. PEARSON said the amendment was: That the words "and the Urban District Councils Association" be inserted in the resolution immediately after the words "Association of Municipal Corporations."

Mr. SHAW (Ilford) seconded the amendment, and it and the resolution as amended were carried unanimously.

Mr. ROLES said they should have a definite policy before their representative gave evidence before the Committee. The large and small towns would probably have different ideas. They should consider the matter first separately and afterwards jointly and make a joint report.

Mr. ELLIS agreed with Mr. Roles. They would be absolutely cut out unless their representative produced a different scheme.

Mr. ROLES moved "that it be a request to the Council to prepare a report outlining the policy of this Association in regard to the organisation of electricity supply." The resolution was carried.

The result of the election of Officers and Members of Council for the year 1917-18 was then announced as follows:—

President: S. J. Watson (Bury); *Senior Vice-President:* F. Ayton (Ipswich); *Junior Vice-President:* J. Roles (Bradford) (*Past Presidents* H. Richardson, A. C. Cramb and F. M. Long continue in office); *Hon. Solicitor:* Ald. G. Pearson (Bristol); *Hon. Secretary:* H. Faraday Proctor (Bristol); *Hon. Treasurer:* J. E. Edgcome (Kingston-on-Thames). *Members of Council:* (*Engineers*) S. T. Allen, J. H. Bowden, S. E. Britton, J. Christie, W. W. Lackie and S. L. Pearce; and (*Committee Representatives*) Coun. H. R. Barge, Coun. A. Sinclair, Ald. W. Walker and Ald. C. West continue in office. *New Members of Council:* (*Engineers*) S. E. Fedden (Sheffield); W. T. Kerr (Hereford); J. A. Robertson (Salford) and (*Committee Representatives*) Ald. A. R. Jephcott (Birmingham) and Ald. Robinson (Bradford).

The HON. SECRETARY stated, in reference to the clause in the report regarding "Alleged Preferential Charging at Hackney," that £1,000 had been voted in support of the Hackney Council's defence.

It was agreed that the question of the place of the next Annual Meeting be left in the hands of the Council.

Mr. PURSE called attention to the fact that power companies and private interests seemed to get what they wanted from the Ministry of Munitions in regard to extensions of plant, but municipalities were not allowed to make extensions, and consequently might have to shut down on various occasions during the winter. There must have been great favoritism to power companies and private interests. The power companies could thus take customers the municipal undertakings had to refuse. Drastic action ought to be taken in regard to that matter. If the Ministry of Munitions would not give them satisfaction they should ask their Members of Parliament to ask in the House how much money had been loaned for extensions of plant to power companies and private interests and municipalities, respectively.

The HON. SECRETARY said the matter could best be brought to a head by asking the members who had facts bearing on the subject to bring them before the Council who would try to get some explanation from the Government.

Mr. T. D. CLOTHIER (Bootle) suggested that when circulars and inquiries were received by members they should be sent to the Secretary and that permanent records should be kept of them. Such matters as records of labour conditions would be worth keeping.

Mr. J. E. EDGCOME (Kingston-on-Thames) said keeping a bureau such as Mr. Clothier suggested would be a pretty big thing if carried out thoroughly. From the Treasurer's point of view it would necessitate considering the question of increasing the subscriptions.

Bailie SMITH (Glasgow) moved a vote of thanks to Mr. Long for the way he had filled the Presidential Chair and conducted the business of the Council during the past year, to the Hon. Solicitor (Ald. Pearson), the Hon. Treasurer (Mr. Edgcome) and the Hon. Secretary (Mr. Faraday Proctor). The motion was carried with applause.

At a special meeting which followed the members approved proposed alterations of the Articles of Association in reference to the election of Members of Council.

With regard to the resolution set out under "Articles of Association" in the Council's report, Mr. Purse said he would have preferred the figure to be 100,000 instead of 50,000.

Mr. SHAW did not think population should govern the matter. It was important that Urban District Councils should be represented on the Council, and it was possible that the proposition before the meeting would not altogether meet that requirement. He would move that there should be 12 engineer members on the Council, not less than three of whom should represent Urban District Councils.

Mr. BARHAM (Watford) seconded Mr. Shaw's amendment.

Mr. A. NICHOLS MOORE (Newport, Mon.) supported the Council's proposal.

The amendment was lost, and the resolution was carried.

ANNUAL REPORT OF THE COUNCIL.

The following is an abstract of the annual report of the Council submitted to the annual general meeting of the Association on Friday last:—

Membership.—The membership of the Association stands at 374. There is a decrease of two in the total membership, the decrease being in the Associates' class.

Model General Conditions of Contract.—At the last annual general meeting of the Association it was pointed out that for two years previously the Council of the Association had been in negotiation with the Council of the Association of Municipal Corporations on what were then known as the "Beama" clauses of the Institution model general conditions. As no report was received from the Association of Municipal Corporations on the subject, and as that Association did not respond to the repeated applications of the I.M.E.A. Council to complete their consideration of the matter, it was suggested by the Council of the I.M.E.A. at the annual general meeting last June that the resolution of the annual general meeting of 1913 should be rescinded and the conditions provisionally adopted. This proposal was withdrawn at the time, as the meeting was given to understand by a member of the association that the Law Committee of the Association of Municipal Corporations had approved the final draft, and that all that remained to be done was for the Council of the Association to report to the general body of members on the subject. Since then the Council has definitely ascertained that the statement referred to was made by the member concerned under a misapprehension, and that no agreement on the subject had been come to by the Association of Municipal Corporations. Further recent inquiries by the I.M.E.A. have resulted in a reply from the Association of Municipal Corporations admitting that the subject is in a position that cannot be regarded as altogether satisfactory. It may be pointed out that the matter has now been before the Association of Municipal Corporations since the year 1913. The present deadlock can only be removed by the general meeting rescinding the resolution of 1913, and so enabling the Council of the Association to move in the matter independently. The Council therefore recommend to the general meeting that the resolution referred to be rescinded, and the matter left in the hands of the Council.

Supply of Electricity Bill.—Immediately after the business meetings last June, a joint meeting of representatives of the Council of the Association and of the Association of Electric Power Companies was held, and it was decided to form a Joint Committee to deal with the Supply and Electricity Bill now in draft, and to invite the I.M.E.A. to appoint three representatives in addition to Mr. H. Faraday Proctor, who had been appointed joint honorary secretary of the Committee with Mr. de Turckheim. Mr. F. M. Long, Ald. Walker and Mr. J. W. Beauchamp were appointed to represent the Association. As the outcome of the work of the Joint Committee, several new clauses have been embodied in the Bill. These new clauses deal with the granting of wayleaves over, under or through private property, the construction of lines over ground, the re-drafting of the clause dealing with the giving of partial supply in certain cases (stand-by), the supply to districts where there are no authorised undertakers, obligation of undertakers to furnish a supply, methods of charging, charging and maintenance of electric vehicles, &c. The various clauses in the Bill were gone through, and evidence in support of the same was given in considerable detail by your president, Mr. Faraday Proctor and Mr. Roles on behalf of the I.M.E.A., and Mr. W. A. Chamen for the I.A.E.P.C., before the Board of Trade Committee on Electrical Trade after the war.

Linking Up.—On the same day, at a similar meeting, the I.M.E.A. was invited to appoint five representatives on a joint committee in addition to Mr. H. Faraday Proctor, who was appointed joint honorary secretary with Mr. de Turckheim. The I.M.E.A. representatives are Messrs. T. Roles, S. L. Pearce, R. A. Chattock, W. W. Lackie and J. H. Bowden. Several meetings of the Joint Linking-up Committee have been held, and local Committees have been appointed in various districts throughout the country, all of whom have had meetings and are getting out statistics and other information, and in some few instances considerable progress in the matter of linking-up has actually been made.

Eastbourne and the Board of Trade.—The Council have received a number of suggestions from members in regard to this matter, and these suggestions have been dealt with by a special sub-committee, whose report has been received. In view of the fact that the recommendations of the officer of the Board of Trade were not adopted by the Board of Trade, and bearing in mind that the electrical adviser to the Board of Trade is retiring from office in June, 1917, and that, therefore, it was difficult to take up the question of detail with him, further consideration of this matter has been deferred.

Training of Disabled Sailors and Soldiers.—At the invitation of the Institution of Electrical Engineers the I.M.E.A. nominated Mr. J. W. Beauchamp to serve on the committee formed by the Ministry of Labour to make inquiries into the question of the employment of disabled sailors and soldiers in the electrical industry, and the training necessary for this purpose. Mr. Beauchamp also represents the Association on a similar but distinct committee formed by the Ministry of Labour.

Engineering Standards Committee.—The Association has contributed £21 to the funds of this Committee, and continues to be represented on many of its sectional committees, sub-committees and panels.

Digitized by Google

Research on Buried Cables.—At the request of the Institution of Electrical Engineers, the Council of the I.M.E.A. issued an appeal to undertakings represented in the Association to support financially the Institution in the work which it was carrying on in this matter.

British Trade After the War.—Following the resolution passed at the last annual general meeting which was communicated to the Prime Minister, the Engineering members of the Association were circularised, and the honorary secretary, Mr. Faraday Proctor, attended on several occasions before the Board of Trade Committee on electrical trade after the war. The President, Mr. F. M. Long, and Mr. Thos. Roles, of Bradford, also gave evidence. The report of the committee has not yet been published.

As previously mentioned in this report, evidence was given at great length in support of the various clauses of the Supply of Electricity Bill, and also in connection with various recommendations put forward as to the constitution, duties and limitations of Government departments, concerned in the regulation of the actions of electrical undertakers, and the supply of electricity generally.

Alleged Preferential Charging at Hackney.—The members will be aware that the Gas Light & Coke Co. are bringing an action against the Hackney Borough Council on a case of alleged preferential charging. The Council considered that Hackney had a very good case, and strongly recommended the members of the I.M.E.A. to contribute towards their defence. The Council take this opportunity of again reminding members that their promises of contribution should be sent in as early as possible.

Articles of Association.—The Council have given very careful attention to the question of the revision of the articles, providing for postal ballot, and also for an altered constitution of the Council. The proposals as regards the alteration of the articles have already been communicated to every member. The effect of the alterations is that while the number of the Council—viz., 25 members—is not increased, there will be only one vice-president and only one past president; thus adding three to the number of ordinary engineer members of the Council, without increasing the total number, or altering the present proportion between engineer and committee members. As regards the question of the definite representation of all sizes of undertakings, small as well as large, the Council are of opinion that this will be better dealt with by a resolution of a general meeting, rather than by embodying any decision arrived at in the articles, as any resolution adopted could be amended if occasion arise without the formalities necessary for an amendment of the articles of association. At the forthcoming annual general meeting, therefore, a member of the Council will move a resolution somewhat in the following form:—

> "That whereas by Article 28 there shall be 18 ordinary members of Council, 12 being engineer members of the Association, and six representing municipalities, and by Article 29*a*, four engineer members of the Council and two municipal representatives of the Council shall retire annually, it is resolved that annual elections be so arranged that there shall, during each year, be nine engineer members on the Council from undertakings owned by local authorities where the population of the area of supply exceeds 50,000; and three engineer members from undertakings owned by local authorities where such population does not exceed 50,000."

Electric Vehicle Committee.—During the past year the scope of the Electric Vehicle Committee has been widened, as is indicated by its new title "The Electric Vehicle Committee of Great Britain. Formed under the auspices of the I.M.E.A."

Honorary Treasurer's Report.—The general expenses and postages show an increase due to increase in work undertaken. The cost of printing is higher because the "Proceedings" were larger. Total expenditure is £545, or £50 more than last year. The income from subscriptions is normal, and the revenue from "Proceedings" £154, an increase of £50. The receipts from members' and delegates' fees are normal, and the total income is £554, as against £506, leaving a balance of £10 as surplus for the year. The total surplus of assets over liabilities is £936, so that the Association continues to be financially sound, but there is no margin for expansion, and it is a question whether the subscriptions should not be raised so as to enable the Association to deal with more advantage with questions affecting the interest of that section of the industry represented by the Association.

Agricultural Development.—The Paper submitted by Mr. W. T. Kerr, of Hereford, at the last Convention on "The Use of Electricity in Agriculture," led to the formation of the Committee on the Development of Electricity in Agriculture. The following members of the Council were appointed to form the nucleus of this Committee: Messrs. Long, Ayton, Britton, Christie, Allen and Faraday Proctor, with Mr. Britton as convenor, and the following sub-committees have been formed: Publicity (Mr. W. T. Kerr, chairman) and Technical (Mr. F. M. Long, chairman). The committee have in preparation a pamphlet on the subject with a view to distribution at the present Convention.

It is proposed to invite representatives of Government departments, agricultural societies and electrical associations to serve on the committee, so as to co-ordinate co-operative effort in carrying out the objects of the committee.

The Honorary Secretary.—The Council desires to place on record its appreciation of the untiring and valuable services of the hon. secretary, Mr. H. Faraday Proctor. During the past year, in addition to devoting a very great deal of time and personal effort to the normal work of the Association, he has undertaken a large amount of work in connection with matters arising from the state of affairs caused by the war.

THE ELECTRICAL PROPERTIES OF GASES.

(*Concluded from page* 315.)

In his fourth lecture, Sir J. J. Thomson exhibited photographs of spark discharges and of lightning flashes, some of the latter showing black (reversal) branches and multiple discharges, bands of many fairly parallel lines. The "roll" of the thunder, he remarked, was partly due, no doubt, to reflection from clouds; but with flashes miles in length the acoustic effects of the discharge would naturally be drawn out, and as the observer might be equally near two points of an oblique discharge, the sound might momentarily be intensified into a crash. Lightning conductors should be regarded from two points of view: (1) As decoys to draw the discharge they should offer the shortest path to earth. The ordinary electric resistance of the conductor was of little importance for the sudden rushes; it was more a question of inertia, like setting a tube full of liquid suddenly into motion. In a demonstration a spark-gap was shunted by 7 ft. of wire; the ordinary current went through the wire, the gas discharge through the gap. From this point of view a bad conductor was worse than no conductor at all, and a conductor on the neighbour's house better than one on one's own. (2) To reduce the intensity of the field. For this purpose the conductor should end in points, from which a stream of negative electricity would escape, forming a layer of that electrification above the house and below the positively charged cloud, so that the house became surrounded by ionised conducting air, like Faraday's metallic cage. The wind would distribute this layer, and towns might conceivably be protected by placing apparatus to produce ionisation in such a position that the wind should spread the ionised air as a shield over the town.

Prof. Thomson then demonstrated the appearance of the discharge through gases by a series of experiments under different conditions, especially of potential, gas pressure and electrode distance. At ordinary pressure a spark passed through a tube; as the pressure was reduced the glass shone with a bluish glow, then a diffuse reddish glow filled the tube, giving way to a green phosphorescence of the glass. Finally, a velvety glow spread over the kathode; next this was the narrow dark space of Crookes; then the short negative glow and the dark space of variable length of Faraday, beyond the luminous positive column up to the anode. When the kathode was perforated, a stream of positive rays (not deflectable by the magnet) was seen to pass through the canals. Broadly speaking, the potential required for the discharge was greater the greater the electrode distance and the greater the gas pressure; but it was extraordinarily difficult to get very short sparks, and with constant gas pressure there was, in fact, a preferential electrode distance which a spark would cross rather than either a longer or a shorter gap. Similarly, there was a preferential gas pressure with constant electrode gap.

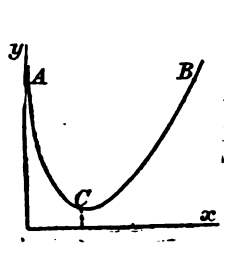


FIG. 1.

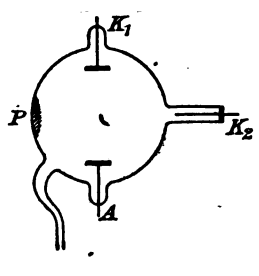


FIG. 2.

The essential thing was the quantity of gas between the electrodes, as Fig. 1 exemplified, in which the potential was plotted against the quantity of matter as abscissa. At *A* there was little, at *B* abundant, matter, and in both these cases the discharge would hardly pass, whilst *C* marked the optimum discharge conditions. In one of the demonstrations a glass tube was so shaped that it formed a flat coil and two bulbs, joined by a narrow tube, all in a closed circuit. In the narrow tube the wire electrodes approached one another within 0·5 mm., whilst the flat coil had a length of 0·5 m.; the discharge preferred to take the long way round. In another experiment

Digitized by Google

a spark-gap in air shunted a wider electrode gap in a tube which was being exhausted. At first the spark crossed the outer gap, then the discharge passed within the bulb, and at the highest exhaustion the outer gap was again preferred. In a third similar experiment the electrode distance was altered; the kathode of the vacuum tube was floating on mercury, and was raised or lowered by altering the mercury level. First the discharge preferred the outer path, then it crossed the shortened gap inside, and finally again the outer path.

Before passing to the striated discharge, Prof. Thomson (fifth lecture) went back to the discharge conditions and Fig. 1. To sustain the discharge, a supply of ions had to be kept up. An electron colliding (in the field) at sufficient energy with molecules would "breed" more — and + ions, at the rate of interest compounded, not yearly, but every day or second. When $A=A_0e^{at}$ (*e.g.*, where a was $1+5/100$), one electron travelling 3 mm. could create $e^3=20$ electrons, and create three millions on a path of 15 mm. Yet those electrons would be swept over to the anode and vanish, and the discharge might fail. The sluggish positive ions were hence drawn into the explanation; their part was perhaps exaggerated, Sir Joseph said, though theoretically they had to be considered. The radiation from the walls struck by the + particles had been overlooked, he thought, and there were other agencies helping the + particles in creating the one negative particle required for maintaining ionisation. If X were the electric force, λ the distance between one collision (of an electron and molecule) and the next, when the previous history of the electron was wiped out, Q the energy required for ionisation, V the potential between electrodes at distance d, p the gas pressure, then $X\lambda e=Q$, $Xe=Q/\lambda$ and $Ve=Qd/\lambda$, and V varied as Qdp, *i.e.*, as the quantity of gas in the gap d. Now, if it were easy to get up to enormous numbers of collisions with sufficient gas, those numbers would rapidly fall off likewise if either the gas pressure p or the gap d were much reduced. From millions of ions we might come down to, say, five, and it might need 1,000 positive ions to produce a fresh ion. For that reason the discharge might fail at A in Fig. 1, owing to there not being enough gas in the gap. The optimum condition in the case of air (C in Fig. 1) corresponded to 300 volts, and the product, gas pressure × distance pd was 7, when p was measured in mm. of Hg and d in mm. A gap of 7 mm. would be about ·15 times the free path of the molecules.

As mentioned, ions might also be produced by radiation. For instance, by a Röntgen radiation, which gave rise to a peculiar dark olive green (not the ordinary yellow green) phosphorescence of glass. This was demonstrated with the aid of the bulb, Fig. 3, which had two kathodes, K_1 and K_2, K_2 being within a capillary tube, from which it did not project. When the discharge passed first between K_1 and A, a bluish stream was seen; when the kathode K_2 was joined up, the appearance changed, and a reddish, very soft radiation (well up in the Schumann region) was noticed between K_2 and the spot P opposite K_2, which showed this dark green phosphorescence. That a gas only began to radiate when the electrons exceeded a certain minimum energy was shown with the aid of a Wehnelt kathode; at 40 volts the gas in the bulb remained dark, at 80 volts the whole gas phosphoresced.

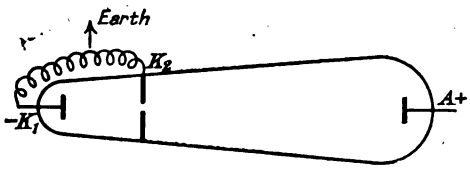


FIG. 3.

In the ordinary discharge the field was uniform, and the graph of the energy required to break up the molecule was a straight line. Not so in the case of the striated discharge. As the gas pressure in a tube was reduced (demonstration), the positive column increased in intensity and length, and then separated into bright and dark patches; on further reducing the pressure the intensity diminished again, the striation became indistinct, and finally there was only the greenish phosphorescence of the glass. The distance between the striations depended upon the diameter of the tube; in the narrow portion of a tube the striations crowded up, and were more difficult to produce. In the next demonstration Prof. Thomson showed that striations might be produced even between electrodes which were at the same potential. The two kathodes K_1 and K_2 (Fig. 3) were connected and earthed, K_2 being a disc perforated in the centre. Yet the whole space from A to K_1 was filled with the discharge; when, however, the current was reversed, the part K_1K_2 remained dark. That seemed paradoxical. When we were dealing with gases at low pressure, however, we were no longer dealing with forces at any particular point, but with the average force over a distance which was considerable when compared with the mean free path. A certain energy and velocity were needed for the electrons to produce ionisation. As long as the free path was short (fraction of a mm.) the Q was equal to $X\lambda$ (leaving the e out), as generally in energy. But when the λ was several cm. in length in a vacuum, the Q depended on the X, not at the beginning or at the end of the path, but on the average value of X. The force might be negative at the beginning and yet have a positive average value; thus it was possible to get a current with no potential between the terminals (K_1 K_2 in Fig. 3), or actually against the potential. In investigating the striations at very low pressures he had made use of the Torricelli vacuum (a barometer tube, containing two electrodes connected by a sheet of glass) and the pencil of soft radiation (K_2A of Fig. 3) from a kathode encased in a capillary. He floated the horizontal tube on mercury, so that the striations were brought up to the vertical pencil of rays and deflected P. In this way he had obtained the curve roughly indicated in Fig. 4, the convex side of the striation facing the negative terminal. Just in front of the luminous crescent

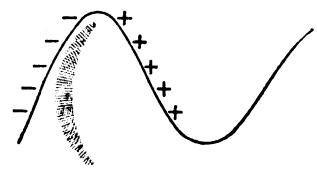


FIG. 4.

the force was negative, but it increased rapidly as one came closer to the luminosity; it then turned positive, dropping off on the other side, becoming negative again, and so on. On the steep side of the striation the negative force certainly preponderated, and it was actually negative at sufficiently low gas pressure when these effects were exaggerated. But how were the striations kept stable? Supposing we started from a spot, at which the force was negative and had been negative for some time. An electron there would be unable to ionise the gas, and the spot would be dark. As the electron proceeded it would get into a stronger field and ionise the gas; but the resulting + particles would move slowly and almost appear stationary. When the number of + particles equalled the —, the charge would be nearly neutralised, and the graph of the force would become horizontal, then fall off, because the — particles would be attracted back by the +. The rate of ionisation might, however, continue to increase for a time, because the maximum force did not coincide with the mean maximum. Striations would arise between two points if the drop of potential between the two were less than the average value required for continuous discharge.

In the last lecture Prof. Thomson considered first the connection between gas ionisation and luminosity. When the discharge was sent through a tube, different colours appeared in different parts; there was no ionisation in the dark spaces we knew, and the question arose: Was the light the result of ionisation, and did we get light where we had ionisation? Before light and ionisation set in, the particles had to be speeded up to certain values; but was ionisation essential to luminosity? There were cases of luminous gases without ionisation; vapours of iodine, anthracene and other compounds, with several benzene rings, became luminous in ultra-violet light without any trace of ionisation. Yet the exceptions might be apparent only. There was no actual ionisation, but perhaps a quasi-ionisation, a shifting of the electrons which acted as mortar for the atoms in the molecules. These electrons might be differently grouped, double bonds be changed into simple bonds: $C=C$, C into $-C-C-$; that might be so in phosphorescence and other forms of cold light. The converse question, Was there always luminosity wherever ionisation appeared? was difficult to answer, because ionisation was far more easily detected than luminosity. Röntgen rays sometimes carried ionisation without light; in any case, it could not be said that complete ionisation was necessary for light. Another question:—At what stage did the luminosity set in; when the electron left the atom, or when it returned to its atom? In the striated column it might be either way; but some experiments of the lecturer's supported the latter view. He let soft X-rays impinge on solid oxides at different speeds, and studied the variation of the radiation with the speed. He found that a certain voltage (15 or 20 volts) was required to start radiation. On increasing the volts the radiation increased, but remained mostly of the same type, until a jump occurred and another type of radiation appeared. That was repeated, and the radiation remained in each successive step of a certain type (though not entirely so). That was difficult to understand if the radiations were to be due to the emission of electrons which took place at increasing speeds, but was compatible with the view that the radiation was due to the return of the electron, which was at the same rate for all speeds. The

Digitized by Google

different types were explained by the assumption that the positive residue to which the electron returned retained sometimes one, and sometimes two charges, &c., and that the spectroscopic type changed in accordance with the charge. By altering the condition of discharge (in the induction apparatus) the discharge through argon was known to change from pink to blue; that might be a case of different charges. Here ionisation would be essential. When a bulb contained a mixture of hydrogen and chlorine, and was placed inside a discharge coil, the green chlorine ring was seen close to the glass wall and the pink hydrogen glow in the inner portion of the bulb, because the chlorine was the more difficult to ionise, and was hence ionised only in the strong field close to the coil. In another demonstration (after Gehrcke and Reichenheim) a dried paste of alkali salts was fixed to the top of the anode, which was surrounded by the kathode in the shape of a coil of stout aluminium wire; the bombarded salts sent a beam of red positive rays upward.

There was a difficult point, however. How could the hydrogen atom, if consisting only of a positive nucleus and one electron, give the infinite number of lines of the Balmer series? Two views had been suggested: (1) If the electron circulated at different speeds, there would be many kinds of hydrogen atoms, and the spectrum ought to be continuous; hence something between (1) and (2) equilibrium positions at certain distances, seemed more probable. The repulsive forces required to maintain the equilibrium positions might be of centrifugal nature. In hydrodynamics the liquid of a vortex ring moved in circles, such that the product of velocity and radius was constant and proportional to the number of vortex lines included, and if the number of vortex lines were 1, 2, 3 . . , there would be equilibrium positions at the definite distances, 1, 2, 3. In the hydrogen rings the electrons would be at different distances from the positive particle, and there ought to be hydrogen atoms of different chemical properties therefor. There was no evidence of this so far, but many things had not been found out before we knew what to look out for. There was another way of accounting for the second, very complicated spectrum of hydrogen. Imagine the — and + particle held together by curved lines of electric force; an electron shooting across these lines would disturb the equilibrium and set up vibrations depending upon the configuration of the lines of force; Professor Thomson seemed to assume that there would be a system of lines of force between the negative and the positive particles.

As regards the structure of the atom, the characteristic X-ray spectra were exceedingly simple, and the frequency of these radiations were proportional to the squares of the atomic numbers N (Moseley), which merely indicated the number of the elements in the sequence of the periodic table. The atomic weights (at. w.) themselves—at any rate of the elements of small at. w.—differed by small amounts only from integers (Prout), and the atoms were believed to be built up of units (of mass of hydrogen atoms), making up the positive charge proportional to the number of these units, and thus to the at. w., and to be held together by free electrons in number proportional to N. Without the electrons the atoms would be unstable. We knew too little about intra atomic forces at the smallest distances. With regard to the at. w. below 40 (calcium), however, it was striking that the quotient at. w./4 left either the remainder 0 or 3, not 1 or 2 (except beryllium and nitrogen). One could understand that if the number of free (inside) electrons required for stability were always to be an even number and at least equal to half the at. w. That rule would exclude an element of at. w. 2. As regards at. w. 3, half of 3 would be 3/2 or 2 (nearest even number), so the element should have 3+ and 2— charges, or one resultant positive charge, like the hydrogen atom itself, from which it might be indistinguishable chemically. The body $X=3$, found by Sir Joseph by positive-ray analysis, was probably identical with hydrogen. Going through the at. w., Sir Joseph showed that, of the elements of at. w. 1, 2, 3, 4, 5, 6, 7, 8, 9 . . . , (2), (5), (6) should not exist, and did not exist ($\frac{1}{2}$ of 5 would be 5/2 or 3, odd, not even); (3) seemed to exist; (8) ought to exist, but was unknown; whilst (9) (beryllium or glucinum) ought not to exist, but did exist. Above 40 the relations became more complex; more electrons than $\frac{1}{2}$ at. w. were probably required for stability.

Finally, Prof. Thomson stated that in most cases (Si and Cl excepted) the at. w. was slightly less than an integer. It was essential in these considerations to base the at. w. on hydrogen H=1, as chemists used to do, and not upon oxygen O=16 (when H=1.008), as chemists did now. Mass was not constant. The mass of the combined + and — particles was smaller than that of the separated particles, and the difference represented the work to be done in bringing them together. That work could be estimated as difference between the integer and the at. w. The differences were small, but the energy amounted to more than the energy of an α-particle. In the case of chlorine, at. w. 35·2, there was a possibility that chlorine was mixed with a few per cent. of an element of higher at. w. There would be 35·5/2=18 inside, and 35—18=17 outside electrons.

DECIMAL COINAGE.

We have received from Mr. Harry Allcock a communication, in which he points out the retention of the £ as our monetary unit would involve an alteration in the values of all our bronze coins, and would present a difficulty in securing uniformity. He, therefore, suggests the adoption of the dollar. We are unable to devote sufficient space to reproduce the whole communication, but the line of argument is indicated in what follows:—

Parts of the Empire—*e.g.*, Canada and Newfoundland—have already discarded the £ sterling in favour of the dollar, and they are not likely to revert to the £. Further reference to this consideration is made below.

Appreciating these difficulties, let us consider the merits of an alternative monetary unit. Given an unfettered choice, the best monetary unit for a decimal system of coinage in any country is a coin having a value equal to 100 times that of the smallest coin in common use. Applying this definition to the United Kingdom, we should have $100 \times \frac{1}{2}$d. = a British dollar of 4s. 2d. Such a unit would be practically equivalent in value to the gold dollar already in use in the U.S.A., Canada, Newfoundland and most of South America.

Although the value of this unit might be considered very small by reason of its representing only about one-fifth of our present £ sterling, it should be appreciated that it would nevertheless be equal to about twice that of the Russian rouble or Japanese yen, three times that of the rupee, four times that of the mark, and five times that of the franc.

Apart from the well-known advantages to be derived from our adoption of a *decimal* system of coinage it will be apparent that our selection of the above-mentioned British dollar as our unit would assist in bringing about the ultimate adoption of one universal system of decimal coinage for use not only in the entire British Empire, but also throughout the English-speaking world. The entry of the United States into the war provides a stimulus for joint action to secure this boon. We could proceed forthwith to keep all our accounts and conduct all our trade in British dollars and cents, and thus reap many of the benefits of decimal coinage *without waiting for the minting of new coins and without altering the value of any coin now in use.*

The purchase of metal for the new coinage, the minting of new coins and the date or dates of issuing such new coins could be deferred until after the war, when it is important to note that any or all of the new coins could be used simultaneously with our existing coins without loss to the individual or to the State.

In the course of time as the use of the new decimal coins became established the old coins could be gradually withdrawn and re-minted on the new basis.

Every sum of money now expressed in £ s. d. could be *exactly* expressed in British dollars and cents by reducing it to halfpence, and placing the decimal point to the left of the last two figures. Moreover, less figures would be required in our accounts and the time spent together with the risk of error would thus be enormously reduced.

It would appear from the above review of the situation that while the relatively few who are concerned in high financial operations would naturally prefer to retain the £ sterling, there is much to be said for the alternative basis herein described when considering the general convenience of the community at large.

If it is felt that the retention of the £ sterling is necessary for purposes of international finance, there is no reason why it should not survive for that special purpose. We still speak of guineas, although it is many years since guinea coins were withdrawn from circulation, and the £ sterling could be entered as 4·80 British dollars just as we now express the guinea as £1. 1s.

If the difficulties referred to in the opening part of this article could be satisfactorily overcome there would, of course, be no necessity for us to consider the merits of any alternative unit. But, on the other hand, if those difficulties are considered insuperable, the demand for decimal coinage could be satisfied without further delay by our adoption of the British dollar as the monetary unit.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Examples in Battery Engineering," by Prof. F. E. Austin, E.E. (Hanover: Prof. F. E. Austin.) Pp. 90. $1.25.

Digitized by Google

The Electrician.
FRIDAY, JUNE 29th, 1917.
Editorial and Publishing Offices:—
8, BOUVERIE STREET, LONDON, E.C. 4.
Telephone: City 9853 (4 lines). Telegrams: "Benbrotric Fleet London."

PERSONAL INTEREST IN MUNICIPAL ENTERPRISE.

It is often felt that municipal enterprise does not offer sufficient inducement to obtain the best services from the staff employed, and consequently such enterprises are less efficient, on the whole, than those operated by companies. The root cause of this difference is simply due to the fact that a company must pay dividends or result in failure, and the staff realise that if these dividends are not on a satisfactory scale, and that their services do not sufficiently contribute to this end, their position is insecure. On the other hand, in Government and municipal services there is a strong feeling of security of tenure, irrespective of results, and this feeling, although there is much to be said in favour of reasonable security of tenure, may lead to a slackness which results in inefficiency.

It is with a view to eliminating this defect that Mr. J. H. BOWDEN read a Paper last week before the Incorporated Municipal Electrical Association, entitled "Individual Interest in Municipal Enterprise." In this Paper Mr. BOWDEN proposed that the employees of any municipal enterprise should receive a certain annual bonus based on the profits, so as to give them a direct interest in the business. By so doing it is contended that a better service is obtained. We think there is a great deal to be said in favour of this contention, in both municipal and private enterprises. The employee very naturally takes the view that if a business makes satisfactory progress he should share to some extent in the profit that has been made. There are, however, certain difficulties which must be borne in mind in initiating any such scheme.

The method suggested by Mr. BOWDEN consists in placing 40 per cent. of the profit balance at the disposal of the Finance Committee; then 20 per cent. up to a certain figure, and 10 per cent. thereafter, is to be divided among the staff and employees, and the remaining balance is to be placed to the credit of capital machinery account, and for writing down obsolete plant. Opinions will differ as to whether a portion should be placed at the disposal of the Finance Committee. Mr. BOWDEN, although not supporting the idea that municipal trading should be undertaken purely for the purpose of relieving the rates, considers that the rates should be relieved on a well defined scale. We disagree with this view, and prefer that an electricity undertaking should be run on as sound a basis as possible, and with a view to giving as cheap a supply as possible, without in any way relieving the rates. It is much sounder to let the ratepayers be satisfied with benefits that are indirect, such as a cheap and efficient service, or increase in rateable value and the attraction of industries to the locality.

Leaving this point on one side, however, we come to the question whether it is desirable that the bonus should depend simply on the balance of profit that has been obtained. In some cases it may not be easy to define just what the profit is, and there may be a tendency, if the staff are dependent upon the extent of the profit, for depreciation to be minimised and for stocks to be put at a somewhat inflated value. Also, in the case of an electricity undertaking, more particularly a municipal undertaking, the fact that a reduction in the prices charged for electric energy, although such a reduction may be highly desirable from the point of view of causing a satisfactory growth of the undertaking, may lead to a considerable reduction in the annual balance and a consequent reduction in the bonus available, may cause difficulties. Further, the bonus may be adversely affected by increase in rating. There are, indeed, many causes over which the staff have little or no control, and it would seem better if possible to base the bonus upon those quantities which are directly affected by their labours. This has been attempted by Mr. T. HALL at Burton-on-Trent, where the decrease of total expenditure below 1d. per unit sold has been taken as a basis of the bonus given. Here again, however, we come against a difficulty, namely, that the figure taken to-day is not one that would necessarily be taken in five years' time. For example, five years ago we do not suppose that Mr. HALL would have selected the figure of 1d. per unit, as this would probably have given a negative bonus. Taking figures merely at random, let us suppose that some years ago he had adopted a figure of 1·5d. per unit. This would have been satisfactory at that time, but by now this arrangement would be giving a bonus of about 20 per cent. instead of 7. It is desirable that any bonus so distributed should not be so high as to be uncommercial, and it must be remembered that there is always a difficulty in revising a basis that has once been adopted. We come back in fact to the old difficulty of rating piece work. One way of dealing with this objection is to give a somewhat lower salary or wages on the ground that any deficiency is made up on the bonus, but we agree with Mr. D. H. LITTLER in his remarks upon this Paper that the salary or wage given should in any case be fair and such as would be given without a bonus, the latter being something purely in addition.

Some diversity of opinion was shown in the discussion as to whether a part of the bonus should be subject to investment. We doubt if compulsion can be satisfactorily applied in cases of this kind. Much can be done by providing facilities, for the individual of small means often does not save because an easy and suitable method of doing so is not just to hand. We think that facilities should be provided for investment, and probably one of the best plans is for an undertaking to pay something further into a fund to which the employee is willing to subscribe for the purpose of providing an annuity. But whatever is done in the way of investment, let it be on sound lines. We feel some doubt as to the desirability of investing a man's earnings simply in the business in which he is employed. The chance is he has no voice in the direction of the business. This may at some time or another be run on unsound lines and get into financial difficulties, and in that case, the employee is liable to experience a loss that may be very serious for him.

All these schemes are, of course, included in the term "co-partnership." In his recent address to the Institution of Gas Engineers, Mr. A. E. BROADBERRY suggested that co-partnership was breaking down under the stress of war. We doubt if this is so. We understand that Dr. CARPENTER has found co-partnership to be eminently successful in the case of the South Metropolitan Gas Co., even under present conditions. It must be remembered, of course, that these schemes were not made to stand the stress of war, and even if they failed under these very exceptional conditions that would be no reason for assuming they were useless in times of peace. It appears to us that co-partnership is the right principle, and that in one form or another it must make very considerable headway within the next few years, but it may well be that a good deal of work on the trial and error principle will be necessary before a really satisfactory scheme is obtained.

Digitized by Google

NATIONAL PHYSICAL LABORATORY.

The annual report of the Executive Committee of the National Physical Laboratory was submitted to the General Board at the annual meeting on June 19th.

In what follows we reproduce some sections of general, physical and electrical interest. It is to be noted that during the past year war work has been the predominant feature of the activities of the Laboratory, and many of those investigations naturally cannot be described at the present moment. This fact is emphasised in the general report, with which we will first deal.

The last report recorded the loss which the laboratory and engineering science in the country suffered through the deaths of Sir Frederick Donaldson and Mr. Leslie Robertson; the Committee have now to record with great regret the death of their former colleague, Mr. David Howard, who represented the Society of Chemical Industry both on the General Board and on the Executive Committee for nine years up to 1914.

Of the senior staff, Dr. Harker and Mr. Rayner have been lent for important work to the Munitions Inventions Department, and Mr. Paterson has given nearly the whole of his time to developing for that department an apparatus invented by himself and Mr. Walsh.

The Director has continued to act as adviser in physics to the Ministry of Munitions.

An agreement has just been reached between various bodies in London concerned with the organisation of instruction in technical optics, and the Director has been appointed to represent the Laboratory on the Advisory Council for Technical Optics appointed by the London County Council, and on the Technical Optics Committee of the Imperial Technical College. He has also become a member of the Main Committee of the Engineering Standards Committee, and is devoting much time to standardisation questions, specially those relating to electrical machinery and to screw gauges.

The outstanding feature in the work of the year has been the growth of the gauge testing work. When the work started in August, 1915, the Director was asked to arrange for the testing of some 30,000 gauges to relieve the inspection department at Woolwich; the number tested during the past year has been about 277,350. In November last gauges were being tested at the rate of between 4,000 and 5,000 a week. The numbers now dealt with range from 9,000 to 10,000 weekly; but the space is insufficient, and permission has been secured to erect a new building 140 ft. by 50 ft. in area.

Turning now to the work of the departments, the electrical standards division has been almost entirely occupied with special research work, relating particularly to wireless problems. Comparisons of the resistance standards have been made, and a few Weston cells set up, in order to ensure the maintenance of the standards. A large number of magnetograph records have been taken in connection with the disturbances caused by the electric trains of the L. & S.W. Railway Co.

In the division dealing with general electrical measurements further improvements and additions have been made in connection with the methods of measurement employed in tests of inductances, of horse-shoe magnets and of iron sheet. A number of special investigations have been carried out.

Work for the Munitions Inventions Department has occupied most of the time of members of the staff in the electrotechnics division. The testing of luminous dials for instruments of various types has greatly increased. A research on the heating of buried cables is in progress for the Institution of Electrical Engineers, who have received a grant for this work from the Department of Scientific and Industrial Research. An investigation into the corrosion of lead-covered cables has been arranged.

In the heat division the Laboratory standards for dealing with high-temperature tests of pyrometers have been greatly improved and extended. Valuable work has been done in the improvement of furnaces for work at high temperatures. Interesting results have been obtained in an investigation into the thermal conductivities of refractory materials, and the thermophysical properties of such materials are being generally studied.

The optics division has had to deal with a very large volume of test work, and a number of special problems have been submitted to it for investigation. The tables of data for the construction of achromatic telescope objectives have been amplified and extended.

In the metrology division the work of gauge testing already referred to has necessarily absorbed all the time and energy of the staff engaged in it.

In the engineering department progress has been made with some of the more important investigations in hand. In connection with the recommendations made in 1909 by the International Association for Testing Materials relative to notched bar impact testing, tests have been made by the desire of the Engineering Standards Committee on the effect of varying the form of the notch. The research on hardness tests included a comparison of the effects of dry rolling abrasion and dry sliding abrasion; a determination of the ratio of the Brinell hardness number to the Shore Scleroscope number; investigation of the relation between the Brinell hardness number and the resistance to sliding abrasion. The work on the fatigue resistance of materials under combined bending and twisting stresses has also been advanced. The Reynolds theory of the transmission of heat from surfaces to fluids flowing over them has been investigated for artificially roughened surfaces, and so far as the experiments have proceeded appears to be in accordance with the observations.

The observations on the rate of growth of cracks in the buildings of the Tower of London have been continued.

Other special investigations carried out have included a series of fatigue tests on compressed gas cylinders and a valuable research into the properties of a number of different timbers for use as railway sleepers, undertaken for the Great Northern Railway Co.

In the aeronautics division much important work has been done, and there have been a number of changes.

It has now been arranged that the meetings are to take place at the offices of the Air Board, and arrangements for connecting the work of the aeronautics division more closely with the technical work of the Air Board are under consideration. The Advisory Committee have recently appointed sub-committees dealing with engines and with light alloys, and Dr. Stanton and Dr. Rosenhain represent the Laboratory on these respectively. The Director, as chairman of the Advisory Committee, is ex officio a member of both. Problems relating to light alloys have largely engaged the attention of Dr. Rosenhain and his staff. The Aeronautical Society has arranged for student lectures to the workers in aircraft factories and others, both at London and at Cardiff, and three of these have been given by members of the staff.

The department of metallurgy and metallurgical chemistry has been very fully occupied, practically entirely on work connected with the war, chiefly of a confidential character. A somewhat large proportion of the staff are on service. Their places have been very satisfactorily filled by women, now nine in number. Most of these have been trained as chemists; the superintendent has instituted for their benefit a course of lectures on metallurgy, which has attracted a number of other members of the staff.

A proposal to arrange, in co-operation with leading metallurgists, for the standardisation of steel samples for use in analysis was approved by the Executive Committee, and the preliminary steps for the work are now under consideration by a committee of the Iron and Steel Institute. It is suggested that the samples should be designated as "standard steel samples prepared and standardised by the National Physical Laboratory in co-operation with a committee of the Iron and Steel Institute."

The Alloys Research Committee of the Institution of Mechanical Engineers, who have for many years contributed largely to this branch of work, held a meeting at the Laboratory in November, 1916, and as a result an application was made to the Department of Scientific and Industrial Research for funds to provide a considerable increase both for buildings and equipment. To this the department has agreed, and the Office of Works are now engaged in enlarging the foundry to double its original size. Meanwhile, some theoretical work urgently needed for the understanding of practical results has been undertaken, mainly by lady members of the staff.

Work on steels for automobile and aircraft construction has been carried out in conjunction with a committee of the Institution of Automobile Engineers, and promises valuable results.

The optical glass research undertaken by aid of a grant from the Research Department has also made good progress, particularly in regard to special refractory materials and the construction of melting pots resistant to attack from molten glass, which is the part of the investigation into the manufacture of optical glass which has been undertaken by the Laboratory. In this work the Laboratory is collaborating closely with the Society of Chemical Industry and other bodies concerned in the scheme of research approved by the Advisory Council of the Privy Council Committee for Scientific and Industrial Research.

The report of the Advisory Committee for the William Froude National Tank is very satisfactory. The time of the staff—reduced by the absence of men on service—has been given almost entirely to war work, and very little pure research has been possible.

Mr. Baker has received the Shipbuilding Gold Medal of the North-East Coast Institution of Engineers and Shipbuilders for his Paper entitled "Notes on Model Experiments."

The difficult question of the future position of the Laboratory has occupied the thoughts of the Committee during a great part of the year. In accordance with the wish expressed by the General Board at its meeting on November 8th, the President of the Royal Society brought the question before the Department of Scientific and Industrial Research, and Lord Crewe, in a reply to a deputation from the Board of Scientific Societies in November last, referred very cordially to the work of the Laboratory and to the desire of the Department to assist it. Conferences are now being held with a view to the preparation of a scheme for submission to the Council of the Royal Society, who will no doubt bring it before the General Board.

Reference has been made in previous reports to the need for a more adequate recognition of the services of the staff, and in connection with a scheme for the future organisation of the Laboratory this question has been considered both by the staff and by the Executive Committee.

At a meeting in the autumn the Director indicated to the staff the steps that had been taken in the past, and expressed his willingness to lay before the Committee a statement from them. The Executive Committee appointed a sub-committee to consider this statement when it was prepared and to discuss it in detail with representatives of the staff. Several meetings of the sub-committee have taken place. At one of these the staff representatives were present, and a preliminary report to the Executive Committee is in course of preparation, but the question is

Digitized by Google

clearly very closely connected with that of the relations of the Laboratory with the Research Department, and the arrangements made as to the ultimate financial responsibility for expenditure.

The accounts have been audited and will be presented to the Treasury in due course. They show a credit balance on the year's working of £3,802. 3s. 4d. Of this, the sum of £2,468. 15s. 10d. is due to the Tank Department.

The income for the year was £70,896. 14s. 3d., an increase of £19,524. 13s 8d. over that for 1915-16. The fees received for the ordinary test work have risen from £19 141. 18s. 3d. to £23,657. 9s. 2d., the Treasury grant for aeronautics from £9,175. 8s. 9d to £14,168. 18s 11d. work done for the Ministry of Munitions, chiefly the testing of gauges, from £10,908. 10s. 3d. to £18,344. 3s., while other items have shown considerable increase.*

On the other hand, the expenditure has risen from £49 803. 18s. 4d. in 1915-16 to £67,094. 10s. 11d. in 1916-17. By far the greater part of this increase is in salaries and wages, the figures for which are £37,349. 13s. and £50,409. 9s. 2d. respectively. The staff has increased from 337 to 420, and the salaries and wages have been raised. The rise in price has, of course, had an effect in nearly all items of expenditure, and the large increase in work for the Ministry of Munitions has, together with the additional wages, necessitated a growth in the expenditure of some £1,300, while a sum of £459. 19s. 5d. has been allocated from income to equipment, in addition to the usual grant of £500.

As stated at the end of last year's report, there was then a liability of £1,660. 14s. 4d., balance of loan for the completion of the William Froude National Tank. This has been liquidated during the year, leaving a credit balance in the general fund of £2,254. 13s. 2d. To this must be added £3,802. 3s. 4d., the excess of income over expenditure, making the balance to the credit of the fund at present £6,056. 16s. 6d.

Among the researches which it is hoped to carry out during the year 1917-1918 the following are mentioned :—

In the physics department, Mr. Campbell hopes to be able to continue the research on magnet steels, and an investigation on "stalloy."

In the heat division, it is hoped to extend the calibration of the Laboratory standard total radiation pyrometers up to a temperature of about 1,600°C. The standard optical pyrometers will also be calibrated, and other measures will be taken with a view to securing improvement in the accuracy of measurement of very high temperatures.

In the electrotechnics division the research on the heating of buried cables will be continued. An investigation relative to the corrosion of the sheathing of lead-covered cables is also in progress. These two investigations are being carried out for the Institution of Electrical Engineers with the aid of grants made by the Department of Scientific and Industrial Research.

Grants have also been received from the Department for other investigations, which are being carried out in the engineering and metallurgical departments of the Laboratory. The engineering department is examining methods of impact testing of notched specimens, and of hardness testing, and is conducting a research on the transmission of heat from a solid to a fluid flowing over it. The Metallurgy department will continue the work on light alloys which is in progress for the Institution of Mechanical Engineers, with the aid of a grant made to the Institution by the Department of Scientific and Industrial Research.

The research on optical glass, for which a grant has been made by the Department, will be continued. Good progress has been made with this work during the past year, and it is hoped that the application of the improvements in method which have been introduced may lead to valuable results.

(To be concluded.)

CONTROL OF MOTORS FOR INDUSTRIAL WORK.

A booklet under the above title, by Mr. Frank Walker, is issued by the British Westinghouse Electric & Mfg. Co. (Ltd.), describing some of the principal devices manufactured by the firm for the control of industrial motors.

The description is arranged in four sections, devoted respectively to : (1) General Functions of Control Apparatus, (2) Direct Current Control Gear, (3) Alternating Current Control Gear, and (4) Resistances. Under the first heading we have again the two divisions of "Control" and "Protection." The principle of "no-volt" protection is explained, and various devices for this purpose are described. Overload protection can be secured either by fuses or special mechanical devices. Reference is also made to the Home Office Electricity Regulations, under the Factory and Workshop Acts.

The booklet is well illustrated. Section (2) explains the nature of the standard direct-current motor starter, open and enclosed types being shown. Liquid motor starters are also dealt with, and speed regulation devices for series motors are explained in detail.

In section (3) we have corresponding data for alternating-current motors, the diagrams here being particularly useful. In section (4) the construction of starting and control resistances, winding up with the latest development in motor control apparatus, the contactor control gear, is dealt with.

Apart from its purpose of showing the chief types of Westinghouse motor-controlling apparatus, the booklet is quite useful as giving an easily followed account of the current practice in this field.

* This work was not commenced until July, 1915, so that this figure represents nine months' receipts.

FERGUSON, PAILIN & CO.'S TRUCK TYPE SWITCHBOARD.

From a perusal of the annual reports of the Electrical Inspector of Factories it is evident that a large proportion of the electrical accidents come under the heading "cleaning, repairing, &c., at live switchboards or other live conductors."

The total number of accidents under this head, reported during the four years 1911-1914 inclusive is 157, whereas the *total* electrical accidents for the corresponding period is 341. It is therefore not surprising that the "Safety First" campaign should be extended to electrical switchgear, and numerous innovations have recently been introduced to make switchgear dead for cleaning and repairs. Of these one of the most important is the truck-type switchboard for high-pressure supplies.

Messrs. Ferguson, Pailin & Co. (Ltd.), of Higher Openshaw, Manchester, have recently introduced a switchboard of this class which has several unique features. The main idea which has actuated the designers has been to make the switchboard absolutely foolproof and to render it impossible for anyone to touch live gear.

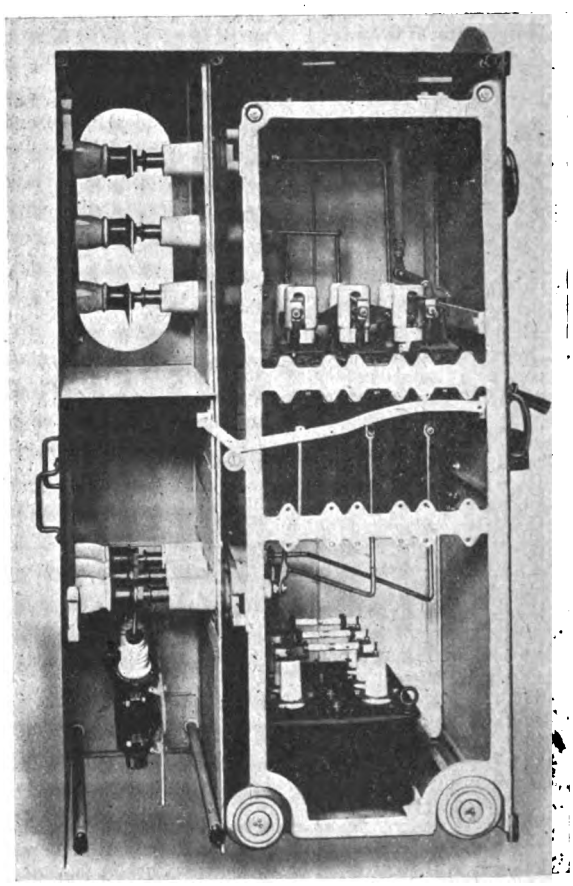


FIG. 1.—SECTIONAL VIEW OF GENERAL ARRANGEMENT.

The truck cannot be withdrawn until the oil switch is "off," neither can the truck be replaced with the oil switch "on." When the truck is withdrawn shutters automatically close over the holes through which the plugs have passed, so that the whole of the live metal work is protected. As the carriage is wheeled in the shutters are automatically raised to allow the plug insulators to pass. This is a most important feature as the switchboard can be left with any of the trucks withdrawn, and no high-tension metal exposed.

The plug contacts are self-aligning, the plugs being circular in section, and having a free movement in both directions, so that they can adjust themselves to make perfect contact in the sockets even though the carriage may be slightly out of alignment. Practically no movement is required, as the runways for the carriage are part of the side frames, and are not dependent on the station floor, which may be uneven.

The carriage wheels are fitted with roller bearings, so as to provide ease of movement.

The oil switch has a heavy breaking capacity and is provided with separate tanks for each phase. The switch used has been standardised by two large electric supply authorities, each of which have generating plant exceeding 50,000 kw.

The structure may be erected against the wall, so as to economise in space, and the design allows of easy extension—any number of panels may be added from time to time. We understand that switchboards of

Digitized by Google

this class are at present being built for two separate Government departments.

FIG. 2.—VIEW OF COMPLETE UNIT.

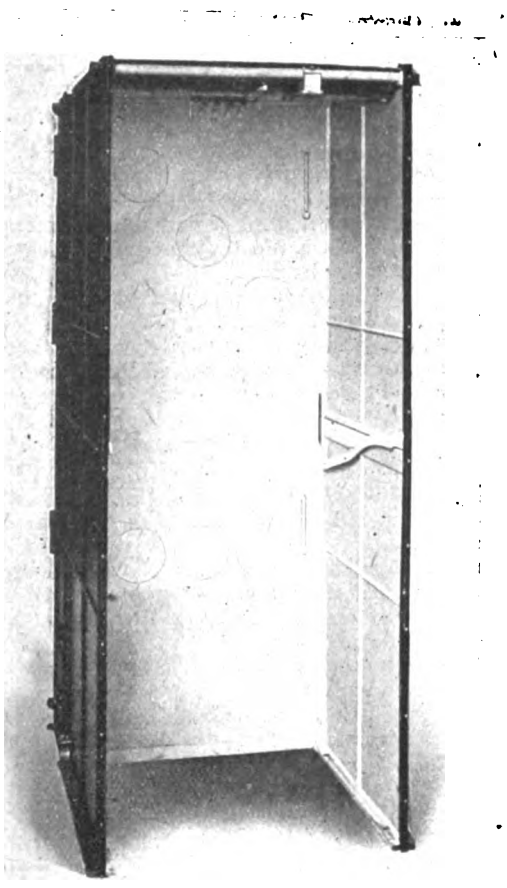


FIG. 3.—UNIT WITH TRUCK WITHDRAWN.

Fig. 1 shows a sectional view of the arrangement, whilst Fig. 2 shows the unit complete, and Fig. 3 the unit with the truck withdrawn.

CORRESPONDENCE.

CITY GUILDS' EXAMINATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We read with interest the editorial in your issue of 1st inst., and are sorry to see that—beyond Mr. Maycock's letter in your current issue—your invitation to those concerned to express their opinions on the points you brought up appears to have fallen on deaf ears.

Why need our professors and teachers be silent on a subject which concerns them so closely—viz., the conduct of the only electrical-engineering examinations by which their students are enabled to test their abilities against those of other students all over the country? Echo answers, Why, indeed?

We agree with all your correspondent said concerning "electrical installation work." This, though one of the minor peaks (as regard altitude) in the mountain range of electrical knowledge referred to by him, is a very sturdy and an absolutely essential eminence in its way. It has to be traversed by every electrical man, whether he be a consultant or a wireman; though most seem to prefer side tracks which give them an imperfect knowledge of the country. In many cases this is due not only to the paucity of adequate instruction, but also to the fact that the examination authorities surround this field of knowledge with wire-entanglements.

The current City Guilds' programme states that the examination is adapted to the requirements of journeymen and foremen; though most people know that the classes often contain a minority of students of this description. Nothing is said about apprentices and improvers, or about still younger students straight from school, of which a fair number is fortunately to be found in most classes. Then, there are generally various "outside" people concerned with electrical work to be found in a class, together with students who afterwards pass on to what are somewhat invidiously termed electrical-engineering subjects.

If the subject of electrical installation work is not in practice restricted to journeymen and foremen (it would be bad for the support received if it were) why not amend once more the only-just-revised syllabus. Perhaps there are people who are under the belief that this obviously ill-considered restriction is enforced.

Another entanglement is that a student cannot sit for examination unless he has made a certain number of attendances of a certain duration at his class. Now, considering that those students who are actually earning their living at the work are frequently (even in normal times) very busy thereon, and sometimes at distant locations, the aforementioned entanglement helps to keep out of these classes the very people for whom they are primarily intended.

Further, we should very much like to know why outside or private students are not permitted to sit for examination. Considering, that for many, class-attendance is an impossibility, either because they are too far off or because the date or time happens to be inconvenient, the reason for this entanglement is quite difficult to grasp.

We believe we are right in stating that this fundamentally-necessary subject, formerly styled "Electric Wiremen's Work," was included in the City Guilds' scheme about 10 years' ago mainly through the exertions of Mr. Frank Broadbent, M.I.E.E., the recent examiner.

In the report for the session 1913-14 we read that only 361 candidates came up for examination and that only 209 of these passed. This is a paltry result after 10 years, and proves that the educational authorities in different towns are very neglectful of the army of workers waiting attention. Why! our own private examinations in "Electric Light Switching" have been as successful—as regards numbers—even since the outbreak of the War!! We only mention this to prove the apathy of those who could make Electrical Installation Work classes a success if they cared to.

It would be interesting if the present examiner, Mr. W. R. Rawlings, A.M.I.E.E., were to express his opinions on the way the subject is taught.—We are, &c.,

London, June 18. A. P. LUNDBERG & SONS

Digitized by Google

ITALIAN WIRELESS TELEGRAPH INVENTIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read the letter signed by Mr. Bellini that appeared in THE ELECTRICIAN of June 1. In this letter Mr. Bellini was compelled to admit that it has been ascertained through decisions of the Court of Appeal that he acknowledged by a public deed dated April 5, 1912 (before Rolando, notary public), that the apparatus forming the subject matter of Artom's Italian patents No. 88,765 (triangular dirigible aerials) and No. 88,766 (radiogoniometer) of April 11, 1907, are the intellectual patrimony of Prof. Artom; that Mr. Bellini bound himself never to contest publicly Prof. Artom's priority and ownership of the above inventions.

Mr. Bellini cannot, therefore, pretend to disown now what he acknowledged in a public deed; nor to raise again a question that was settled once for all by his admission in the said public deed.

I reserve to myself the right to proceed against Mr. Bellini for breaking his obligation not to contest publicly that the above-mentioned inventions belong to my intellectual patrimony.—I am, &c.,

ALESSANDRO ARTOM.

Turin, June 9.

[This correspondence is now closed.—ED. *E.*]

PHYSICAL SOCIETY.

A meeting was held on June 8, 1917, at the Imperial College of Science, Prof. C. V. BOYS, F.R.S., President, in the Chair.

A Paper, entitled

"An Alternating Current Bridge Method of Comparing Two Fixed Inductances at Commercial Frequencies,"

by T. PARNELL, M.A., was read by Dr. SUMPNER.

The Paper describes a method of avoiding the troublesome double adjustment required in Maxwell's method of comparing inductances. A current detector, whose deflections depend on the component of the current in quadrature with the E.M.F., is employed, which makes it possible to arrange that the condition for no deflection depends chiefly either on the inductances or resistances. In series with the bridge is placed either a non-inductive resistance or a capacity. In the first case the balance depends chiefly on the inductances, and in the second case on the resistances. A few alternate repetitions of the two adjustments suffice to balance the bridge, both for resistances and inductances. As detector a sensitive moving coil galvanometer in conjunction with a commutator, or a Sumpner electrodynamometer, may be employed; the latter proved more satisfactory.

Dr. D. OWEN said that this was simply the Maxwell bridge; but the author had shown how to use it under the best conditions. It was impossible to get satisfactory results without the double adjustment for inductance and resistance. Mr. Parnell had shown how this could be most easily done by using currents in quadrature with one another for the two adjustments. The difficulty still remained, however, that one adjustment upset the other; but it was satisfactory to note that the desired end was reached in a short time. The method was probably easy to apply with small inductances; but he would expect practical difficulties to arise with large ones. It was difficult to know what the phases of the bridge currents were with respect to the field current of the electrodynamometer, and there might be some trouble in getting on the right track. A similar method of using the electrodynamometer had been tried at the Bureau of Standards, a phase shifter being used to turn the phase of the voltage on the field coils through 90 deg. to get balances for the two conditions.

Mr. T. SMITH pointed out that in double adjustments of this nature, if the wrong adjustment were made first, the successive errors got larger instead of smaller. It would have been helpful if the author had extended his mathematics somewhat, and given some criterion (*e.g.*, some function of the various quantities involved being either positive or negative) as to which of the adjustments—inductance or resistance—should be made first.

Dr. BRYAN asked if the method could be used for small inductances of a few micro-henries?

Prof. BOYS asked if inductances with iron cores could be measured, or only air cored coils, in which the sine law was nearly fulfilled.

Dr. SUMPNER said, in reply, that the author had not gone in great detail into the range of usefulness of the method. He might point out, however, that the sine law was not essential to work with the electrodynamometer. The author did not appear to have experienced any difficulty about the order of the adjustments; though in some cases this might doubtless cause considerable trouble. He admitted the validity of the author's criticism of the Paper by himself and Phillips; and agreed that the double adjustment was essential. At that time, however, he was principally concerned with describing the instrument, and was not using small inductances in which the resistance effect was important.

MR. A. CAMPBELL communicated the following: Mr. Parnell's system is interesting, and may be of value in other methods where two adjustments are necessary to obtain a balance. In connection with his commutator method it may be mentioned that L. T. Robinson applied a commutator in the galvanometer circuit in a somewhat similar way for testing transformers by inductance methods ("Trans." American Institute of Electrical Engineers, p. 1040, Vol. XXVIII., June 30, 1909).

A Paper, entitled

"On the Wave-Lengths and Radiation of Loaded Antennæ,"

was read by Mr. BALTH VAN DER POL, JUN.

The Paper consists of a mathematical treatment of the subject, the following being some of the conclusions arrived at: The radiation resistance of a loaded antenna and also the radiation from the antenna are dependent not only on the wave-length, but on the current values at the top and bottom. The radiation cannot, therefore, be written $\Sigma = \frac{AT^2l^2}{\lambda^2}$, where A is constant and T is the R.M.S. current at the base, as is done in most textbooks. Rüdenberg's formula for flat top or umbrella antennæ is valid only for very long wave-lengths, with a capacity at the top of the antenna very large compared with that of the vertical part, and Austin's table of radiation resistances up to ratios of $\frac{l}{\lambda} = 0{\cdot}4$ is based on an unjustifiable extrapolation of Rüdenberg's results.

The Paper also treats of the directions in which the energy is most strongly radiated under difficult conditions.

Prof. J. A. FLEMING communicated the following remarks: The Paper seems to me to be valuable and the analysis correct. The formula for the radiation resistance of a flat-topped antenna, which is commonly called Rüdenberg's formula, has no claim to be attributed to him; it can be at once derived from Hertz's expressions for the forces due to a small oscillator. As I have shown in my book on the "Principles of Electric Wave Telegraphy," third edition, Hertz's reduced expressions are obtained on the conditions that the current has the same value at all points in the rod of the dumb-bell oscillator; and hence applies also to the reduced formula for radiation resistance. The polar radiation curves which the author has delineated for the higher harmonics of the loaded antenna seem consistent with the delineation of the field of electric force round a rod oscillator given by F. Hack from the equations of Abraham (*see* phase VI., Chapter V., "Principles of Electric Wave Telegraphy"). The possibility of projecting upwards in an inclined direction what is virtually a beam of electric radiation is interesting. By observing where the beam comes to earth it may be possible to determine the height of the reflecting masses of ionised air. There is, however, a certain difficulty exciting any required high harmonic in an antenna, especially if the capacity and inductance are chiefly located at certain points. When the possibility of experimental work returns it will be interesting to attempt to confirm these results experimentally.

A demonstration of a method of preventing sparking at a rapid make and break, which incidentally produces colloidal platinum, was given by Dr. A. GRIFFITHS.

The apparatus exhibited was one described by him in the "Philosophical Magazine" for March, 1895, p. 232. The device consists of a series of electrolytic cells placed as a shunt across the spark-gap.

The electrodes consist of platinum and the electrolyte of strong sulphuric acid. The cells polarise, and on making the gap an E.M.F. is introduced opposed to the E.M.F. of the battery, so that the current rapidly diminishes, decomposing the liquid and doing chemical work.

Dr. Griffiths made the following statements:—

1. The platinum cathodes disintegrate and a colloidal solution of platinum is formed.

2. The cathode on the negative side of the spark-gap generally disintegrates to the greatest extent; the next cathode disintegrates less, and so on, the least disintegration occurring in the cell at the positive side of the spark-gap.

3. The cathodes develop, to the naked eye, an appearance as if they were covered with platinum black. Certain plates examined under the microscope seemed covered with numerous craters.

4. The production of gas does not appear to be the same in each of the electrolytic cells in series; sometimes no gas at all appears to be evolved from the most negative cathode.

5. The rate of disintegration of a cathode appears to be small when the cathode is first placed in the sulphuric acid, and appears to increase to a maximum in course of time.

6. One specimen of platinum appears to behave differently from another.

Dr. Griffiths added that by using electrodes made of gold leaf floated on glass with the aid of methylated spirits, he had obtained what was probably colloidal gold. Prof. Hicks, of Sheffield, had told

Digitized by Google

him that he had used electrolytic cells to stop sparking at a pendulum-mercury intermittent contact. He had not observed disintegration of the platinum as far as he (Dr. Griffiths) was aware.

Dr. R. S. WILLOWS said he was interested in the chemical aspect of the experiment. There was no doubt that Dr. Griffiths was the first to obtain colloidal platinum, though he did not call it by that name when the result was originally described. The difference in the intensity of the action in different parts of the circuit reminded him of the similar phenomenon which occurs in a train of X-ray valves, in which most of the action takes place in one valve of the train. Measurements of the potential across each cell would be instructive.

Prof. BOYS mentioned that he had used electrolytic cells to quench the sparking of a pendulum contact in his gravitation experiments. He had not noticed any action on the platinum. To what did Dr. Griffiths attribute the effect ?

Mr. A. CAMPBELL communicated the following remarks : Many years ago Helmholtz introduced the use of a condenser, shunted by a suitable resistance, across the spark gap for the purpose of suppressing the spark. More recently a better system was employed by the engineers of the G.P.O., who kindly communicated it to the National Physical Laboratory, where it has been used with the greatest success on all kinds of spark-gaps (from 1 break per second up to 1,000 per second). This consisted in putting the resistance in series with the condenser. By adjusting the value of the resistance to suit the particular circuit it is nearly always possible to suppress the spark. There is no leak across the break, as in the shunt system.

Dr. GRIFFITHS, in reply to Prof. Boys, said that he thought the disintegration was due to the inductive rush of the current, but many points required investigation.

LEGAL INTELLIGENCE.

Osram-Robertson Lamp Works (Ltd.) v. Pope's Electric Lamp Co.

The hearing of this appeal has been continued during the week in the House of Lords.

Mr. Walter, K.C., Mr. Colefax, K.C., and Mr. Gray appeared for appellants ; and Mr. Thomas Terrell, K.C., Mr. E. M. Kerby, K.C., and Mr. E. Russell Clarke for respondents.

In opening the appeal, Mr. WALTER, K.C., said that the appellants brought an action claiming that respondents had infringed their letters patent No. 23,899 of 1904. Mr. Justice Joyce found that respondents had not infringed the patent and dismissed the action, with costs. That decision was upheld by the Court of Appeal, and from the order affirming the judgment of Mr. Justice Joyce the present appeal was brought. The patent was by Dr. Alex. Just and Franz Hanaman for an invention of improvements relating to the manufacture of incandescent electric lamps, and letters patent No. 18,622 of 1906 were granted to P. M. Justice for an invention of an improved method of producing metallic incandescence bodies for electric glow lamps. There was also the usual claim for damages and other relief. Counsel gave an outline of the history of filaments made at various times. There were two essentials for good conductors—they must possess (1) a very high melting point, and (2) be capable of being produced in filament form. Prior to the introduction of appellants' process in 1904 tungsten had never been applied for use under any process for lamp filaments. No method of producing a tungsten filament was known. Appellants found that by mixing finely divided tungsten with a carbon paste material so as to keep the metal particles together and heating the compound in moist hydrogen, the oxygen in the water steam combined with the carbon, and left a coherent mass of tungsten in the form of a paste that could be squirted into threads. Their process of manufacturing tungsten filaments consisted, therefore, in the following steps : (1) Mixing finely divided tungsten or tungsten compounds with a suitable organic binder ; (2) squirting the paste so formed into threads ; (3) carbonising the binder in the threads by heating to a suitable temperature ; (4) heating the thread to a suitable temperature so as to remove the carbon chemically by oxidation. Respondents said they employed two methods in the manufacture of their alleged infringing filaments, which were referred to in the Courts below as the "ordinary hydrogen process" and as the "vacuum process." Counsel having explained these processes,

Viscount HALDANE : The respondents succeeded in establishing in the Courts below that both these methods differed from the detailed example set out in the appellants' specification.

Mr. WALTER replied that was the case. His contention would be that they constituted differences, if they were differences at all, only from the detailed example set out in appellants' specification. They were not differences from the essence of appellants' invention as described in the claim which on its true construction covered a process embodying all the alleged differences. He went on to compare respondents' process with that detailed in appellants' specification and claim. Having cited the judgments in the Courts below the learned counsel then argued the question of infringement. He read and commented at length upon the evidence given at the trial and at the conclusion of his argument.

Mr. COLEFAX, K.C., followed on the same side.

The hearing had not concluded when we went to press.

Electricity Works Assessment.

At Dublin last week a Divisional Court (Justices Gibson, Madden and Kenny) heard an appeal, on a case stated (at the request of the Commissioner of Valuation in Ireland) from a decision of the County Court of Monaghan in regard to the valuation of the buildings and plant of the Clones Electric Light & Power Co. The matter came before the County Court Judge on appeal from the revised valuation of £100 assessed by the Commissioner of Valuation upon the company's electric lighting and power undertaking, and in his judgment, which was fully reported in THE ELECTRICIAN for Feb. 2 last, the County Court Judge reduced the valuation to £75, apportioning £25 to the buildings and engines and £50 to the mains and poles and easements

The questions for the decision of the Court were whether the County Court Judge was right in holding that the accumulators, dynamos, switchboard and shafting and electrical instruments were not machinery for the production of motive power ; and in eliminating the value of that machinery from the calculation as to "landlords' allowances," and treating that value as part of the tenants' capital in respect of which "tenants' allowances" should be made.

After hearing arguments, the Court dismissed the appeal, with costs.

Alien Enemy Patent.

The Patents Court has been asked by the British Museum authorities to grant a licence to use the German patent 8,621 of 1909 "for rendering organic and inorganic bodies transparent and translucent" by the employment of the refraction of light.

Dr. HARMER, F.R.S., explained that the process could not be applied to living creatures, but an intestine, for instance, might be made so transparent that one could observe a marble traverse its entire length, or a rat might be rendered so transparent that his bones, organs and arteries could be seen through his skin as through coloured glass. The process was covered by a German patent in the name of Streller, though Dr. Harmer suggested that the patent was bad, because it sought to effect a German "corner" in one of the principles of optics and light. The basic idea was that when the index of refraction of a given tissue—or the mean of the indices of the various tissues of a body—had been ascertained, the body, on being placed in a liquid having the same index of refraction, would at once become transparent to light. The process, the operation of which was explained by Dr. Harmer, had several commercial uses, one being for testing the value of grain, and revealing the presence of insect pests or larvæ.

The CONTROLLER said the licence ought to be granted, if a licence was necessary, and every facility should be given the authorities for making experiments with so useful a method.

The Telephone Service.

Last week, before Mr. Justice Eve, Mr. Maugham, K.C., moved on behalf of the Queen Anne's Residential Mansions and Hotel (Ltd.) for and injunction until judgment or further order to restrain the Postmaster-General, his servants or agents from cutting off or disconnecting the telephone service to plaintiffs' premises. Before 1905 there were no telephones in plaintiffs' premises, but in that year an agreement was concluded with the National Telephone Co. for a telephone service, one term of that agreement being that the company were not to remove the internal wiring on termination of the agreement. In 1911 the National telephone system was taken over by the Postmaster-General. A notice to determine the original agreement was given by the Postmaster-General on Dec. 29, 1916, and the terms of a new agreement were arranged, except that the Postmaster-General desired that all wiring should continue to be his property on termination of the agreement. To this plaintiffs objected, whereupon defendant threatened to cut off the telephone service.

Mr. AUSTEN-CARTMELL, for the Postmaster-General, said that an action would not lie against a Government department, and certainly not an action for an injunction. The Postmaster-General would, however, be prepared to waive his rights in order that the rights of the parties might be determined on the understanding that the action should be set down for hearing at an early date.

Mr. MAUGHAM assented to this course, and the motion stood over until trial of the action.

Effect of War on Contracts.

Last week the House of Lords delivered an important judgment in a case (Wilson & Co. *v.* Tennants) which raised the question as to the effect of war upon a contract. In 1913 defendants contracted to sell to plaintiffs during 1914 a quantity of magnesium chloride to be delivered monthly. The contract contained the following clause :—

"Deliveries may be suspended pending any contingencies beyond the control of the sellers or buyers (such as fire, accidents, war, strikes, lock-outs or the like), causing short supply of labour, fuel, raw material or manufactured produce, or otherwise preventing or hindering the manufacture or delivery of the article." The price rose to such an extent that defendants could not carry out the contract except at a loss. The rise in price was caused by a scarcity of chloride of magnesium brought about by the war, and defendants suspended deliveries. By a majority the Court of Appeal (Mr. Justice Neville dissenting) held that economic unprofitableness was not a prevention or hindrance within the meaning of the contract, and plaintiffs were entitled to recover. By a majority the House of Lords have now allowed the appeal.

Digitized by Google

Trade Marks Registration.

Mr. Justice Eve recently heard an appeal to vary the decision of the Registrar of Trade Marks by removing the limitation imposed with regard to the territory in which a mark might be used. Messrs. Richard Crispin & Co. proposed to apply to metals a triangular mark bearing the word "Bravo" in English and in Russian characters. The registration was opposed, and the Registrar held that the opposition on the ground of the mark being triangular failed, as that mark was common to the trade; but he further held that, as the mark bore a Russian word, its use should be limited to Russia.

His LORDSHIP held that the Registrar had no power to impose a territorial restriction on the registration of a trade mark.

Gordon & Co. v. Kirk & Co.

At Dublin recently a Divisional Court (Justices Gibson and Madden was asked on behalf of defendants to grant a new trial of this action on the grounds that Mr. Justice Dodd, who tried the case without a jury, had misdirected himself. The action was brought to recover the price of two turbine wheels supplied to defendants. By the terms of the contract the machinery was to be supplied within a specified time, and as they were not supplied within that time defendants refused delivery and repudiated the contract. Mr. Justice Dodd held that defendants had acquiesced in the extension of the time, and found for plaintiffs for the amount claimed, awarding defendants £25 on their counterclaim, which defendants regarded as wholly inadequate.

The Court refused the application with costs, being of opinion that Mr. Justice Dodd's decision was right.

Duties of a Tramcar Conductor.

The Second Division of the Court of Session, Edinburgh (the Lord Justice Clerk and Lords Dundas and Salvesen), has heard an appeal by Mrs. A. L. Wallace against a judgment of Lord Anderson dismissing an action in which she sued the burgh of Leith for £200 damages for injuries received by her. Pursuer alleged that when she was on the rear platform of a tramcar waiting to alight at a stopping place the car did not stop, and that when it was rounding the bend just beyond the stopping station she was thrown off on the roadway. She alleged that the conductor was collecting fares on the top of the car at the time the car reached the stopping place, and that it was his duty to be on the rear platform and to signal the car to stop at the stopping place. The defence was that pursuer was herself to blame for the accident by approaching too near the edge of the platform in an attempt either to dismount or signal the driver to stop. Lord Anderson dismissed the action on the ground that pursuer had not averred any fault on the part of defenders, and after argument the Division adhered to the judgment of the Lord Ordinary. The Lord Justice Clerk said it could not be held that in law there was any duty on the part of the conductor to be on the platform at the stopping place—which was a "stop if required" station—to see if any passenger wished to alight. It was not fault to say that the car ran past the "stop if required" station unless it was signalled to stop, and it was conceded that it was not signalled to stop.

PARLIAMETARY INTELLIGENCE.

Electric Lighting Provisional Orders.—The bill to confirm the provisional orders granted to the Electrical Distribution of Yorkshire (Ltd.), and relating to the districts of Featherstone, Garforth, Horbury, Otley, Penistone and Rawdon and Yeadon has been read a second time in the House of Commons.

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding, Lieut.-Col. C. D. Clay, V.D.

Orders for the Week :—

Officer for the Week.—Commander E. A. Ullmann.

Next for Duty.—Platoon Commander C. Campbell.

Monday, July 2nd.—Technical instruction for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' drill, 6.30.

Tuesday, July 3rd.—Lecture, 6.30. Physical drill and bayonet fighting, 7.30.

Wednesday, July 4th.—Drill, No. 1 Company, Left Half Company.

Thursday, July 5th.—Drill, No. 2 Company, Left Half Company. Ambulance class, 6.30. Signalling class.

Friday, July 6th.—Technical instruction for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' drill, 6.30.

Saturday, July 7th.—N.C.O.'s parade, 2.30, under Platoon Commander Watkins. Map reading.

Armlets.—Members are warned that armlets must be worn at all plain clothes' parades.

Musketry.—For all Companies, see Notice at Headquarters.

NOTE.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street).

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

6,893 CRAWFORD, A., & PRESTON, W. Electrical fuse boards or systems. (15/5/16.) (Cognate Application, 12,043/16.) 106,305.

6,945 PARRIS, J. F. & BAUMGARTNER, C. J. Telegraph systems. (15/5/16.) 106,312.

7,187 BURNETT, F. C. E., & BRUNNING, E. J. Electric heating devices. (19/5/16.) 106,332.

7,380 MERSING, J. Electric lamps. (24/5/16.) 106,338.

7,796 CABOT, S. Electric conversion. (1/6/16.) 106,008.
Relates to a system for the conversion of polyphase current to direct current, or direct current to polyphase current, or direct current at one potential to direct current at another potential, by polyphase commutation, and comprises the use of a polyphase transformer having such small leakage-inductance that the current may be sparklessly commutated for all loads within the rated output of said transformer with a fixed angle of commutation.

8,433 CABLE ACCESSORIES Co. & REEVES, F. H. Electric heaters. (15/6/16.) 106,011.

8,960 WOOD, R., & CALLENDER'S CABLE & CONSTRUCTION Co. Means for printing identifying marks on individual cores of multicore electric cables. (26/6/16.) 106,016.

9,702 ELIBSON, C. P., & PAYNE, E. G. Electric controllers for vehicles. (10/7/16.) 106,358.

9,804 GULSTON, H. S. Hand or portable electric lamp. (12/7/16.) 106,025.

10,328 BACK, H. C. Contact screw of the armature of field telephone induction coils. (22/7/16.) 106,029.

11,956 SPENCER, W. H.C., & COLLINS, LTD., H. Electrical stop motions for knitting machines. (23/8/16.) 106,380.

11,968 BASTIAN, C. O. Electric glow lamps and the like. (26/1/16, divided application on 1,271/16.) 106,036.

13,953 LANDTMETERS, J. C. Electric resistance furnaces. (25/9/16.) 106,044.

16,201 COOKE, G. F. Armatures of magneto-electric machines. (11/11/16.) 106,422.

16,359 CRAWFORD, A., and PRESTON, W. Contacts for electric switches and other electrical apparatus and the mode of and means for mounting or supporting same. (15/5/16, cognate application, 15,033/16.) 106,054.

18,649 CANNART D'HAMALE, F. DE. Electro-mechanical make-and-break movement for electric circuits. (30/12/16.) 106,064.

1917 SPECIFICATIONS.

1,437 GRAHAM, E. A. Electrical pushes. (29/1/17.) 106,446.

4,937 MAYER, F. Telephone appliances. (5/4/17.) 106,457.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

April 10, 1917.

4,993 HOLLINGWORTH. Demagnetiser for continuous or alternating currents.

5,005 THOMSON. Current or voltage regulator.

5,009 WARDELL & WOLSELEY MOTORS (LTD.). Controlling current in connection with electromagnetic gear boxes of automobiles.

5,018 MARR. Telephone transmitters.

5,028 AMES. Light projection apparatus.

5,054 FLETCHER & HALLIMOND. Magnetic separators.

5,067 MUIRHEAD & HUSKINSON. Telegraphic receiving and tape perforating apparatus.

April 11, 1917.

5,072 ETCHELLS & GREAVES. Electrically-heated resistance furnaces.

5,073 MCCOLL. Alternating-current elec. systems.

5,088 GARRARD & RAILING. Elec. switchboards.

5,112 IGRANIC ELEC. Co. & CURTIS. Housing of switchgear.

April 12, 1917.

5,151 ISHERWOOD & TURNER. Elec. welding apparatus.

5,161 SARTORI. Asynchronous motors.

5,168 BRIT. WESTINGHOUSE ELEC. & MFG. Co. Control of S.P. commutator motors. (12/4/16, U.S.)

5,177 JONES. Electrically depositing metal.

5,178 CHITTY. Elec. machines.

April 13, 1917.

5,220 WALKER. Elec. welding. (14/4/16, U.S.)

5,224 BRUSCHKE. Telephone meters.

5,246 SCHAANNING & THOMPSON. Tanks for electrical transformers.

5,254 TROSDAHL. Current interrupters.

5,260 JONES. Electrodes for arc soldering.

5,261 HADFIELD. Points and switches for tramways, &c.

5,267 LE PONTOIS. Ignition current generators.

April 14, 1917.

5,281 HIRST. Elec. submarine destroyer.

5,292 B.T.-H. Co. (G.E. Co.) Elec. regulators.

5,295 FELTEN & GUILLEAUME CARLSWERKE A.G. Insulation of submarine telephone cables. (14/4/16, Germany.)

5,301 BRIT. WESTINGHOUSE ELEC. & MFG. Co. Control of dynamo elec. generators.

5,305 BROOK. Insulating devices.

April 16, 1917.

5,312 COLES. Automatic fire alarm.

5,333 MARTIN. Wireless receiving circuits.

5,349 COX. Electric lamps.

5,354 SASSULIEF. Manufacture of incandescent lamp caps and sockets.

5,358 BULLERS & TWISS. Electrical insulators.

5,363 LATOUR. Audion or lamp relay or amplifying apparatus for wireless telegraphy and telephony. (15/4/16, France.)

5,365 GRAHAM & RICKETS. Thermostatic apparatus applicable as relays and circuit interruptors.

April 17, 1917.

5,400 B. T.-H. Co. (G. E. Co.) Metals and their manufacture.

5,401 LORAS. Transformers for alternating currents. (9/6/16, France.)

5,410 CAMPBELL. Electric heating of metallic bodies.

5,411 SOC. ANON DE MAGNETOS ET APPAREILS ELEC. SAMA. Magneto or dynamo-electric machines. (17/5/16, France.)

5,412 SOC. ANON DE MAGNETOS ET APPAREILS ELEC. SAMA. Electric contact breaker. (26/5/16, France.)

5,413 FORBES. Storage batteries.

5,414 DAVIDSON, DEARLOVE & PERRYMAN. Telegraph systems.

April 18, 1917.

5,431 CRAVEN. Plug for telephone switchboards, &c.

5,448 STANNARD. Manufacture of metallic tungsten and its alloys.

5,451 B. T.-H. Co. (G. E. Co.) Protective devices for electrical apparatus.

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Excess Profits. The Federation of British Industries and the Central Council of the Associations of Controlled Establishments have arranged to move certain amendments on the Committee stage of the Finance Bill, in order to place the basis of the excess profits tax upon the actual profits and not upon inflated figures. To reach this basis the following points are considered to be important:—

1. Proper allowances should be made for depreciation and obsolescence of all assets, including buildings, plant and machinery, whether due to the war or not.
2. The valuation of the stocks held by manufacturers should be retained at a normal figure in accordance with the existing practice, and not written up for taxation purposes to the market value at the moment.
3. That the principle of the excess profits tax laid down in the Finance Act of 1915 should be preserved, and not destroyed, as proposed by clause 19 of the Finance Bill.

* * * *

Machine Tools. The Minister of Munitions has withdrawn the Order applying Regulation 30A of the Defence of the Realm Regulations to machine tools and machinery driven by power suitable for cutting, stamping or working metal, and the general permit for purchasing or entering into negotiations for the purchase of machine tools, except in so far as they relate to insurance.

All applications for a permit to purchase or enter into negotiations for the purchase of the war material referred to in the Order should be made to the Executive Officers of the Area Clearing House Boards, whose addresses may be obtained upon application to the Director, Central Clearing House, Ministry of Munitions, Charing Cross-buildings, W.C. 2.

No new or second-hand machinery can be purchased, hired or transferred from the premises where it is at present located without the sanction of the Minsitry of Munitions. No application will be considered for the release of Machine Tools, whether new or second-hand, for class "C" work, or work not essential to the conduct of the war.

* * * *

Importance of the Power Load. From the accounts of the Lincoln Corporation electricity undertaking, which are abstracted in another column, it will be seen how important is the power load. The total output of the undertaking was 5,345,000 units (compared with 3,152,831 in 1915-16) and for power 4,636,007 units were sold (against 2,183,406), including 3,116,425 to a local firm. Notwithstanding an increase in the cost of coal of more than ½d. per unit, the works costs (exclusive of interest and sinking fund) only increased by slightly less than ½d. per unit, this result being mainly due to savings in the standing charges. When interest and sinking fund are taken into consideration, the total costs are the lowest on record, being more than ½d. per unit less than in 1915-16, which also was a record year.

The engineer and manager (Mr. Clegg) points out that the increased cost of fuel was not all due to the increased price, as the continuous use of the old low-pressure plant resulted in the consumption of coal per unit generated being increased from 4·095 lb. to 4·65 lb. This is a strong argument in favour of the replacement of the small and inefficient sets by modern turbo-generators. The change would result in great economies, including a large saving of coal

* * * *

Loans for Electric Vehicles. In the annual report of the Electric Vehicle Committee of Great Britain it is stated that the Committee has had under consideration the short loan periods recently granted by the Local Government Board for the purchase of motor vehicles. A communication was sent to the Board expressing the hope that upon the termination of the war the latter would be prepared to consider evidence, which the Committee would be able to place before it, showing that the actual useful life of the electric vehicle was such as to justify a considerably longer period than five years.

Though there is not a great deal of experience to guide it, we think the Board would be justified in granting a longer period for repaying loans for electric vehicles, whose life is stated to be longer than five years. However, it seems to us that, under normal conditions, it would be inadvisable for local authorities to take up loans for such a short period as five years, and it would be more economical to pay for the vehicles out of the rates.

Registration of Business Names. It is announced that documents filed under the Business Names Act will be available for inspection by the public on and after Sept. 1.

The fee payable for each inspection will be 6d. Up to the present the registrations number about 100,000, but it is believed that several thousands more ought to have registered. For the omission to register the Act provides heavy penalties.

* * * *

Cheaper Power. One of the results of the war has been to demonstrate the great importance of a cheap supply of electric power, and many of the leading commercial and municipal organisations of the country are preparing to give evidence before the Board of Trade Electric Power Committee.

The British Empire Producers' Association is collecting detailed statements from associations of manufacturers and producers in order to submit a full statement of the manufacturers' side, and already Walsall Chamber of Commerce and some industrial organisations in the Midlands have decided to co-operate with the Association in the matter. The following (among other organisations) are also to submit evidence: The Association of Municipal Corporations, the London County Council, the Incorporated Municipal Electrical Association, the Institution of Electrical Engineers and the Association of Electric Power Companies.

* * * *

Tyneside Electrical Industries. The members of the Electrical Section of the Newcastle-on-Tyne Chamber of Commerce have decided to improve and strengthen the section.

The chairman of the section (Mr. H. W. Clothier), who presented a report on the matter at the recent meeting, stated that the need for national organisation was now well recognised. The tendency now was to strengthen the existing organisations and to promote new ones having a collective interest in the national prosperity. Whilst the war engaged their first and urgent attention, the time which could be devoted to prospects of trade after the war must necessarily be limited, but the best opportunity must be taken to secure whatever time was available to help in making the moulds which would give shape to the industry of the future. In view of the prominent place Newcastle had taken in engineering from time to time, it was fitting that in electrical progress it should be an example to the rest of the country. To put their experiences into concrete and more useful form, it was now proposed to consolidate the Electrical Section of the Chamber of Commerce. Amongst the objects of the section were: "To give collective attention to matters of commerce affecting the progress of the electrical industry in the district; to discuss subjects which apply to the national prosperity, and to communicate, where necessary, considered local opinions to Government departments and national industrial associations; to be the channel for communication with consular officers abroad and the dissemination of commercial information to firms immediately interested; and to consider the question of cheap and unlimited power for manufacturers after the war."

* * * *

Our Mineral Resources. A Department of the Ministry of Munitions, under the direction of Sir Lionel Phillips is devoting attention to the development of mineral resources of Great Britain and Ireland.

A number of engineers, it is announced, are assisting the efforts of the Department, and considerable work has been done in furthering war purposes. Steps are being taken to control and expand wolfram mines, from which it is expected to produce a home supply of tungsten powder. A complete survey of the lead resources of the country is being carried out; new sources of supply are being investigated and old workings reopened. In one instance steps have been taken to assist in the drainage and development of an important lead mine, from which there is a prospect of an immediate increased output. Action is also being taken with regard to the production of zinc. A sulphur pyrites mine has been acquired and certain low-grade copper deposits of considerable extent and promise are being carefully watched.

* * * *

Excess Profits Duty Appeals. There is a growing demand for giving the right of appeal from the Inland Revenue Commissioners in excess profits duty cases.

It appears that when an application is made to the Commissioners for a case to be heard by the Board of Referees objection is frequently raised that the matter has already formed the subject of a decision, and that there is no need for the case to be referred, thus preventing the right of appeal beyond the Commissioners. In consequence of the large sums which are sometimes involved, and in view of the whole circumstances it is felt that there should be a right of hearing before an unprejudiced third party, and several Chambers of Commerce have made representations on the subject to the Chancellor of the Exchequer.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Battersea (London).—Extensions of mains, estimated to cost £1,441, have been authorised by the Council.

Halifax.—The option given to the Electricity Committee to acquire land at Copley for a new generating station has been extended to Aug. 4.

Poplar (London).—The Electricity Committee has considered the tenders submitted for the supply of a 3,500 kw. or (alternatively) 5,000 kw. turbo-generator.

The most favourable tender was that of Messrs. Willans & Robinson, who quoted £20,623 for the 3,500 kw. set, less £234 spares, and £24,380 for the 5,000 kw. set. In view of the limited supply of condensing water the fact that the effective capacity can only be assumed at 3,000 kw. in the event of breakdown, the space required, and capital cost, the engineer (Mr. J. H. Bowden) is of opinion the smaller machine should be installed. The Director of Electric Plant at the Ministry of Munitions will be satisfied with the installation of the smaller machine and will release the plant now partly completed, and of which delivery and erection can be made within six months. The actual capacity of the plant would be 4,250 kw. at normal pressure, and overload would bring it up to 4,780 kw. on occasion for short periods.

Stafford.—Application has been made to the L.G. Board for sanction to borrow £8,700 for an additional boiler and other plant at the electricity works.

Stoke-on-Trent.—The Board of Trade have authorised the supply of electric current to premises in the Leak Rural and the Smallthorne Urban areas.

GENERAL.

Barnes.—The assistant electrical engineer (Mr. Law) recently asked to be allowed to join H.M. Forces, but the Electricity Committee was unable to give him permission owing to the shortage of staff.

The chairman of the Lighting Committee (Coun. Wilson) stated at the recent meeting of the Council that several applications had been received for supplies of current, but owing to the shortage of new cable there was considerable difficulty in carrying out such work. The committee asked that all firms desirous of making application for new work should first of all apply to the engineer and ascertain whether new cable was necessary or was obtainable. The work could only be done under a Class A certificate, and even then the committee could not guarantee that the work could be carried out, as the shortage of material made it almost impossible.

Barnstaple.—On Monday the Council adopted a recommendation to increase the salary of the electrical engineer (Mr. J. W. Hadfield) to £275 per annum, and the premiums for pupils instructed by the engineer will be received by the Council.

Birkdale.—Southport Corporation has authorised the Birkdale Electric Supply Co. to increase its charge for current to 5d. per unit, plus 5 per cent. for private lighting "on condition that the increased profits or residue so arising shall not be taken into account in the event of the future purchase of the undertaking by the Corporation."

Doncaster.—The borough electrical engineer and tramways manager (Mr. E. S. Rayner) has applied for and been granted an early release from his position in order to take up an appointment under the Admiralty at a salary of £700 per annum.

At the last meeting of the Council the Electrical & Tramways Committee recommended that Mr. Rayner's salary be raised from £450 to £500 a year, but after a rather heated discussion the recommendation was referred back.

Dublin.—The members of the Corporation have indulged in a further lengthy discussion on the management of the electricity undertaking, and ultimately it was decided to refer the report of the Special Committee to the Electricity Supply Committee with power to deal with the matters.

Electricity in Agriculture.—At the meeting of Chester Corporation on Wednesday it was reported that at a conference at the offices of the Board of Agriculture and Fisheries on the 15th inst. when there were present Mr. Hall (Board of Agriculture), Sir John Snell, Sir Owen Philipps, K.C.M.G., M.P., the Electrical Engineer and Town Clerk of Chester, plans prepared by the Electrical Engineer (Mr. S. E. Britton) were submitted and considered for the generation of electrical energy by water power from the River Dee for agricultural purposes.

Mr. Hall stated that the Board of Agriculture desired that the City Council should make an application to the Treasury for a grant of £200 from the Development Fund for collecting data and making investigations as to the practicability of the scheme, and that the Board would support the application.

Therefore the Electricity Committee recommended the Council to make an application to the Treasury for a grant of £200 under sec. 1 of the Development and Road Improvement Fund Act, 1909, for the expense of collecting data and making investigations into the practicability of utilising the water power of the River Dee above Chester to generate electricity to be used for agricultural purposes and the development of Rural Industries. The recommendation was adopted by the Council.

Gillingham.—The Council has decided to increase the war bonus of the employees of the electricity department to 6s. per week.

Linking-up in South London.—The Board of Trade has approved of the agreement under which the County of London Electric Supply Co. will supply electricity in bulk to the South London Electric Supply Corpn.

Slaithwaite.—The Urban Council has been granted another extension of 12 months to carry out the provisions of its Electric Lighting Order of 1914.

The L.G. Board has reminded the Council that in the schedule of work proposed to be undertaken by the Council after the war was the electric lighting scheme, at an approximate cost of £7,900. No application had yet been made for a loan, and if the Council intended to borrow money it should submit its proposals to the Board as soon as practicable, so that they might be considered, and, if found necessary, brought to the point when sanction to the borrowing could be readily granted when circumstances permitted.

It has, however, been decided to defer the matter for the present.

Surbiton.—In his half-yearly report the consulting engineer (Sir John Snell) states that there has been a serious falling-off of lighting units of 15½ per cent., but an increase in the power units of 28·4 per cent. There was a decrease in the total units sold of 8 per cent. Despite a falling-off of lighting units and an increase of power, the load factor decreased by 2 per cent.

Worcester.—In regard to the proposal of the Electricity Committee to raise the Powick Weir, so as to get additional water power, the Severn Fishery Board have decided that, unless the Electricity Committee give an undertaking that the proposed work will create no obstruction to the free passage of fish, it will oppose any interference with the weir.

LIGHTING AND INDUSTRIAL POWER.

Cheam.—In consequence of the refusal of the local gas company to reduce its charges for public lighting there was an animated debate on public lighting at the last meeting of the Parish Council.

The Lighting Committee reported that the Electric Lighting Co. had promised a rebate of 66 per cent. on the contract price for street lighting, but the Gas Co. had stated that they could not see their way to make a further rebate.

The chairman (Mr. D. W. Shaw) said that opened up the question as to whether it would not be advisable for the whole district to be lighted by electricity and not a portion as at present. As the Council's agreement with the Gas Co. would end in September he thought the time was opportune to consider the subject. It was agreed, however, to refer the matter to the Lighting Committee.

Electric Driving of Factories.—At the new factory of the British Everite & Asbestilite Works (Ltd.) at Farnworth, Lancs, the electric drive has been adopted throughout. Current is supplied by an independent electric plant driven by 200 H.P. National gas engines.

Electric Steel Furnaces.—The "Iron & Coal Trades Review" announces that licences have been granted by the United States Steel Corporation for the installation of six more Héroult electric furnaces, which will bring the total of this type, operating or contracted for in the United States and Canada, to 114. Of these 30 have been licensed since Jan. 1 last.

Nitrates from the Air.—The "Manchester Guardian" announces that the International Nitrogen & Power Co. has leased 2 acres of land near Manchester for the erection of plant for the manufacture of nitrates from the air, and adjoining the site are the works of the British Carboid Co. It is expected that the works will be in operation by the autumn.

Water Power in Russia.—The Ministry of Trade has drawn up a scheme for the temporary control of the water power of the country.

Under the scheme all sources of water-power, no matter on whose land they may be found, are subject to the supreme disposition of the Government. Water-power may be used either by the Government itself or by local governments, or again by private persons or companies. For the purpose of controlling the use of the water-power a committee will be formed.

Digitized by Google

ELECTRIC TRACTION.

Brighton.—On Tuesday about 50 women tramcar conductors struck as a protest against the dismissal of a conductor.

Cheap Tramway Fares.—Coventry Corporation have applied to the Board of Trade to allow the maximum cheap fare of ½d. per mile (or fraction of a mile) authorised by sec. 17 of the Corporation Tramway Act of 1903, being increased to ¾d. per mile.

The Yorkshire (Woollen District) Tramways Co. recently revised their rates and abolished the ½d. workmen fares. Owing, however, to the action of Dewsbury Corporation and other local authorities, Mr. W. Runciman, M.P., was induced to intervene and approached the Board of Trade in the matter, and as a result the Board recently ordered the company to restore the ½d. fares.

Croydon.—On Monday the Council decided to increase the war bonus as from the 28th inst. as follows:—

To all male employees by 3s., and all female employees by 1s. 6d., making a total war bonus per week of 5s. for motormen and male conductors, 2s. 6d. to female conductors and 7s. to other grades.

Darwen.—The Tramways Committee has refused to grant leave of absence to the manager (Mr. F. J. S. Hosken), who has been offered an appointment on Admiralty work.

Electric Vehicle Progress.—The Bolton borough electrical engineer (Mr. W. J. Wood) has been authorised to obtain tenders for an electric vehicle.

At present there are eight electrically propelled vehicles employed in the conveyance of mails to and from Johannesburg post-office.

Hull.—The Chairman and Deputy-Chairman of the Electricity Committee and the Acting Engineer recently discussed with the Chairman of the Tramways Committee and the Tramways Electrical Engineer the question of linking-up the tramways power station with the electricity works, and it was agreed that the Chairman, Deputy-Chairman and Electrical Engineer of the Tramways Committee should submit a report at the next meeting of the Committee for their approval.

The immediate advantages to the Electricity Department of linking-up will consist in obtaining a load outside the hours of maximum load at the electricity works, and consequently without the necessity for any capital outlay on generating plant, and the fuller and more beneficial employment of the department's most efficient machinery. In the event of the Tramways Committee deciding to take the supply it will be necessary to extend the e.h.t. main and install certain switchgear in the tramway power station at an estimated cost of £4,800. The proposed extension of mains would have to be made in the ordinary course from the point of view of expediency. The Electricity Committee has, therefore, decided that, subject to the Tramways Committee deciding to take a supply of electricity from the Committee, it is prepared to afford such supply, and the question of the terms has been left in the hands of the Chairman, Deputy-Chairman and Acting Engineer to arrange.

Leicester.—The Tramways Committee has decided to increase the tramway fares on the Stoneygate, Clarendon Park and Aylestone routes.

Nuneaton.—The Council, which proposes to obtain powers to provide a system of transit at the end of the war, has decided to use motor-omnibuses in the town and for running to neighbouring towns and villages.

Ald. SANDS stated at the Council meeting last week that the Highways Committee had considered two systems—overhead electric tramways and motor-'buses. From inquiries where both systems were in vogue they were convinced the motor-'bus service was more convenient, cheaper and the more likely to be remunerative. The cost of an electric tramway system was estimated at £9,000 to £10,000 a mile, and it was estimated they would have to spend anything up to £150,000 for putting down such a system. A motor service of 15 omnibuses, with garage, petrol stores, &c., would cost about £18,500.

Petrograd Underground Railway Scheme.—An old scheme for the construction of an underground electric railway in Petrograd was before the Town Council in April.

The original scheme was prepared by an English firm of engineers who would construct the railway on a concession basis. Hydro-electric current from the Imatra water-falls would be used. Consideration of the scheme, which will have to be considered by a fresh Duma, has been deferred.

Tramway Employees' Wages.—The tramway employee of the Lancashire and Cheshire undertakings, who recently received an extra 2s. 6d. per week, are dissatisfied with the terms of the award.

On Saturday and Sunday last the Manchester tramway service was disorganised because the employees refused to work extra cars, and they insisted upon limiting the number of passengers on all cars. Since the outbreak of war it has been customary to allow extra passengers inside and also on the outside platforms; but without official authority the employees (who claim a further increase in wages of 7s. 6d. per week) reimposed the old restrictions.

At Salford similar conditions prevailed, and the employees refused to overload the cars or carry more than six standing inside per small car or nine inside a large car, no one being allowed to stand outside.

West Ham.—It has been decided not to proceed with the work of doubling the tramway track at Connaught-road, but the span-wire system is to be substituted for bracket arms.

The Commissioner of Police has intimated that under present conditions tramcars are to be allowed to resume normal lighting inside, providing that the lighting circuits are so arranged that the whole, except the ordinary traffic lights, can be switched off when necessary. If one or more interior lights are kept on to complete the circuit they must be kept shrouded or screened, so that no light is visible from outside during the period of air raid warnings.

MISCELLANEOUS.

Electrical Engineering in Warfare.—The "Frankfürter Zeitung" announces that the German Government has requisitioned all electrical machinery and apparatus, and it is not now possible to buy or sell electric motors without special permission.

In an article in the "Cologne Gazette" on a visit to Kiel, where the dockyards are said to be mainly, but not entirely, engaged with repairing work, contains the following passage (which we reproduce from the "Times" of Wednesday) on copper and electricity:—

"Copper is now used in large quantities in all ships, although, of course, consumption is restricted as much as possible. Especially for steam piping there is no substitute for copper, and it is also needed for all purposes where high resistance to sea water and salt air is necessary.

"Over against the boiler shop is the electrical shop, which becomes every day more important with the increased use of electricity. We have already gone a long way in this direction, although we have not yet gone quite so far as the Americans, who even drive the screw-shafts of large ships by electric motors. As regards our submarines, it is indeed much the same with us, for our submarines already consist half of electricity. The submarines are also concerned with the accumulator shop, where accumulators are repaired. Repair is not always possible, for the demands made on the accumulators in war are sometimes too great."

Enemy Firms Wound Up.—The Board of Trade has up to the present ordered the winding up of 467 businesses controlled by alien enemies.

The latest is W. P. Theerman & Co. (Ltd.), 283, Oxford-road, Chorlton-on-Medlock, Manchester, electrical engineers. (Controller: Wm. Eaves, 15, Fountain-street, Manchester.)

Engineering Wages.—Last week the Committee on Production met representatives of the Engineering Employees Federation and of about 40 of the trade unions connected with the engineering industry in order to consider applications for advances in wages in the engineering and foundry trades.

Unemployment Insurance.—It is notified that the unemployment books for 1916-17 cease to be current on 14th prox. and must be exchanged for new books in the week ending July 21.

Stamps representing contributions payable after July 14 must be affixed to the new unemployment books. Applications for refunds under sec. 94, as amended, must be made in the prescribed manner by Sept. 14. For the purposes of exchange the unemployment books for 1916-17 should be returned as early as possible in the week ending July 21 to the nearest employment exchange or other local office of the Unemployment Fund. Special facilities are offered by the Ministry of Labour to employers whereby if the necessary particulars of the old books are furnished in good time to the Ministry the corresponding new books will be made out beforehand and will be ready for issue as soon as the old books are returned after July 14. Employers desirous of availing themselves of these facilities should communicate with the nearest employment exchange or other local office of the Unemployment Fund.

The umpire has recently decided that contributions are payable in respect of the following:—

Workmen engaged in the manufacture of electrical cooking and heating apparatus.

Enamellers and lacquerers of brass and other materials in connection with the manufacture of electric light fittings.

Workmen engaged wholly or mainly in fitting up, finishing ready for sale, or in repairing (including cleaning) electric stoves, cooking apparatus and similar electric appliances.

Workmen employed by an electric supply authority and engaged wholly or mainly in assembly and finishing cable accessories, such as jointing boxes.

Workmen engaged wholly or mainly in the manufacture of electric condensers.

Contributions are not payable in respect of the following:—

Workmen (other than those engaged in sawmilling or machine wood work) engaged in the work of handling, preparing and creosoting telegraph poles and other timber.

Slate enamellers employed in connection with the manufacture of domestic electric light fittings which are not intended for use in war.

Workmen engaged by an electric lighting authority and engaged in the work of (1) cleaning arc and incandescent lamps, not in connection with repair of lamps; (2) making by hand removable wooden meter brackets; (3) fixing removable meters and brackets; (4) fuse hands; (5) boiler cleaning; and (6) fitting up temporary wires and appliances in show rooms and carrying out experiments and tests.

Digitized by Google

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during May, 1917, and (*b*) the aggregate figures from Jan. 1 to May 31, with increase or decrease compared with corresponding periods of 1916 :—

Electrical machinery, (*a*) £137,025 (increase £15,826), (*b*) £627,541 (increase £134,615) ; including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £37,547 (increase £17,366), (*b*) £113,772 (increase £36,244) ; and electrical machinery unenumerated, (*a*) £99,478 (decrease £2,540), (*b*) £513,769 (increase £98,351) ; telegraph and telephone cables other than submarine, (*a*) £2,001 (decrease £9,923), (*b*) £45,853 (increase £2,192) ; telegraph and telephone apparatus, (*a*) £3,199 (decrease £58,947), (*b*) £14,771 (decrease £138,936) ; other electrical wires and cables, rubber insulated, (*a*) £1,223 (decrease £14,008), (*b*) £24,056 (decrease £25,632) ; with other insulations, (*a*) £1,603 (increase £1,493), (*b*) £5,275 (increase £2,061) ; carbons, (*a*) £11,984 (increase £2,253), (*b*) £43,788 (increase £754) ; glow lamps, (*a*) £444 (decrease £24,438), (*b*) £60,034 (decrease £51,261) ; arc lamps and electric searchlights, (*a*) nil, (*b*) £38 (increase £38) ; parts of arc lamps and searchlights (other than carbons), (*a*) £10,071 (increase £3,236), (*b*) £47,553 (increase £15,631) ; primary and secondary batteries, (*a*) £18,256 (increase £2,572), (*b*) £147,630 (increase £61,655) ; meters and measuring instruments, (*a*) £3,749 (increase £681), (*b*) £12,856 (decrease £2,538) ; switchboards, (*a*) nil (decrease £4), (*b*) nil (decrease £257) ; electrical goods and apparatus unenumerated, (*a*) £47,244 (increase £10,470), (*b*) £222,883 (increase £95,161). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £99,774 (decrease £86,715), (*b*) £624,737 (decrease £41,132).

Exports.—The exports of electrical machinery, material, &c., (*a*) during May, 1917, and (*b*) from Jan. 1 to May 31, with increase or decrease compared with corresponding periods of 1916, were as follows :—

Electrical machinery, (*a*) £109,219 (decrease £11,568), (*b*) £599,255 (increase £88,735), including railway and tramway motors, (*a*) £507 (decrease £1,548), (*b*) £11,150 (decrease £4,152) ; other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £80,700 (increase £25,536), (*b*) £352,252 (increase £89,623) ; and electrical machinery unenumerated, (*a*) £28,012 (decrease £35,556, (*b*) £235,853 (increase £3,364) ; telegraph and telephone cables, submarine, (*a*) £3,322 (decrease £12,053), (*b*) £99,301 (decrease £1,476); other than submarine, (*a*) £74,412 (increase £15,127, (*b*) £373,281 (increase £112,080) ; telegraph and telephone apparatus, (*a*) £10,787 (decrease £3,831), (*b*) £80,615 (decrease £27,860) ; other electrical wires and cables, rubber insulated, (*a*) £9,158 (decrease £34,388), (*b*) £118,935 (decrease £66,737) ; with other insulation, (*a*) £25,963 (decrease £73,987), (*b*) £159,465 (decrease £174,905) ; carbons, (*a*) £5,964 (increase £5,351), (*b*) £14,450 (increase £10,307) ; glow lamps, (*a*) £12,073 (decrease £7,492), (*b*) £61,574 (decrease £8,304) ; arc lamps and searchlights, (*a*) £100 (decrease £347), (*b*) £10,648 (increase £5,350) ; parts of arc lamps and searchlights (other than carbons), (*a*) £1,342 (increase £961), (*b*) £17,261 (increase £12,273) ; primary and secondary batteries, (*a*) £13,237 (decrease £16,484), (*b*) £76,577 (decrease £32,323) ; meters and measuring implements, (*a*) £4,972 (decrease £10,762), (*b*) £50,165 (decrease £24,815) ; transformers, (*a*) £6,449 (decrease £5,891), (*b*) £29,196 (decrease £1,047) ; switchboards, (*a*) £6,602 (decrease £1,514), (*b*) £16,868 (decrease £12,819) ; electrical goods and apparatus unenumerated, (*a*) £62,717 (increase £1,257), (*b*) £295,262 (increase £51,605). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £237,098 (decrease £144,053), (*b*) £1,403,598 (decrease £157,571).

EDUCATIONAL.

Manchester Municipal School of Technology.—The new session for 1917-18 will begin on Oct. 5 and the matriculation and entrance examinations will be held in July and September. Complete courses of instruction, leading to the Manchester University degree in the faculty of technology, are provided and good provision is made for advanced study and research in mechanical, electrical and sanitary engineering, the chemical and textile industries, mining, architecture, &c. Prospectuses will be forwarded post free on application.

Huddersfield Technical College.—Sir John Ramsden, Bart., has given a donation of £3,000 towards the extensions fund of this College.

Wireless Telegraphy Classes.—Owing to the great increase in the number of students in the electrical engineering department, particularly in connection with the wireless telegraphy classes, Birmingham Education Committee propose to take premises in Ludgate Hill in order to provide accommodation for 800 students.

The Committee has had a communication from the Postmaster-General stating that he wished the attention of students to be drawn to the present shortage of wireless operators in the merchant service, and that arrangements had been made with the War Office to issue under certain conditions certificates of protection to young students in training and qualifying within a specified time for the Postmaster-General's certificate based on the Government examination for wireless operators.

TENDERS INVITED AND ACCEPTED.

Water-cooling Towers and Motor-driven Pumps.

WOLVERHAMPTON Corporation require tenders by 10 a.m. June 30 for supply and erection of water-cooling towers and motor-driven pumps at the electricity works. Specification from the Engineer and Manager.

Induced Draught Plant, Fuel Economiser Extensions, &c.

NEWPORT (Mon.) Corporation invite tenders for induced draught plant ; additions and extensions to fuel economisers; and cooling towers. Forms of tender from Mr. A. Nichols Moore, M.I.E.E., borough electrical and tramways engineer. Tenders to the town clerk, Mr. Albert A. Newman, by 10 a.m. June 30.

BRIGHTON.—The Council has accepted the tender of the Underfeed Stoker Co. for supplying and fixing three travelling grate mechanical stokers, at £3,087.

POPLAR (LONDON).—The Electricity Committee has accepted the offer of Messrs. Willans & Robinson for the supply of a 3,500 kw. set, at £20,389.

Government Contracts.—The following tenders were accepted by the British Government Departments during May :—

War Office—J. L. Hancock (Ltd.) and Schall & Schall, X-ray appliances; India Rubber, &c., Co. and Siemens Bros. & Co., electric cable ; India Rubber, &c., Co., C. Macintosh & Co. and Peel-Conner Telephone Works, ebonite ; Benjamin Electric (Ltd.), Electrical Conduits (Ltd.), Elm Works (Ltd.), Eureka Conduits & Fittings Co., Forward Electric Co., Gabriel & Co., S. Heath & Sons, Ingram & Kemp, Nettlefold & Sons, Oriental Tube Co., Perfecta Seamless Steel Tube & Conduit Co., Rainsford & Lynes, Satchwell & Gittines, C. J. Thursfield & Co , Veritys (Ltd.) and Ward & Goldstone, electric light fittings and accessories ; Coventry Simplex Engines (Ltd.), W. H. Dorman & Co., R. A. Lister & Co. and Record Engineering Co., generating sets and accessories ; Davis & Timmins, L. Herve, Houghton-Butcher Mfg. Co. and C. J. Thursfield & Co., electric instrument terminals ; Ellis & Ward, electric lighting.

India Office—Peel-Conner Telephone Works, carbon cups ; General Electric Co., cells ; Bullers (Ltd.), insulator cups ; Automatic Telephone Mfg. Co., switchboard ; Peel-Conner Telephone Works, telephone sets ; Brunner, Mond & Co., voltoids.

Post Office—Automatic Telephone Mfg. Co. and H. White & Co., telegraph apparatus ; Automatic Telephone Mfg. Co., Gent & Co., Sterling Telephone & Elec. Co. and Western Electric Co., telephone apparatus ; Bullers (Ltd.), A. Kendrick & Sons and Ley's Malleable Castines Co., c.-i. brackets ; Telegraph Construction & Maintenance Co., submarine cable ; British Insulated & Helsby Cables, W. Geipel & Co., Henley's Telegraph Works Co., New Gutta Percha Co., Telegraph Construction & Maintenance Co., Union Cable Co. and Western Electric Co., telegraph cable ; Siemens Bros. & Co., cases for telephones ; British Ever-Ready Co., John C. Fuller & Son and General Electric Co., dry cells ; London Electric Wire Co. & Smith's, telephone cords ; Baxendale & Co., lead ; Walls (Ltd.), earth plates ; Bullers (Ltd.), stay rods and insulator spindles.

APPOINTMENTS VACANT.

The Government of the Union of South Africa require an industrial adviser to the Industries Section of the Department of Mines and Industries. Salary, £2,000. Applications to the High Commissioner, 32, Victoria-street, London, S.W. 1, by July 31.

Switchboard attendants are wanted for a generating station in the Manchester district. *See an advertisement.*

An electrical and mechanical engineer is required to take charge of electric power and pumping installations at Didcot Ordnance Depot. Salary £250. Applications to the Chief Engineer, Southern Command, 12, Wilton-road, Salisbury.

An assistant engineering master will be wanted in September at the Coventry Municipal Technical Institute. Forms of application from the Secretary, Education Committee, Council House, Coventry. Applications by July 16.

BUSINESS ITEMS.

Chas. Norman Large and Walter Wallace Large (trading as Large Bros.), electrical engineers, &c., Penrhyn-road, Colwyn Bay, have dissolved partnership. Debts by both the late partners.

Chas. John Hobbs and Fredk. Murgatroyd (trading as C. J. Hobbs & Co.), electricians and contractors, 86, Fratton-road, Portsmouth, have dissolved partnership.

Sale of Shares by Tender.—The Public Trustee offers for sale by public tender 119,660 shares of £5 each (fully paid) in Messrs. Siemens Bros. & Co. (Ltd.). Tenderers desirous of inspecting the works should apply to the Public Trustee, Kingsway, London, W.C., to whom tenders are to be delivered by noon of July 12. *Further particulars are set out in an advertisement.*

Plant for Sale.—Mr. Frank Gilman, 62, Lightwoods-hill, Birmingham, has for sale some generating sets, particulars of which are given in an advertisement.

New Works.—Official permission has been obtained for the purchase and installation of the machinery and tools required for the new works of the India Rubber, Gutta Percha & Telegraph Works Co., at Burton-on-Trent.

The site of the new works covers some 40 or 50 acres, and when equipped employment will be given to several hundred persons. The first sections of the buildings is complete, and measures 470 ft. by 105 ft.

Chemical Manufacturers Combine.—It has been decided to combine businesses of Messrs. Chance & Hunt (Ltd.) and Messrs. Brunner, Mond & Co. (Ltd.). No alteration in the name of the company is intended, and no material change of administration is contemplated.

BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 9s. 6½d. is payable at the O. R.'s, 26, Baldwin-street, Bristol, in the liquidation of the Colston Electrical Works (Ltd.), 9, Denmark-street, Bristol.

Winding-up Order. — Last week Mr. Justice Neville made a winding-up order against Steel's Electric & Engineering Co. (Ltd.).

CATALOGUES, &c.

Turbo-Alternators.—We have received from the British Westinghouse Elec. & Mfg. Co. a copy of Circular No. 1,426 giving a general description of the company's turbo-alternators. We hope to refer further to this in an early issue.

Switches and Fuse Sets.—Messrs. W. T. Henley's Telegraph Works Co., Ltd., Blomfield-street, London Wall, E.C. 2, have issued a neat folding card giving particulars and prices of their switch and fuse sets. Copies may be obtained by those interested.

Digitized by Google

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Belfast.—The accounts of the tramways department for the year ended March 31 last have been issued, and they show a gross capital expenditure of £1,456,965 (increase £72), of which £202,190 has been redeemed.

Revenue was £301,345 (=11·58d. per car-mile), and working expenses were £189,665 (=7·29d.), leaving gross profit £111,679 (=4·29d.), to which are added interest on investments (£542) and bank interest (£125). Dividends on stock required £45,022, and redemption contributions £34,975. £17,000 has been placed to depreciation or renewals fund, £8,961 to general purposes fund and other items provided for out of the year's revenue were: Equivalent of interest on debentures redeemed £5,478, income tax £5,207, stamp duty £652, rent of leased lines £750, registration of stock £632, depreciation fund (interest on balance uninvested) £485, and proportion of street widening charges £74. Car-miles run were 6,245,012.

Burton-on-Trent.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £129,938 (increase £2,458) and the net outstanding debt is £58,383. The accounts have been approved by the Council.

Revenue was £23,902 (compared with £20,310 in 1915-16) and working expenses were £12,516 (£9,770), leaving gross profit £11,386 (£10,540). £943 (£972) was contributed for cost of extension of plant, while loan charges, &c., amounted to £7,432 (£7,630), leaving net balance £3,011 (£1,938), of which £1,350 is to be applied to replacing overspent capital and £1,661 is being placed to reserve. Average price received per unit was 1·38d. (1·34d.). Motors connected aggregate 4,051 H.P. (increase 691 H.P.). Units sold were 3,993,197 (3,499,338); maximum load was 2,000 kw. (increase 249 kw.).

The borough electrical and tramways engineer (Mr. Thos. Hall) reports that the gross profit was 8·9 per cent. (8·3 per cent.) on the capital expenditure; the power supply increased 22·93 per cent., and heating and cooking 22·2 per cent. Of the increase of £3,570 from sales of current, £2,964 was due to the war increase of 15 per cent. which was sufficient to cover the increased cost of generation and the allowances to employees on military service. The revenue from power supply increased over £3,000. Cost of fuel increased about £2,000 and rents, rates and taxes £500. Although total costs increased 26 per cent., owing to the increased output the total cost per unit only increased by 10 per cent. Fuel used per unit was 6¼ lb.

The tramway accounts show revenue £14,641 (compared with £15,037), exclusive of M. R. Co.'s running and operating expenses were £11,855 (£11,369). Interest required £1,345 (£1334) and sinking fund £1,421 (£1,381), the net result being a deficit of £360 (against a surplus of £1,329). Total revenue per car mile was 10·54d. (9·29d.) and operating expenses including power were 8·52d. (7·05d.). Passengers carried were 3,147,043 (3,223,559), car miles run 333,632 (386,876) and units used 468,305 (483,388).

Hull.—The acting city electrical engineer (Mr. J. F. Magoris) has presented his third annual report on the working of the electricity undertaking for the year ended March 31 last.

The revenue from all sources amounts to £99,991, and the total working expenses, inclusive of war bonuses, but exclusive of special charges, amount to £60,095, leaving £39,896. Of this amount interest and sinking fund absorb £34,069, income tax £2,953 and special charges, viz., guarding of works and contributions to mobilised employees) £1,665, leaving a net balance to be carried to reserve of £1,209. There has been an increase over last year's figures in works costs and total working costs, both of which rose to the respective pre-war figures of 1913-14. The increase is, with the exception of wages (on account of war bonus amounting to £1,206. 14s. 9d.), entirely due to the enhanced cost of fuel per unit sold. The price of fuel per ton delivered to the works has increased by 34·71 per cent. over the average cost of the previous year. However, the contract has been renewed for the main portion of the department's fuel supply at last year's prices, deliveries to extend up to March 31, 1918. The output of power for industrial purposes continues to increase, and for the past year was 49 per cent. higher than in 1913-14, but the units for lighting, although slightly above last year's output, were 22 per cent. lower than in 1913-14. During the year agreements have been entered into for four important bulk supplies, and a new use to which the supply from the department's mains has been applied with success is the operation of steel rolling. The total connections to the mains are:—Power 23,584 kw. and lighting 8,396 kw., a total of 31,980 kw.

Hull Corporation Telephones.—The accounts for the year ended March 31 show an income of £58,210 and expenditure £35,462, leaving net profit of £5,355, compared with £3,645 in 1915-16.

The department pays £3,125 in local rates and £5,640 in royalty to the Government. Up to the present time Hull has paid £35,000 in Government royalties, and it is claimed that the telephone tariff is 33 per cent. lower than that of the rest of the country. The gross profit last year was £22,747.

Lincoln.—The accounts of the electricity undertaking for the year ended March 31 show gross capital outlay £96,402 (increase £3,603), and loan fund accumulations amount to £35,377.

Revenue was £27,324 (compared with £17,447 in previous year), and total costs were £18,784 (£10,516), leaving gross profit £8,540 (£6,930). Repayment of loans and interest required £5,329 (£5,202), and miscellaneous expenditure was £81 (£38), leaving £4,819 (£1,689), which has been placed to depreciation account. Total costs were 0·800d. (0·844d.) per unit, and interest and sinking fund 0·396d. (0·239d.). Units generated were 6,204,993 (3,735,182) and sold 5,345,009 (3,152,831). Total maximum supply demanded was 800 k.w. h.t. and 855 kw. l.t. for lighting and 100 kw. for traction (compared with 1,351 kw. for lighting and 100 kw. for traction last year).

The capital expenditure on the tramways is £44,987 (no increase), of which £15,358 has been redeemed. Revenue was £7,741(£7,424), and working expenses were £5,050 (£4,215). Interest required £1,529 and sinking fund £1,071 (the same amounts as last year). Average total revenue per car-mile was 12·69d. (12·03d.), and working expenses, including power, were 8·34d. (6·88d.). Passengers carried were 2,112,293 (1,992,213), car-miles run 145,343 (147,070), and units used 192,332 (177,636).

Mr. Stanley Clegg (city electrical and tramways engineer) says in his report the abnormal increase in output has been made without any increase in the capacity of the generating plant, and is a further illustration of the advantage of power supply, which tends to keep the plant in use the longest possible hours, and enables the department to obtain a reasonable return from it before it becomes obsolete and inefficient to run, as has been the case with a considerable portion of the department's plant. The whole of the increase is in power units, and whilst the largest increase in power (nearly 1,600,000) was taken by Messrs. Clayton & Shuttleworth, there was an increase of 590,000 in the general power consumers, who had taken a total of more than 1,500,000 units.

With regard to the tramway undertaking, Mr. Clegg says repairs and maintenance represent the largest proportion of the total increased working expenses—viz., £511—of which £220 is increased wages and £291 cost of materials. A certain amount of this is due to the severe strain which has been put on the cars and their equipment by the abnormal winter, and the remainder is due to the extra prices (up to in some cases 100 per cent.) which have had to be paid for spares and replacements The increase under the head of wages is represented by the war bonus charge, and not by extra staff, which has been, and is still being, depleted by the demands of the Army; the members of the staff taken have been in nearly every case at the younger end—viz., conductors and shed lads—and their places have as far as possible been filled by women; of these, two are in regular employment in the shed for cleaning the cars, of the remaining five four are conductors, and one was appointed assistant inspector after passing through a period of service as conductor. As far as Mr. Clegg is able to ascertain, they give satisfaction both to the department and the public. Whilst employing boys as conductors, it was the department's policy to pass them on to the shed if satisfactory, and eventually teach them driving, when they became of great service as spare men for holiday times and for the workmen cars. Up to the present none of the women have been persuaded to tackle driving in a satisfactory manner, and if their employment were to continue for any length of time this might lead to difficulties as far as the driving of cars is concerned. The upkeep of permanent way has been considerably increased, the paving of the track having got into such a bad state that it was absolutely necessary that it should be attended to. The abnormally heavy traction traffic which the requirements of the war have introduced, is causing serious damage to the track, as it not only wears it away, particularly where the older granite setts were used, but it actually loosens the wood paving from its cement bed, and causes it to float, with the result that not only the stud-heads, but the earthernware tee-pieces through which they are let into the track conduits are broken, thus allowing mud and water to percolate into the conduits, introducing an additional cause from which the studs become alive. The cost of the G.B. equipment this year is about the same as last. The work done, as during that period, has been confined to the replacement of dead and live studs, as neither material nor labour could be obtained for any systematic replacement, though a great deal of such work is overdue, so much so that it will be a question for serious consideration by the Council when the war is over whether it will be worth while to spend the considerable sum of money which would be necessary to bring the G.B. system up to a proper state of repair, or to replace it as a system by the overhead, which has from its simplicity of working many advantages over any of its rivals. Taking this year's expenditure on the upkeep of the G.B system, the average annual cost over the 11 years of its life is now £139, or £49 more than the cost estimated by the patentees. The upkeep of feeders, as last year, has been somewhat costly, as the policy of re-insulating the vulcanised bitumen-covered cables with paper, and afterwards lead sheathing them, in order to guard against the action of water, has been continued; it is likely, however, that although the work is not yet completed, what still requires to be done may have to wait over till the end of the war, as the use of lead for cable is now being very much restricted by the Government.

Digitized by Google

COMPANIES' MEETINGS AND REPORTS.

BRITISH ELECTRIC TRACTION CO. (LTD.)—At the meeting last week the chairman (Mr. E. Garcke) said that the stupendous expenditure by the nation and the employment of so many hands, both male and female, in the production of munitions of war, combined with restricted railway facilities, had had an effect upon the company's receipts akin to that which would be produced by great trade prosperity. The value of the increased receipts, however, must be weighed against the increased expenses, and it was then seen that the balance of profits was not proportionate to the increased work done. Prices generally, with the remarkable exception of tramway fares, had more than doubled since the beginning of the war, and were still rising. Wages had gone up considerably, taxation had increased, and restrictions on all forms of enterprise other than war work were enforced by all sorts of regulations, by dearth of labour and executive staffs, by prohibition against investment of capital other than for national purposes, and by feelings of uncertainty with regard to the future. Those conditions applied generally to the industries in which the company was engaged—namely, tramways, light railways, omnibus services, electric light and power supply, manufacture and finance. The revenue for the past year was £226,744, and the net profit practically £200,000, compared with £209,000 for the previous year. The reduction in net income was explained by a decrease in revenue of £17,000 and a decrease in debits of £8,000. The decline in revenue was due to the fact that, while the associated companies which had not done so well had reduced their dividends, some of those which had done better had not increased theirs, but it should not unduly depress them, because they knew it was the result of the abnormal conditions. They were placing £15,000 to reserve, paying dividends at the same rate as in the preceding year (6 per cent. on the preference and 3 per cent. on the ordinary stock), and carrying forward £97,598, compared with £86,428. At the end of 1915 the underlying companies—excluding the London companies—had total reserves of £1,300,000, and during the past year they had added £243,000, a total of over £1,500,000, to which must be added the reserve and carry forward of this company, amounting to a further £500,000. The investments stood at £4,285,000, an increase of £8,700 over the preceding year's figure. In regard to tramway fares, he said that, in view of the changed conditions, it was only equitable that the existing statutory restrictions should be reviewed by the Board of Trade or other Government Department, and steps had been taken by the Tramways and Light Railways Association to have the question considered by the authorities. The motor omnibus business had not received from the Government the recognition which it deserved, and every day the owners of omnibuses were finding it more and more difficult to satisfy the requirements of local and road authorities. There were two points which required settlement. The first was the question of licensing vehicles. To-day almost every borough and urban authority was empowered to make its own requirements. Omnibus services traversing routes 30 or 40 miles in length might be subject to the licensing conditions imposed by 10 or 12 different local authorities. The second point was the contribution required from omnibus owners towards the maintenance of the roads. Before the war the Government recognised that money would have to be spent on improving the roads, and a tax was placed on petrol, the proceeds of which were to be used for the improvement of the roads, under the direction of the Road Board. Since the war commenced the proceeds of that tax had been diverted into the Imperial Exchequer, with the result that the road authorities were all endeavouring in their own way to obtain contributions from those who were working omnibuses. In view of the fact that an omnibus in regular service contributed in the form of petrol tax £50 to £60 per annum, it did not seem reasonable that because the Government had appropriated the tax for national purposes the owners of omnibuses should be required by local authorities to contribute a second time. He hoped that the Government would do something to remove some of the disabilities which restricted the best development of the electrical industry; and he urged that after the war it was imperative that this country should have a protected home market for its manufactures as a base from which, in conjunction with its colonies, it could keep a hold on international markets and incidentally help to raise a part of the huge revenue which would be required for interest and redemption of war indebtedness. A continued policy of direct taxation to provide the major part of the revenue, as at present, would defeat its own object, for it would discourage the accumulation of capital, which was indispensable for new enterprise. From that point of view it was to be hoped that the excess profits tax would be withdrawn at the earliest possible date, for the excessiveness applied now to the tax rather than to the profits, and would deter enterprise and therefore check capital creation. With regard to the prospects of the associated companies, the view immediately before them was cloudy, but they saw a silver lining in the distance which indicated better times to come.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—The gross profit for the year ended May 31 was £5,170. 11s. 6d. After deducting general charges, interest on debenture stock and adding £10,194. 10s. 1d. brought forward, the balance was £12,999. 4s. 9d., which the directors have carried forward.

GLOBE TELEGRAPH AND TRUST CO. (LTD.)—The net revenue for the year ended May 31, after deduction of expenses, amounts to £226,623, and makes, with £36,849 brought forward, a total of £263.472. From this amount there has been distributed £115,468 in interim dividends, leaving an available balance of £148,004. The directors now recommend payment of the following final dividends, viz.: 3s. per share (less tax) on the preference shares, making, with previous distributions, a total dividend for the year on those shares at the rate of 6 per cent. per annum (less tax); and 8s. per share (tax free) on the ordinary shares, making, with previous distributions, a total dividend on those shares at the rate of 7 per cent. (tax free) for the year. These dividends will absorb the sum of £92,827. 11s. 9d. During the year £1,500 Anglo-American Telegraph Co.'s preferred stock and the company's holding of 3,700 shares in the West Coast of America Telegraph Co. have been sold, also 18 certificates of the Submarine Cables Trust have been drawn and paid off a £120 per certificate. The proceeds have been re-invested in the stocks and shares of other telegraph companies, and the 5 per cent. War Stock.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—The report for 1916 states that the gross revenue amounted to £270,181, an increase over the preceding year of £61,282. The increase was derived almost entirely from the subsidies from additional contracts. The net profit amounts to £96,748 after deducting £31,790 for depreciation and debenture interest, and compares with £63,630 for 1915. Including £26,996 brought forward the amount available is £123,744. The losses sustained in consequence of attacks upon the mercantile fleet during the year have been debited to profit and loss. The total number of public telegraph stations owned and worked by the company on the high seas increased from 1,008 to 1,472. The organisation of the company, together with that of its associated companies, with a total of some 3,000 mercantile vessels fitted with Marconi telegraph stations, has continued to render inestimable service. The directors have pleasure in recommending payment of a final dividend of 10 per cent. for the year, which with the interim dividend of 5 per cent. paid in February last will make 15 per cent for the year. The directors have pleasure in referring to the courage and loyalty shown by the seagoing staff, which have been beyond all praise. The Amalgamated Wireless (Australasia), Ltd., paid a dividend of 5 per cent. for the year ended June 30, 1916. In consequence of the considerable expenditure in providing installations for the increased number of ship stations the remainder of the authorised capital was offered to the shareholders in November last at a premium of 15s. per share. Since the end of the financial year the business has increased even more rapidly. Orders in hand are so large that additional capital becomes essential, and an extraordinary general meeting has been convened for increasing the capital to £600,000, a portion of which will be issued as soon as possible after the necessary formalities have been fulfilled. During the year Messrs. Henry William Allen and William Walter Bradfield, who have been with the company since its incorporation, have been elected to seats on the Board. Mr. Maurice Alfred Bramston has also been elected to the Board.

METROPOLITAN CARRIAGE, WAGON & FINANCE CO. (LTD.)—At an extraordinary general meeting on Monday it was decided to increase the capital of the company to £3,675,000 by the creation of one million new ordinary shares of £1 each. The new capital is required to acquire a controlling interest in the British Westinghouse Elec. & Mfg. Co.

UNITED ELECTRIC TRAMWAYS OF MONTEVIDEO (LTD.)—The directors recommend payment of a dividend of 6 per cent. per annum (less tax) on preference shares for the past half-year, making 6 per cent. for year; £15,000 is placed to renewals and contingencies account, £3,921 to debenture stock redemption account, £2,500 to share capital redemption account and £12,814 forward. Receipts for the year ended Oct. 31 last were $1,634,537 (increase $80,713) and passengers carried were 42,747,070 (increase 2,409,427).

J. G. WHITE & CO. (LTD.)—The report for the year ended Feb. 28 states that the net profit was £18,739, an increase of £1,359 over the preceding year. Following precedent of two previous years, the directors decided not to pay an interim dividend in January last, and are now recommending a dividend on both classes of shares at rate of 6 per cent. per annum. The balance to credit of profit and loss, after bringing in £34,940 from previous account, is £53,679. The directors recommend a dividend of 6 per cent. (less tax) on the ordinary shares, carrying forward £41,679.

CITY NOTES.

BRITISH TRADE CORPORATION.—The directors are inviting applications for an issue of 150,000 further shares of £10 each at par. The capital of the corporation is £10,000,000 in £10 shares, of which 100,000 shares have already been subscribed and allotted.

EASTERN TELEGRAPH CO. (LTD.)—The company announce payment on the 14th prox. of a dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ending 30th inst., and a first quarterly interim dividend of 1½ per cent. on the ordinary stock (tax free) in respect of profits for the year ending Dec. 31, 1917. The transfer books of the ordinary stock will be closed from July 6 to 13 inclusive.

SUFFOLK ELECTRICITY SUPPLY CO. (LTD.)—The directors, who were recently asked to reconsider their decision to increase the price of current from 8d. to 10d. per unit, state that "every consumer of current must be aware that the increase in price is warranted, and should have been made long ago. It is not a greater increase than other companies have made. Less than half those who signed the complaint pay 8d. per unit."

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—A final dividend of 4 per cent. has been declared on the preference shares, making 10 per cent. for the year 1916, and 3 per cent. for the six months ending 30th inst. A dividend of 5 per cent. on the ordinary shares for 1916 is also recommended. This is the first distribution on the ordinary shares since the formation of the company.

Digitized by Google

THE ROUND TABLE.

By "KVA."

One visitor to the Convention, who is a notorious (I think that's the best word) salesman of steam turbines, turned over the pages of Mr. Robertson's fuel economy paper with an indignant gesture: "Fuel Economy, indeed, why trouble to use all this paper on it or discuss it; there is only one word to be said on the subject ——" And he would have let loose on the merits of his fuel-less, steam-less turbine but somebody offered him a cigarette!

* * * *

Which reminds me that the Convention brought the smell of the fragrant weed into the sacred and spacious hall of the Institution of Civil Engineers. Before the men came out from the meeting the commissionaire did his duty nobly by turning stray smokers into the library; but when a flood of members, each lighting pipe, cigarette or cigar, flowed down the main staircase he was overwhelmed and had to leave the beautiful hall and dome to their fate!

* * * *

The "dark forces" discussed at the Convention informal meetings were the supposed company and trust attempts to "collar" the Board of Trade Power Committee. A lot of the members, especially the committee-men, have properly "got the wind up" on this matter. Who is the "Electrical Rasputin" at the head of the "dark force" movement?

* * * *

The pièce de résistance of the Convention was the Westinghouse loose-leaf pocket programme which almost everybody seemed to have, even the representatives of rival manufacturers. Mr. Rand came down with his pockets full to supply odd copies, but was soon sold out. If the Company do the same thing next year they might add the names of the chief "branch offices" and "dug outs" adjoining the place of meeting!

* * * *

The electro-culture apparatus shown by Harry W. Cox & Co. to the Convention members was a great attraction, except that no one seemed attracted enough to the discharge wire to want to touch or try to stroke it. Small wonder when it gave off a healthy 3 in. spark!

* * * *

The Coal Controller was given a very warm quarter of an hour at the Friday meeting. He had to answer a volume of questions, not the least interesting of which was fired at him from Dartford: "Will the Government make up the difference between the normal and the abnormal prices of coal to the small electricity undertakings?" Why not? Out of the 80 per cent. of the excess profits!

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, June 26, 1880.]

STRUCK BY LIGHTNING WHILE UNDER WATER.—At Halifax, N.S., May 29, while divers were at work at Cole Harbour Dike, a storm came upon them, and the lightning striking an air-pump, passed down to a diver under the water. When brought up he was insensible, but his injuries are not serious.

THE VOLTA PRIZE.—This prize, instituted in 1852 for the purpose of rewarding the most important applications of the voltaic battery, has this year been awarded by a committee under the presidency of M. Dumas to Alexander Graham Bell for his invention of an articulating magnetic-electric telephone. The prize in question consists of the sum of 50,000 fr. A second prize of 20,000 has been awarded to M. Gramme, for his magneto-electric machine. The Volta prize was awarded for the first time to M. Ruhmkorff, in 1864, for various apparatus of great service in industrial applications.

On Friday the cotton mills of Messrs. Pooley, Bradford-road, Manchester, were found to be on fire. The man in temporary charge of the fire escape had his charge taken away by the crowd, which, with the best intentions, was evidently unable to manage the apparatus. As the people dragged the fire escape along, the ladder caught the telegraph wires that were attached to a chimney, when, of necessity, in the haste and unavoidable loss of nerve on such occasions, something had to give way. It was the top of the chimney, which fell upon a woman, injuring her so that she died at the Royal Infirmary later on the same day. The evidence given at the inquest, held an Monday last, showed that the wire was a private one, and that there was no altitude defined by act of Parliament for such wires.

Australasia.—The Associated Chambers of Commerce of Austra ia recently passed the following, amongst other resolutions:—

That the State Governments be urged to discontinue the policy of embarking on commercial enterprises; that the adoption of the metric system of weights and measures and decimal coinage would be of material value in facilitating commercial transactions and that the Commonwealth Government be urged to take the subject into immediate consideration with a view to securing action by the Imperial authorities; that Chambers of Commerce should be consulted when any future appointment is contemplated by either Federal or State Governments of commercial agents abroad.

An announcement regarding the Victorian Government scheme for controlling the various municipal tramway services of Melbourne and suburbs was made recently by the Minister of Public Works (Mr. W. A. Adamson), who pointed out there were eight separate bodies controlling the tramways of the metropolis—five municipal trusts, the Victorian Railways (conducting the St. Kilda-Brighton electric line), the central tramway body (the temporary board controlling the cable tramways), and the private company managing the North Melbourne-Essendon tramway. The tramway issue had been clouded by the dream of the Greater Melbourne scheme. It was the intention of the Government to bring in a tramway Bill to create a board of 14 representatives, 12 of whom would be elected by the municipalities, and two would be nominated by the Government. The board would take over the properties of the present tramway board and all the municipal undertakings; it would also have power to acquire the North Melbourne-Essendon lines, the St. Kilda-Brighton electric railway and the system from Sandringham to Black Rock now being constructed. The new body would have the power of taking over the whole electric supply and power business of the metropolis, but that course would not be taken at present, as the Government did not think the time was opportune for the introduction of a measure of that sort, and also because they were on the eve of great and important developments with regard to electricity, in which the brown coal deposits of the State were concerned. The Government had concentrated the best brains in the community on the question of the utilisation of brown coal for the generation of electrical energy. It had already been stated by those carrying out the investigation that they could generate electric power at Morwell and that the Government would be justified in putting down a large power plant and transmit the energy to Melbourne by means of overhead cables carried on towers along the railway line. After that was done it was proposed to recommend the business of the generation and sale of electricity in bulk should be in the hands of the Government. A special meeting of the Melbourne Municipal Tramways Conference, called to consider Mr. Adamson's statement, was held subsequently, when the following resolution was passed:—'That this Conference re-affirms its previous support of the principles of the Bill prepared by the Conference and introduced in the Legislative Council by Mr. Robert Beckett in 1913, subject to any amendment that may be agreed on as between the Minister and the executive committee of this Conference."

Canadian Telegraph Service.—The earnings of the Canadian cable, telegraph and wireless companies and the Government telegraph service were larger in 1916 than in any previous year.

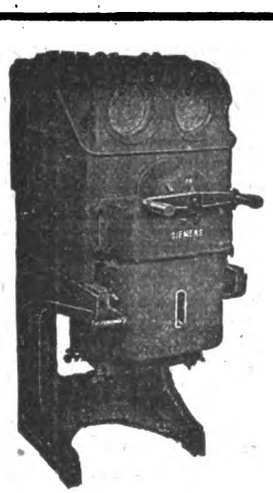
The statistics cover the operations of nine private companies, the Dominion Government Telegraph Service, the Temiskaming & Northern Ontario Railway Co. lines and the Pacific cable. Gross earnings in 1916 were £1,251,148, against £1,107,267 in 1915, the increase being partly due to a substantial augmentation in receipts from war cablegrams. The pole mileage of telegraph lines in Canada in 1916 was 40,251, and the wire mileage 206,551. In 1916 there were 10,835,936 telegrams and 1,134,905 cablegrams transmitted, compared with 9,952,135 land messages and 977,389 cable messages in 1915.

L.P.S. INSULATING SLEEVING.
BRITISH MADE & ALWAYS IN STOCK.
A most efficient insulation for all internal connections in electrical apparatus.
An excellent substitute for perishable rubber tubing. Very flexible, water and oil proof; and of high dielectric strength.
Write for Particulars:—
THE L.P.S. ELECTRICAL COMPANY, 14, Howick Place, Westminster, S.W.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 100, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

Digitized by Google

SIEMENS



IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars
Distribution Boards
Main Switchboards

Write for particulars to —

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Contral Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood Bldgs.
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

MASTER

BATTERIES FLASHLIGHTS

MASTER
Tungsten - Light Batteries:
Guaranteed to satisfy.
Give brightest light and longest life.
Will not corrode or leak on shelf.

PERFECTION
Best describes MASTER Flashlights:
Novel and unique in design.
Hardcorrely finished.
Carefully constructed of durable materials.

Investigate the MASTER line of Batteries and Flashlights—a Product with a Profit. Direct importations from the U.S. or deliveries from our complete London stock.

Request catalogue and quotations for full business, with guaranteed deliveries.

THE RIVER PLATE COMMERCIAL COMPANY
EXPORT ORDER DEPARTMENT,
UNITED BATTERY CORPORATION.
MANSION HOUSE — 15, GEORGE ST. — LONDON, E.C.

MINING IN JAPAN.

An interesting article on the "Mining Industry of Japan," by Prof. Toshio Watanabe, appears in the "Far Eastern Review." It is stated that the principal mineral products of Japan are coal, petroleum, sulphur, gold, silver, copper and iron. No other country in the world, except America, produces so many varieties of mineral wealth. The rarest mineral products of the world—tungsten, molybdenum, and even mozanite, are found in Japan. The store of coal and iron in Japan, however, is of a very meagre description compared with that of other Powers of the world.

The value of the coal for 1916 was 288,000,000 yen against 220,000,000 yen in 1915. The value of mineral products of Japan may be roughly appraised as follows:—Gold 21,000,000 yen, silver 7,000,000, copper 100,000,000, iron 55,000,000, coal 80,000,000, petroleum 1,600,000, and sulphur 7,000,000 yen. The temporary paralysis of the mining trade caused by the disruption of August, 1914, was soon followed by a heavy demand for copper, zinc and antimony, which brought copper an increase in value of 15,000,000 yen in the following year, although the increase in output was quite insignificant. The manufactories of the Osaka Zinc Co. and the dry process factory managed by the Mitsuis were still in an experimental stage when the war broke out, but the new conditions enabled those works not only to complete their equipments but to extend their plants beyond the limits originally contemplated. The ore is imported from Australia, India, Siberia and China, and in 1915 zinc to the value of about 4,000,000 yen was exported. A high degree of efficiency had been developed in Japan in the refining of antimony, but the work had remained comparatively inactive owing to the scarcity of the ore, which was imported from abroad, and in 1915 some 9,000,000 yen worth of antimony was produced at Osaka. There was an increase in the production and value of iron owing chiefly to the extension of the iron foundries. Tungsten also showed a remarkable increase. In 1916 the extensions to the former plants were nearly completed, and the output of copper increased by 20 per cent., while its market value rose 55 per cent. over that of 1915. Zinc refineries sprang up at many places. The general expansion of the manufacturing industries and the decrease of the stock sent up the price of coal to an extraordinary point, hence the unprecedented increase in the total value of the mineral products of the country. At ordinary times, Japan imported from 50,000,000 to 60,000,000 yen more owing to her heavy requirements of iron, but in 1915 she exported 7,000,000 yen more than she imported. This tendency was still more marked in 1916, though due mainly to the decrease of imported iron. The most noteworthy facts in 1916 were that Japan imported large quantities of raw materials from Australia, Siberia, China and India, and exported equally large quantities of finished articles—zinc, copper and steel tubes and copper wire. Numerous refineries were established at Chikuzen and in other provinces, and mining works were started in China under the joint management of Chinese and Japanese.

Iron Ore.—The meagreness of Japan's iron supplies was one of the industrial problems that attracted the keenest attention of all classes during the year. The work of investigation was first started by the union of industrial interests in Osaka, and this was followed by the presentation to the Government of a joint memorial by companies representing iron, steel, arms and shipbuilding interests. The outcome was the organisation of a committee of investigation into iron manufacture, whose labours have now advanced so far that the projects framed by them for the encouragement of iron industry are to be submitted to the present session of the Diet. Japan's demand for iron reaches 1,350,000 tons per year, of which she is able to supply about one-third from her own mines. By the time the third term extension of the Government ironworks is completed (in 1921) they will be producing nearly 650,000 tons, but the demand for iron will be increasing apace, so that the works may not be able to supply more than half the country's needs. China is, of course, the land whence Japan will have to draw the supply of iron ore, and if Japan is going to produce 2,000,000 tons of iron a year she will need 7,000,000 tons of coal. Japan is by no means rich in coal; her store of the variety needed for making coke is extremely limited. In the writer's opinion, how to achieve the self-supply of iron is not of as much moment to the military defence of the country as how to preserve her present supply of the material for coke, and how to keep the means of conveyance in a state of readiness and perfection. Fortunately for Japan, the scarcity of iron within her own domain is made up for by the presence of rich veins in Chosen and China.

Steel.—The manufacture of steels of a special and costly description, using electricity instead of gas or coke, is coming into vogue. A similar process was started at Suwa, Shinshu, on a small scale several years ago. The Wakamatsu Iron Works and the Fujitagumi Steel Works at Kirokawa, Inawashiro, are now equipped with electric furnaces. The latter works produces ferro-silicon chiefly and the laboratory owned by the same financial house situated at the Osaka Harbour is manufacturing, besides ferro-silicon, tungsten and chrome alloys. The Japan Electric Iron Works (with a capital of 150,000 yen and managed by Messrs. Miyakuchi & Sakurada) are situated within the compound of the Sakuragawa Kydro-Electric power-house; the Electric Iron Works at Atsuta (capital 600,000 yen) were started by Baron Shibusawa and Mr. Inouye, and the Kishimoto Iron Works, situated midway between Osaka and Kobe, are engaged either in trials or in the manufacture of the special products mentioned. At Yasuki and Yoneko ores prepared from dust iron are being passed through electric furnaces. The most profitable use of the electric furnace being to make good steel out of indifferent materials, the above-named Japanese works, if they do not

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

It is better to be good than beautiful.

It is best to be both.

Like our Loop Type Insulators, which, while handsome in appearance, are insulators through and through, and are designed to maintain their alignment in use.

D.4411. For Frog Pulls and light Pull-offs.

D.4412. For heavier wires.

Delivery from stock.

BRITISH INSULATED & HELSBY CABLES.

Cablemakers and Electrical Engineers, LTD.,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

QUARANTEED **SECOND HAND**

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.

Phone: Victoria 4026. Grams: Vicmaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh. *See our Illustrated Advt. last week.*

Digitized by Google

Electrical Engineers and Manufacturers

The House for Electric Heating.

Special Offer of "Quead" and "Ensign" Fires from Stock. Be Patriotic and Save Coal.

Other Specialities include Cables, Motors, Dynamos, Lamps, Fans, Switch Gear.

Telephone: Gerrard 7601 (2 lines)

Petrol Engine Sets.

Manufactured in sizes from 2 kw. to 20 kw.

Quotation for larger sizes on application.

F. HUSBAND Ltd
CRAVEN HOUSE
KINGSWAY LONDON

FOR

High and Low Tension

SWITCHGEAR

THE

NEW SWITCHGEAR CONSTRUCTION CO., Ltd.

SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

Manufacturers of

PHOSPHOR BRONZE,

GUN METAL, MANGANESE BRONZE

TRADE MARK.

Brass & Copper

Tubes and Sheets.

BRASS CONDENSER TUBES FOR STANDARD SHIPS, &c.

CHARLES CLIFFORD & SON, LTD.,

BIRMINGHAM.

LEWIS'S SCIENTIFIC CIRCULATING LIBRARY.

ELECTRICAL, MECHANICAL & GENERAL ENGINEERING TEXT BOOKS & TECHNICAL WORKS.

New Works and New Editions can be had from the Library immediately on Publication. Telephone: MUSEUM 1072.

SUBSCRIPTION, Town or Country, from ONE GUINEA.
READING ROOM open Daily to SUBSCRIBERS.

H. K. LEWIS & Co. Ltd.,

136, GOWER STREET, and 24, GOWER PLACE, LONDON, W.C.

at the same time turn their attention to the production of some other substances, like abrasives, will (according to the writer) soon be brought to the verge of ruin by their keen competition. The Wakamatsu Iron Works is reported to be conducting experiments with induction furnaces.

Copper.—Japan ranks next to the United States of America, which produces upwards of half the world's total output of 1,000,000 tons, and consequently is second in the work in the production of this metal. The Ashio, Hitachi, Kosaka and Besshi mines are producing each upwards of 10,000 tons. Japan's output for 1916 is estimated at 86,000 tons. The price ran from 600 yen per ton in the ante-war period to 723 yen in 1915, to 1,124 yen in June, 1916, and 1,516 yen in December following.

Zinc.—Japan's supply of zinc ore is extermely limited. The Osaka Zinc Co. was first established to treat the ore produced at home, and showed a fair record in point of technical advancement, when the war broke out. The steady rise of zinc and the stoppage of export to the consuming countries (Germany and Belgium) induced the mine-owners of Australia and China and the Japanese refineries to enter into an alliance, and this was followed by an increase of furnaces in Japan Messrs. Suzuki & Co. (of Kobe) laid out a refinery on an extensive scale at Hikoshima in a very short time. The Kuhara Refineries were opened at Saganoseki and Hyogo, and several other works for the electrolytic production of zinc imported, the balance of her consumption (120,000 tons). Japan may justly be proud of her successful utilisation of electricity for production of zinc. The Kosaka copper mine was the first to initiate the new process and the Nishitori, Ajikawa, Takata and Inawashire works of the Osaka Zinc Co. are all turning out pure zinc. The Osaka Zinc Works is erecting a hydro-electric power-house in the neighbourhood of Matsumoto, Shinshu, and the low cost of power obtainable there will eventually induce the concern to remove its entire electrolytic plant to the same locality. The Mogi Works at Uji, the Kano Electric Zinc Co., the Fukushima and Onahama Works of the Electro Zinc Co., the Isoshima Works of the Zinc Electro-Refining Co. and Japan Electric Zinc Co. and the Zinc Electrolising Co. were established in rapid succession.

The almost simultaneous establishment of so many factories is due to the marked appreciation of pure electrolyite zinc immediately after the outbreak of the war. Cheap power is an important element of success for these works at ordinary times. The import of ores in large quantities from abroad has kept the price of the home ore comparatively low. The ore from Mimasaka and neighbourhood with a mixture of iron is now amenable to successful utilisation. Altogether the owners of zinc mines have a very hopeful future before them.

Gold and Silver.—The appreciation of other commodities means the depreciation of gold, and the higher prices paid for quicksilver and cyanide of potash required for the refining of gold much dispirited the owners of the gold mines in Japan, who consequently preferred to sell their ore directly to the refineries instead of refining it themselves. Gold mining in Japan promises to develop still further. The electric refinery at Nikko produces the largest quantities of gold and silver and at the same place, because these gold and silver ores are melted at the same time with copper ore, and the electrolytic refinement of the copper leaves gold and silver as a sludge in the vats. There is not a single paying silver mine of any size in Japan. The above refineries are nearly all situated near the cost of the Inland Sea. The copper refinery at Mizushima was recently purchased by the Furukawa family. The Iwasakis and Mogi are erecting new works in the vicinity of Inu Island, Okayama Prefecture. The metallic work of the East and the South is being concentrated in the western provinces of Japan. The concentration of various industries will cheapen electric power.

Lead, Tin, &c.—Of Japan's annual consumption of lead only 30,000 tons are produced at home. An enormous quantity of lead was consumed last year for war purposes. Furnaces were erected by the Osaka Zinc Co. at their Konoshima works, and by the Suzuki Metallic Products Co. at Hibi, where ores imported from Australia, China and Siberia are being dealt with. Contracts for the import of nearly 40 000 tons of lead were entered into last year. Tin, manganese and tungsten likewise increased in output in 1916. The last-named metal was at one time quoted at 6,000 yen per ton, but has since dropped to 2,000 yen, due to the increased production in America. Sulphur, formerly principally exported to America, was sent in large quantities to Russia in 1916, and the output increased by 30 per cent. due to the higher price ruling.

GENUINE
M & M VULCANISED FIBRE.
MOSSES & MITCHELL, 122 & 124 GOLDEN LANE LONDON, E.C.

INSULATION BEADS
HOLDER-HARRIDEN, LTD.

Digitized by Google

FERRY **FERROZOID**

CONSTANTAN **CHRONIC**

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:
HENRY WIGGIN & CO., Ltd.
George Street, Birmingham.
TELEPHONE: 6400 CENTRAL.
GRAMS: "WIGGIN BIRMINGHAM."

AGENT:
LIONEL ROBINSON,
3, Staple Inn, London, W.C.
TELEPHONE: 6323 HOLBORN.
GRAMS: "FERRYDOM, LONDON."

Electrical Testing Laboratories

(U.S.A.)

Acceptance Tests of Machinery and Materials for Export.

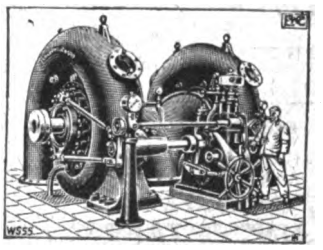
Electrical, Photometrical, Mechanical and Chemical Tests and Investigations at the Laboratories in New York or anywhere in the United States of America.

80th Street and East End Avenue, New York, N.Y.

NOTE.—Through the courtesy of "The Electrician," copies of a booklet describing the Laboratories and its work, and listing testing fees, may be obtained from its London Office.

ESCHER WYSS & Co.

Head Office and Works: ZURICH (Switzerland).
London Office: 109, Victoria Street, Westminster, S.W. 1.
Tokyo Office: 3, Uchisaiwaicho Itchome Kojimachi-Ku.
Montreal Office: 12, Coristine Buildings.

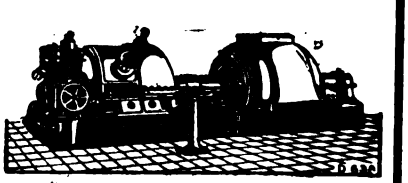


Water-Turbines.

Pipelines.

Zoelly Steam Turbines

Turbo-Pumps.



65/17

Digitized by Google

Theory of the Submarine Cable.

BY

H. W. MALCOLM,

M.A., Ph.D., D.Sc.

Price 18/- net.

600 Pages.

200 Illustrations.

Published early in July.

Prospectus free on application to

"THE ELECTRICIAN" OFFICES,
8, Bouverie Street, London, E.C. 4.

"THE ELECTRICIAN"
ANNUAL TABLES
OF
Electricity Undertakings
1917.

These Tables, containing important statistics and data relating to

BRITISH ELECTRICITY SUPPLY,
COLONIAL AND FOREIGN UNDERTAKINGS,
ALSO
ELECTRIC TRAMWAYS and RAILWAYS of the WORLD,

are now published in new form in ONE VOLUME, with cloth cover, and constitute a valuable compilation for electrical engineers, manufacturers, traders and factors, exporters and installation men.

PRICE 5/- post free if prepaid.

"THE ELECTRICIAN" OFFICES, 8, BOUVERIE ST., E.C. 4.

In regard to the future, Japan, it is said, cannot depend upon the supply of Australian ore; she will be forced to seek ores in China, India and Siberia. Japan will necessarily have to compete with Germany, and could she be credited with the same amount of technical skill, Japan might get the better of Germany. The price of zinc, already on the decline, is beyond the reach of American control. It is advisable that the Japanese refineries should try to excel themselves, and replace their temporary furnaces with those of a permanent and more economical character, and thus equip themselves for the coming industrial struggle. As for coal, its price can be regulated with comparative ease in Japan. The domestic consumption of coal will decrease after the close of the war, while the export will increase rapidly. The lessening of the mining expense and of the price by better selection of coal and the manufacture of briquettes is a desirable improvement. Summarising, the author thinks that mineral products will not maintain their present high prices after the war, but will not fall below the level of the pre-war period. The writer is persuaded that some branches of the mining industry have been enabled by the war conditions to lay foundations for their future development, and possibly expansion in the direction of China and Siberia. A section of the Japanese public thinks that American capital cannot find safe investments in China with her present financial conditions.

H.M. Commercial Attaché at Yokohama (Mr. E. F. Crowe, C.M.G.) reports that the copper ore output in Japan in 1916 amounted to 111,562 tons, compared with 83,017 tons in 1915 and 78,700 tons in 1914, while exports amounted to 57,402 tons in 1916, against 56,528 tons in 1915 and 43,305 tons in 1914. Russia now buys 60 per cent. of the total exports of copper; the United Kingdom takes 20 per cent., while France, the United States and India share the balance. The consumption of copper ore in Japan during 1916 amounted to 59,690 tons, compared with 27,723 tons in 1915 and 32,045 tons in 1914.

KENTISH COAL AND IRON.

Meetings of the proprietors of Kent Collieries (Ltd.) are being held this afternoon for considering a scheme for the fusion of the interests of the Kent Collieries (Ltd.) and the Channel Collieries Trust. In a circular issued to the shareholders it is stated that a large body of ironstone has been proved at Dover on properties controlled by the Kent Collieries, and tests made during the past two years for ascertaining the most economical method of treatment had given encouraging results. The Dorman-Bolckow group, as holders of about three-fifths of the capital of the Trust are prepared to assist in the formation of the proposed new company to work the deposit and consider the erection of iron and steel works for smelting the ironstone locally as soon as financial conditions permit of the raising of the necessary capital. It is proposed to form a new company, which will be entitled the Channel Steel Co., Ltd., with a capital of £750,000.

A TRAMCAR MEGAPHONE.

Messrs. Gabriel & Co., of Birmingham, have placed on the market a megaphone for tramcars.

There is a flexible metallic tube, with a mouthpiece at one end, which is fixed in a convenient place for the motorman. The other end of the tube is attached under the canopy to a brass tube, which is divided by a forked socket, one fork being carried to the inside of the car and the other to the top deck. The megaphones to which the tubes are attached are oval, made in tin and fixed, the one inside the car and the other under the seat on the top deck. The apparatus is used by the motorman, who calls out the next stopping-place before the arrival of the car at the various destinations. The megaphone has been fitted to the cars of the Liverpool Overhead Railway, and has given great satisfaction.

SPELTER AND SMELTING OF ZINC ORE.

At the last meeting of the Society of Chemical Industry Mr. H. M. Ridge read a Paper on "The Utilisation of the Sulphur Contents of Zinc Ore," in which he urged that this country should be more self-sustained in regard to supplies of spelter. The most important and serious factor for consideration was the shortage of zinc-smelting capacity in the country. In 1913 our consumption of spelter amounted to 224,000 tons, of which 74 per cent. were imported.

After allowing for the metal made by the refiners we imported about 166,000 tons of spelter and zinc in other forms. If that quantity were all made from blende the roasting fumes could be used to produce annually 400,000 of 140° Tw. acid. There was no reason why that should not be done and the corresponding quantity of brimstone and non-cuprous pyrites displaced, as well as a portion of the pyrites which was low in copper. Before the war the cost of making 140° Tw. acid from the zinc ore fumes in this country was only between 8s. and 9s. per ton, so that the operation was remunerative and profitable. Zinc ore had got to be treated, because spelter was required, and if the work was not done here it would be done elsewhere. Cheap sulphuric acid had always been an important factor in the chemical industries, and unless we woke up and used the resources of the Empire others would do it for us, and we should be obliged to continue to look on while the foreign subsidiary industries using the acid abroad went ahead.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,042. [Vol. LXXIX. No. 14] FRIDAY, JULY 6, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 533
Arrangements for the Week 535
Bell Transformers: Design and Tariffs. By E. Wirz. Illustrated 536
New Concentric Standard Dynamometer Wattmeter for Heavy Currents: And Concentric Non-Inductive Standards of Low Resistance. By A. E. Moore. Illustrated 539
Tramways and Light Railways Association 542
Mica and Commutation Troubles. By Frederick Murgatroyd, B.Sc.Tech. 545
The Metric System 545
SOME RECOMMENDATIONS OF THE RECONSTRUCTION COMMITTEE .. 546
REVIEWS 546
National Physical Laboratory.—*Concluded* 550
The Insulator Situation. By W. D. Peaslee 552
Tar Oil Fuel for Diesel Engines 553
LEGAL INTELLIGENCE 553
Patent Record 554
Volunteer Notices 554
COMMERCIAL AND INDUSTRIAL SECTION 557
Electricity Supply 558
Tenders Invited and Accepted 560
Financial Matters 561

NOTES.

Wattmeters for Heavy Currents.

ACCURATE wattmeters for currents of a thousand amperes or more are greatly needed for testing the plant and meters used in large power schemes, but their construction has presented many difficulties, owing to the problem of avoiding eddy currents in the necessarily heavy main coils. Two ways of attacking this problem are open to us: the stranding of the main conductors and disposition of the strands so as to prevent changes of current distribution, or the use of concentric conductors in which the field is independent of current distribution provided that it is uniform around the cylinders. Mr. A. E. MOORE, an abstract of whose Paper in the Institution "Journal" appears in this issue, like Mr. P. S. AGNEW, of the Washington Bureau of Standards, has adopted the second method, and has produced a 1,000-ampere wattmeter which appears to give very satisfactory results. Mr. AGNEW has made a 5,000-ampere instrument, which is probably equally satisfactory, although no actual tests of phase angles determined with it have been published. The idea of employing the internal field of the concentric conductors appears to have occurred independently to these two workers, as Mr. MOORE'S provisional specification was lodged in July, 1911, and Mr. AGNEW'S instrument had been constructed and described in the "Bulletin" of the Bureau of Standards by July, 1912, after a previous demonstration of its principle by Messrs. AGNEW and FITCH in the "Electrical Review and Western Electrician," of Chicago.

Some Difficulties in Construction.

ALTHOUGH the concentric cylinder device is attractive on account of its simplicity and freedom from external disturbance its accuracy manifestly depends considerably upon the uniformity of the current distribution round the periphery, as is well shown by Mr. MOORE'S early attempts with wire cages. As half the current has no effect on the moving system, the instrument must be regarded as a shunted wattmeter in which equality of the temperature variation and of the time constant of the shunt is obtained by symmetry of construction, and Mr. AGNEW appears to have realised the theoretical and constructional requirements for accuracy from the outset. The great difficulty is, however, the introduction of the moving coils, and although Mr. MOORE has wisely determined to adopt the plain machined cylinders, we think it unfortunate that he has felt obliged to introduce a joint in the position where local imperfections of contact must produce the worst error. An unfortunate feature of the concentric cylinder arrangement, however, is its limited current range, and for this reason the stranded conductor instrument with the possibility of different series-parallel combinations of the strands has great advantages where cost and convenience are of importance. So far, standard instruments of this type have not been made for currents of much over 500 amperes, but the difficulties of obtaining higher ranges should not be insuperable. In the meantime, Messrs. MOORE and AGNEW are to be congratulated on their practical solution of a difficult problem, and upon the useful principle they have introduced into instrument construction.

The Board of Trade Electric Power Committee.

THERE has recently been considerable agitation on the part of municipal authorities to induce the Board of Trade to nominate further members to the Electric Power Supply Committee, with a view to safeguarding municipal interests. Apparently the idea has become current that the policy of the Committee is to favour the scrapping of municipal undertakings. Whatever justification there may be for such an idea, the result has been that the Board of Trade has now appointed additional members, consisting of Mr. HAROLD DICKINSON, city electrical engineer, Liverpool; Bailie W. B. SMITH, of Glasgow; and Mr. E. F. VESEY KNOX, K.C., of the Parliamentary Bar. This selection seems to us to be somewhat curious. As the Committee stood originally, it might be said that three of the members were possibly actively in favour of private enterprise and two of them in favour of municipal undertakings. It was probably felt, with some justice, that municipal interests were not sufficiently represented. The present nominations, however, put the balance all the other way, which cannot be regarded as satisfactory. Further, we think it will be agreed that the work of the Committee must be mainly concerned with matters of an engineering character. It therefore seems to us a mistake to add further members having mainly the qualifications of city councillors or King's Counsel, however eminent, when there are many municipal engineers available of great experience.

The Manufacture of Physical Apparatus.

PRIOR to the war many of our colleges and schools, consciously or unconsciously, drew their supplies from Germany and equipped their laboratories with apparatus of German manufacture. Disregarding precision measuring instruments and apparatus of the very highest grade, there should be a big demand in the near future for robust, well-finished and relatively inexpensive physical apparatus. To our knowledge the apparatus of German manufacture possessed these characteristics, and, moreover, much of it was novel. In putting

Digitized by Google

our house in order recently we came across a 1,000-page catalogue, in which neither cost nor trouble had been spared to render the work as comprehensive as possible. To this end the products of some of the best-known German firms were fully described, in addition to those of the actual manufacturers who issued the catalogue. From the preface it appears that the firm in question started in 1888 with 19 employés in a shop having a floor area of 195 sq. metres. No power was available for driving the machinery. Fou years later the number of employés had increased to 34, the floor area had been doubled and 3 H.P. was available for driving purposes. In 1911 the number of employés amounted to 405, the floor area to 10,000 sq. metres, and motors of 260 H.P. were installed for driving the machinery. Shortly before the long vacation in 1914 we were invited to send for a complete description of the factory and its equipment, which description could be obtained in the form of a "richly illustrated" pamphlet, "gratis and post free." From the catalogue (and it is more like an encyclopædia than a catalogue) it is evident that first-class physicists originated much of the apparatus, and that the details had been worked out by competent mechanicians. To compete with firms such as these it will be necessary for home firms to combine and to employ highly-skilled men as designers. Faced with a complete stoppage of the supply of chemical apparatus, the chemists, through their institutions, set to work to make good the deficiency. Similar work for the physical laboratory could, in our opinion, very well be undertaken by the Physical Society. But, as we have said, it will be necessary for the dozen or so small firms to enter into a working agreemen before they can hope to make the progress we would have them make. It will be cruel irony if after the war, and notwithstanding the good resolutions, the colleges have to buy cheap physical apparatus from Germany because it cannot be bought elsewhere.

National Physical Laboratory.

THE annual report of the National Physical Laboratory, which we conclude in our present issue, is much less interesting than was the case two or three years ago. The reason is, of course, that the regular work now in progress is of a confidential character for the Government, and, apart from this, there is but little time for work of general utility. Nevertheless, certain investigations are being carried out which may be classed under the heading of scientific and industrial research. This includes the research on buried cables, with which the Institution of Electrical Engineers is concerned. Further, we are glad to note that additional work of this kind is mentioned—namely, an investigation on the corrosion of the lead covering of conductors. This also has been undertaken at the request of the Sub-committee of the Institution of Electrical Engineers. Undoubtedly, this is an important piece of work. For many years it has been known that lead-covered wires cannot be safely embedded in plaster, but there are other metallic coverings which can be used. Some of these consist of lead which is to some extent alloyed, to make it less susceptible to chemical action. It is not possible, however, to depart very far from ordinary lead if the required ductility is to be maintained, and therefore it is very desirable that authoritative tests should be made to discover how far such a covering is endurable under the various conditions that obtain in house wiring, and how far the composition may be varied without giving a poor life. The "compo" tube has been largely used in gas work, and is known to last when embedded in plaster—whatever its disadvantages may be in other respects. There should be no great difficulty, therefore, in obtaining a suitable covering, though there may be difficulty in making experiments in a reasonable time to yield results which can be applied with certainty to a period of, say, 20 years.

Board of Trade Electric Power Committee.—We are informed by the Board of Trade that Sir Archibald Williamson, Bart., M.P., has consented to act as Chairman of the Committee on Electric Power, in place of the Rt. Hon. F. Huth Jackson, who has resigned on medical grounds, and that the following representatives of local authorities owning electric supply undertakings have been added to the Committee, viz.: Mr. W. B. Smith, Mr. Harold Dickinson and Mr. E. F. Vesey Knox, K.C.

The British Science Guild.—A bulletin issued by the British Science Guild contains the Eleventh Annual Report, and a full account of the proceedings at the Annual Meeting on April 30, which has been already reported in these columns. The Report contains a summary of the chief steps taken during the past year in the direction of the advancement of scientific and industrial research, and the addresses delivered at the Annual Meeting by Lord Sydenham, Mr. H. A. L. Fisher and Mr. H. G. Wells.

Birmingham and District Electric Club.—A visit of the Club has been arranged on Saturday afternoon, July 14th, to Walsall, in conjunction with the Association of Mining Electrical Engineers, Warwickshire and South Staffordshire branch, when members will have an opportunity of inspecting the original generating station, the new power house at Birchills and the sub-stations. A Paper will be read by Mr. H. A. Howie, chief electrical engineer to Walsall Corporation, on "Recent Extensions to the Walsall Electricity Undertaking."

Technical Optics.—We regret to find that our note on this subject on the 15th ult. has given the impression that no optical journals exist in this country. What we had in mind was that present publications will not meet the need if the optical industry in Great Britain takes up the position it should at the end of the war. Doubtless the position will be met by suitable expansion. The editor of the "Optician" points out that most of the recognised authorities on the subject have contributed to the pages of our contemporary, and that its columns have dealt fully with every phase of opto-technical education.

Royal Society of Arts.—The annual general meeting of the Royal Society of Arts was held on the 27th inst., at the close of the 163rd session of the society, Dr. Dugald Clerk, F.R.S. (chairman of the Council) in the chair. H.R.H. the Duke of Connaught, K.G., was re-elected President of the Society, and amongst the new vice-presidents elected was Field-Marshal Sir Douglas Haig, who is a Fellow of the Society of over 20 years' standing. Sir Henry Trueman Wood was re-elected secretary, but it was announced that he had tendered his resignation to the Society to date from September next. He has held the secretaryship since 1879.

Tramway Gear Cases.—The Tramways and Light Railways Association "Journal" announces that the Priority Branch of the Ministry of Munitions have requested the Association to inform its members that they will raise no objection to the importation to this country from the United States of gear cases for tramways. Indeed, since it is impossible to obtain these from home makers during the war, the Department will welcome their importation from America. The consent of the Munitions Overseas Transport and the Department of Import Restrictions will, however, have to be obtained.

Investigations of Feed Water for Boilers.—A bulletin (No. 94) issued by the Engineering Experiment Station, associated with Illinois University (U.S.A.), discusses boiler troubles arising from the use of certain kinds of feed water containing sodium hydroxide. It was noted that boilers using feed water containing this often developed fine cracks radiating from rivet holes or extending from hole to hole. The experiments showed that the effect upon the metal is to cause brittleness, which makes it less capable of withstanding steam pressure and temperature changes. Among the remedies suggested is the addition of a salt having properties which cause it to react with the alkali and yield a harmless product. Copies of Bulletin No. 94 may be obtained free by addressing the Director, Mr. C. R. Richards, Urbana, Illinois.

Digitized by Google

Standard Substances for Viscometers.—A recent bulletin issued by the Bureau of Standards points out that the quality of many liquids is often examined in terms of viscosity. For example, many grades of oil are so classified. Now the viscometers used in such tests are constructed in a variety of ways, and yield very different results unless controlled by liquids of accurately known viscosities. In the "Bulletin" referred to (No. 298) a series of standard liquids is suggested, comprising mixtures of alcohol and water, and solutions of sugar in water. These standards cover a wide range in viscosities, the solutions being measured for three different strengths at temperatures between 0°C. and 100°C.

National Electric Light Association and Technical Training.—In looking through the report of the Thirty-ninth Convention of the National Electric Light Association we notice two tables published by the sub-committee on courses and curricula. This sub-committee deals with the approved training of employees of public service corporations and has obtained information representing the concensus of opinion of a large number of executives of public utilities from all parts of the country. This information is summarised in the following tables :—

I. *Studies Advised as Preparation for Responsible Positions with Electrical Utilities in the Order of their Importance.*

1. Mathematics.
*2. Electrical Application.
*3. Electrical Theory.
4. Physics.
5. English.
6. Accounting.
7. Economics.
8. Mechanical Engineering.
9. Commercial Law.
10. Drawing.
11. Cultural Subjects.
12. Civil Engineering.
13. Chemistry.
14. Shop.
15. Foreign Languages.
16. Latin or Greek.

*These two subjects were given practically equal weight in the lists, but discussion seemed to give precedence to Electrical Theory.

II. *Relative Importance of Personal Qualifications and Technical Training for Public Utility Employees.*

1. Mental Calibre.
2. Habits.
3. Energy.
4. Tact.
5. Accuracy.
6. Initiative.
7. Self-reliance and reliability.
8. Enthusiasm.
9. Address.
10. Practical Experience.
11. Industry.
12. Electrical Theory.
13. Mechanical Engineering.
14. English.
15. Science.
16. Mathematics.
17. Popularity.
18. Speed.
19. Civil Engineering.
20. Commercial Law.

We are a little doubtful whether this classification would be endorsed in this country, but, considering the practical character of the National Electric Light Association, it is worth serious consideration.

Economy in Coal Consumption.—The Controller of Coal Mines has been advised that an economy in the use of coal can be effected and much inconvenience avoided during the next and succeeding winter by giving effect as far as possible to the following suggestions :—

1. *Power Uses.*—That the various factory owners throughout the country who at present generate their own power by means of coal should make arrangements for taking their power requirements from an outside source in districts where the power supplies have a margin available, thereby reducing the total amount of coal used. The Coal Controller will assist as far as possible in obtaining priority for plant, machinery and motors required provided a substantial coal saving can be demonstrated.

2. *Use of Coke.*—The use of locally produced coke or coke breeze in place of coal as much as possible in domestic grates, factory furnaces (where such cannot take an outside supply), public utility plants at light loads, also in baths and washhouses provided coke is available in sufficient quantities.

3. *Public Services.*—The curtailment of those public services which entail coal consumption, such as early and late tramway running—after consultation with the Ministry of Munitions where munition workers are likely to be affected—and the prevention of unnecessary use of water.

4. *Stocks.*—The accumulation of stocks in the summer months as far as deliveries will permit of the coal required during the winter months.

5. *Cooking and Heating.*—The installation of gas or electric cooking and heating appliances in public and private buildings, with a view of saving coal generally, and lessening the serious inconvenience to the public next winter should the local distribution of coal become irregular or insufficient.

6. *Emergency Disconnection.*—The application to the Board of Trade by the electric supply authority for sanction under Regulation B.1., to disconnect classes of non-essential consumers in cases of urgent necessity in order to enable the supply to be continued to munition and other essential users. This power should be obtained, although it need not be put into execution until the necessity arises.

7. *Interconnection.*—Making arrangements as suggested in the letter of the Board of Trade dated May 25, 1916, with the neighbouring towns to interconnect electric distribution systems or generating plants by means of underground cables, or, in suitable cases, of temporary overhead wires over the intervening country, so as to enable one or two of the most economical power stations in each district to supply several towns at light loads instead of each town having to run its own power station uneconomically at such times. This would also enable the various power plants to shut down in turn during week-ends and holidays to effect plant repairs, and would provide some amount of power at call as a stand-by in case of coal supplies giving out locally.

In order to carry out the last suggestion the Controller is advised that additional powers will have in some cases to be obtained both as regards passing over private property, trading between public utility companies and local authorities, and possibly relief from some of the existing power supply regulations; and if cases are brought to his notice they will receive his assistance where the saving in coal would warrant the provision of the necessary plant mains, &c.

OBITUARY.

PROF. K. BIRKELAND.—We regret to learn that Prof. K. Birkeland, of Christiania, died in Tokyo on June 18.

Prof. Birkeland, who was born in December, 1867, was educated at the University of Christiania, and subsequently studied in Paris, Geneva and Bonn. In 1898 he became professor of physics at his University of Christiania, but prior to this he contributed a number of interesting Papers on electric waves, on cathode rays and on atmospheric electricity to "Wiedemann's Annalen," the "Comptes Rendus," &c. On three occasions he got together and led expeditions for studying the polar aurora and magnetic disturbances, and the results of these expeditions have been published in Christiania and London. During some experiments in 1903 he discovered a special electric high-tension "disc flame." From this as a starting point, he and Dr. S. Eyde worked out a practical method for the production of nitrates from the air and as a result great manufactories for developing this process have been erected in Norway. In July, 1906, Prof. Birkeland read a Paper before the Faraday Society in London on the "Oxidisation of Atmospheric Nitrogen in Electric Arcs." This Paper, which described the Birkeland-Eyde process, appeared in THE ELECTRICIAN for July 13, 1906. The Société Norvégienne de l'Azote et de Forces Hydro-Electriques are the owners of the Birkeland-Eyde patents, and at the beginning of 1908 the great Notodden-Svalgfos works were opened with 40,000 H.P. Subsequently the company constructed works at Lienfos (15,000 H.P.) and Wamma (55,000 H.P.). With the Badische Anilin and Soda Fabrik, and two other German companies which possess their own method (the Schonherr), the Norwegian Nitrate Company has formed subsidiary companies which possess plants at Rjukan (227,000 H.P.), Tyin (81,000 H.P.) and Matre (83,000 H.P.). Prof. Birkeland was an honorary member of several earned societies.

G. D. SEATON.—We regret to record the death, which took place somewhat suddenly on the 21st ult. at Fallowfield, Lancs., of Gervise D. Seaton, an engineer well known in electrical circles. He was the Manchester and district representative of Messrs. Richardsons, Westgarth & Co., and he was also chairman of the Engineers' Club, Manchester. His genial, witty and social character endeared him to all who knew him.

DEATHS ON ACTIVE SERVICE.—The following are reported to have died on active service :—

Sec.-Lieut. W. P. Calder, King's Royal Rifles, who was killed by a shell on June 14 whilst leading his platoon in attack, was with Messrs. Siemens Bros. & Co. Ltd., for 19 years, and left the cable department of that company to join the Army.

Sapper F. W. Greenfield (R.E.), who has been killed in action, was employed prior to the war in the Postal telegraph department at Cardiff.

Driver Wm. Beisty (R.F.A.), Pte. T. J. Monaghan, Gunner J. Hodgson and Pte. R. Black, all formerly employed in the Liverpool Corporation tramways department, have been killed in action.

Lce.-Corp. Thos. Lees (Lancs Fus.), aged 21, formerly a conductor on the S. Lancs Tramways system, has died in action.

Pte. C. McDonald (Gordon Highlanders), formerly an inspector in the Aberdeen Corporation electricity department, has died of wounds.

PERSONAL.

Many of our readers will be interested to learn that Mr. G. G. Ewer, sales engineer to Stepney (London) Borough Council electricity supply department, who was a captain in the 7th Battalion Essex Regiment (T.F.), and was promoted major in 1915, has just been promoted to lieut.-colonel of the 1/6th Essex Regiment, and has, in addition, been awarded the D.S.O. Lieut.-Col. Ewer saw service in Gallipoli and in Egypt in the early days of the war, and is now serving with the Egyptian Expeditionary Force. The Stepney electricity undertaking has now over 60 employés serving with H.M. colours.

Capt. A. C. Gilling, R.F.C., electrical engineer to Epsom Council, was married on the 23rd ult. to Miss Marjorie Chapman.

Mr. H. R. Watts, motor superintendent in the Hammersmith (London) electricity department, and who enlisted at the commencement of the war, has obtained a commission in the R.G.A.

Digitized by Google

BELL TRANSFORMERS: DESIGN AND TARIFFS.*

BY E. WIRZ.

Summary.—Transformers for operating bells and similar auxiliary services in houses are discussed in detail. Reference is made to design, losses in operation, load and voltage drop, temperature rise, insulation, cost of operation and tariffs. In the cost of operation a comparison is made between transformers and cells.

In recent years the use of transformers has enabled auxiliary services, such as the operation of bells, to be supplied from alternating-current networks to an increasing extent. The fact that there is no electrical connection between the supply and the apparatus installed renders it possible to satisfy at the same time both the regulations for "heavy-current networks" and for "light-current networks." Small transformers have been designed for these purposes by a number of firms, and some types have reached a high order of excellence. It is, however, to be regretted that many inferior types are on the market that have brought the use of this class of apparatus into disrepute. The object of this article is to examine the construction, testing and commercial possibilities of bell transformers and the requirements necessary for connecting them to lighting and power mains, and to discuss the nature of tariffs suitable for their operation.

DESIGN AND CONSTRUCTION

The voltage and current characteristics of bell transformers depend primarily on the construction of the magnetic circuit. A preference has gradually developed for the shell type rather than the core type, a great advantage of the former type lying in the fact that it can be designed to give smaller leakage, and consequently smaller secondary voltage drop. The coils may be either of the cylindrical or flat type, but great care should be taken to arrange them so that there is the smallest possible leakage between the primary and secondary windings. Faulty design in this respect is evident in a number of transformers that were examined, and their operation was found to be quite unsatisfactory, their efficiencies being in some cases only 10 to 30 per cent. Low efficiencies resulted not only from excessive leakage, but also from the use of poor stampings. In the worst examples, in which ordinary sheet iron was used, the no-load losses were between 2 and 5 watts, and the no-load current very great, and the secondary voltage dropped to nearly zero with very small secondary loads. Thick stampings of 1 mm. and over should not be used at the usual periodicities, as they lead to high losses, and stampings of less than 0·25 mm. are difficult to assemble, and increase the cost of the transformers. The best results are obtained with stampings of 0·35 to 0·5 mm. thickness.

In order to diminish the no-load current it is essential to make butt-joints in the magnetic circuit with great care, and to reduce their number as much as possible. Large no-load currents cause heavy line losses, which may be much greater than the no-load losses of the transformers. The joints should be securely held to prevent humming, which is very unpleasant in dwellings.

A new model has recently been placed on the market by Moser, Glaser & Co. (Fig. 1). This transformer is of the shell type, and has no butt-joints. The core consists of two separate parts, each consisting of a continuous band of iron wound through the finished coils. There is no humming, and the transformer cannot deteriorate in use by the loosening of its core. The coils are flat, and arranged with the primary sandwiched between two secondary coils, so as to give small leakage. This model is in many respects superior to the ones of other makes that are at present obtainable.

A point that should not be overlooked is the design of the primary and secondary terminals, which should be adapted for connection to cables run in metal tubes, and sealed covers should be provided to enclose the whole transformer.

CURRENT AND LOSSES AT NO-LOAD.

The no-load current may be considered to be composed of a wattless component required to drive the flux through the core and the joints, and the power component that supplies the hysteresis and eddy-current losses in the iron and the ohmic losses in the primary winding.

In most cases the flux-density in the iron lies between 6,000 and 10,000 lines per square centimetre, and, if the core is not too large and is made of a good alloy, the ampere-turns required for the iron are small, and do not give rise to appreciable copper losses. On the other hand, if butt joints are used the magnetising current is greatly increased, and may go on increasing as the joints work loose in service, and a considerable power component of the no-load current may be caused to flow in order to supply the copper losses produced by the wattless component. Tests on a couple of transformers showed that in 1½ years the no-load current increased by 15 and 20 per cent. respectively. The power component of the current is dependent on the losses in the iron. Some supply authorities stipulate that the no-load losses should not exceed 1 watt. This is possible in the smallest sizes, but in the larger sizes the losses should

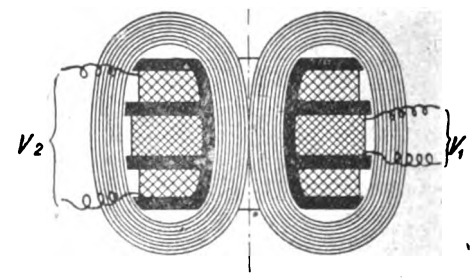


FIG. 1.

be specified as a function of the rated secondary load of the transformer. As the magnetising current has a direct influence on the magnitude of the no-load losses, it is not possible to discuss the no-load losses without reference to the magnetising current, although many attempts have been made to do so. The absence of definite rules to cover this point has thrown too great a weight on the no-load losses and too little on the no-load current, which is of more importance when the number of transformers installed is large. On this account our extensive tests show that manufacturers have paid too little attention to the magnetising current, which in many cases reaches excessive values.

The no-load losses (W_o) and the no-load current (I_o) for four types of transformers are given in Table I.

In type A the losses increase very rapidly with the voltage, but the current only slowly, and the no-load current is too high on account of poorly executed joints in the magnetic circuit. After only half a day's service the screws holding the joints together loosened to such an extent that the magnetising current rose 8 per cent. Type B has slightly lower values for W_o and I_o, but is no great improvement on the former type, notwithstanding the use of better

Table I.

	Volts.	40	60	80	100	120	140	Remarks.
Type A, 110 volts	W_o	0·08	0·18	0·36	0·64	1·02	...	Four butt joints, common punchings 0·5 mm. thick.
	I_o	0·027	0·033	0·039	0·042	0·048	0·057	
Type B, 110 volts	W_o	...	0·20	0·32	0·53	0·79	...	Four butt joints, alloyed transformer iron 0·5 mm. thick.
	I_o	0·024	0·030	0·034	0·039	0·042	0·053	
Type C, 120 volts	W_o	...	0·40	0·69	1·0	1·4	0·137	Core partly solid and partly of punchings.
	I_o	...	0·035	0·056	0·079	0·106	...	
Type D, 125 volts	W_o	...	0·15	0·23	0·35	0·51	0·7	No butt joints.
	I_o	...	0·005	0·006	0·009	0·012	0·017	

* Abstract of an article in the Schweiz. Elektrotechnischer Verein, "Bulletin" No. 12 December, 1916.

Digitized by Google

magnetic material. Type C is one of the worst transformers that were tested. It consisted of a magnetic circuit composed of a solid core holding the windings, the magnetic circuit being completed by punchings with two joints, and assembled so as to form a rectangle touching the ends of the solid core at two butt-joints (Fig. 2). This type must be condemned, owing to the high value of the losses and magnetising current and the excessive voltage drop due to large leakage. The type D (Fig. 3) is the admirable transformer built by Moser, Glaser & Co., and already referred to above. Its no-load current was only 0·0131 ampere, and the no-load losses amounted to only 0·55 watts.

The importance of the no-load current may be seen from the fact that 10,000 of either of the types A, B, C, D would take total magnetising currents of 450, 400, 1,060 and 131 amperes, corresponding to apparent powers of 49·6, 44, 127·2 and 16·4 k.v.a., and actual powers of 8·2, 6·5, 14 and 5·5 kw.

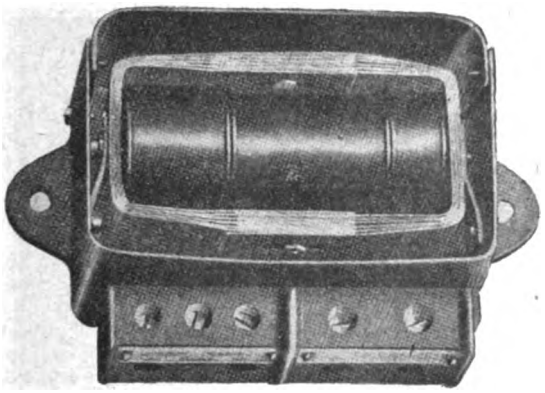


FIG. 2.

The first requirement for a good bell-transformer must, therefore, be a small magnetising current. This current should be less than 0·025 ampere, and the power taken should not exceed 1 watt.

USEFUL LOAD AND VOLTAGE DROP.

The secondary voltage is determined by the apparatus to be supplied by the transformers, and for ordinary domestic installations the currents range between 0·1 to 0·5 ampere, with a secondary load resistance of 4 to 30 ohms, so that secondary voltages of 3 to 20 volts will usually suffice. As a rule, bells and door-openers can be operated at 5 to 10 volts, giving a secondary load of 1 to 5 watts. A great number of transformers are found to be incapable of maintaining these voltages, the voltage dropping nearly to zero on load. Figs. 4 and 5 show the load characteristics of the type D transformer, and

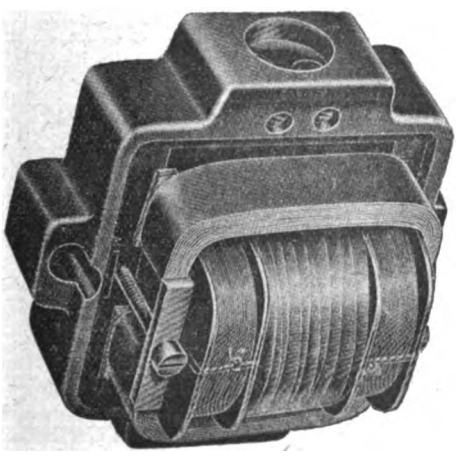


FIG. 3.

Fig. 6 for the type C; similar figures for the types A and B being given in the original Paper.

It may be laid down as a requisite of a good bell transformer that it should have an efficiency η of more than 50 per cent. at currents between 0·2 and 0·8 ampere, and the maximum efficiency should fall at small secondary currents, such as 0·4 to 0·5 ampere, the normal operation taking place on the rising portion of the load curve. The voltage drop ϵ should be small, and, in the case of the smallest transformers, should not exceed 30 to 35 per cent. at load currents of about 1 ampere.

TEMPERATURE RISE.

A striking result of the tests was the fact that the temperature rise was far too great even in some of the best transformers, with the result that they broke down after short periods of service. The

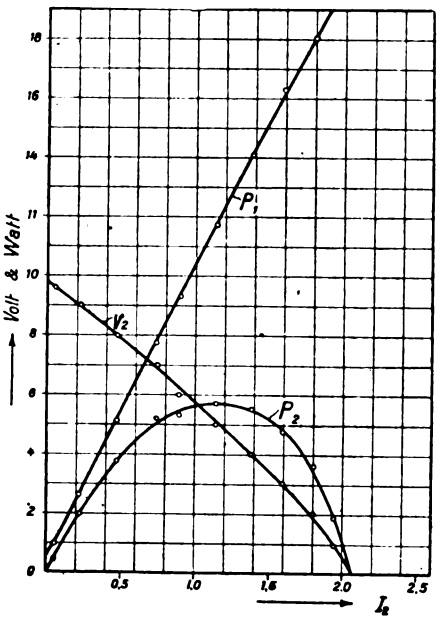


FIG. 4.

cause of this defect lay in faulty design of the magnetic circuit, by the inclusion of too many butt joints and use of punchings of too great thickness, and in the provision of insufficient section in the copper conductors. It was found that, particularly in the event of a secondary short-circuit occurring, the temperature rose to an inadmissible value owing to the lack of sufficient radiating surface. Regulations have been made by the Institution of German Electrical Engineers covering this point, specifying that bell transformers

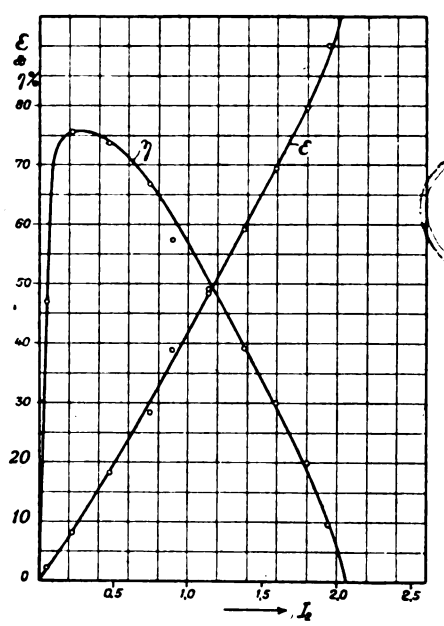


FIG. 5.

LIBRARY OF THE UNIVERSITY OF CALIFORNIA

should not have a temperature rise exceeding 100°C. on permanent short-circuit. This condition implies that a radiating surface of 12 to 18 sq. cm. per watt should be provided with efficient air cooling, and although in many cases the radiating surface lay between 4 to 15 sq. cm. per watt without covers, the temperature rise was excessive even in the types presenting the largest surfaces as soon as the covers were fixed in position. This was particularly noticeable when the

Digitized by Google

covers were constructed of porcelain. On this account some makers advocate the use of fuses to cut off the transformers on the primary or secondary side after a short-circuit has lasted more than a given length of time, and some types were provided with internal resistances to limit the short-circuit current. Such devices are undesirable, as they impair the reliability and capacity of the transformers, and over-heating should be rendered impossible by suitable design. The tests showed that in many instances the temperature rises on short-circuit were too high ; in fact, in some cases the transformers broke down after periods of only 20 minutes. It is recommended that no transformers should be passed for service in which the rise of temperature exceeds 100°C. after several hours run on short-circuit, and this may be achieved by low-current densities in the windings and good air circulation. Hermetically sealed covers are to be avoided as far as possible, and metal covers are preferable to porcelain ones. Aluminium covers give the best results.

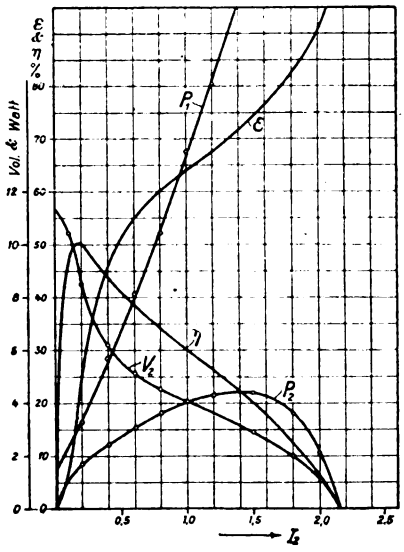


Fig. 6.

Insulation.

The insulation is the determining factor in deciding whether a bell transformer may be safely connected to the supply system. The primary winding, in particular, should be especially well insulated in order to conform to the regulations of the supply companies. In most types the insulation to frame was found to be sufficient, but the insulation from the primary to the secondary winding was not high enough to ensure safety in touching the apparatus on the secondary side. A bell transformer should stand the permanent application of at least 1,000 volts between the primary and secondary windings, and many supply companies specify 3,000 volts and more. If the insulating material is hygroscopic, it may stand insulation tests for a short time, particularly when the transformer is new, but may fail after continuous application of the testing voltage. It is, therefore, suggested that 3,000 volts should be applied for 10 minutes and 1,000 volts for longer periods. The series of transformers submitted to test broke down at voltages lying between 550 volts and 4,260 volts, the majority failing between 1,500 and 1,800 volts.

Economy and Tariffs.

In comparing the cost of operation of bells by cells and by transformers the most important factors are given in Tables II. and III. Table II. gives the ampere-hour capacity AH of the cells for intermittent work, the average life (H) in hours at loads of 0·2 and 0·5 amperes, and the average total watt-hours output (WH) with intermittent load. Further columns give the initial cost (K_1) of the cells and approximate cost of upkeep per annum (K_2), and lastly the total annual cost of one cell (K_3) and of a battery of 2–5 cells (K_4). These figures are necessarily only approximate, and it may be remarked that the cost of operation depends to a great extent on the position in which the cells are installed and the attention that they receive.

Table III. sets out the cost of operation of bell transformers of two types, the worst and best of the series subjected to the tests, denoted by C and D respectively. The cost per kilowatt-hour is taken as 40 and 60 centimes, and the costs are worked out on the assumption that the bells are in service for 5, 10 and 20 minutes per day, which corresponds to 30·42, 60·83 and 121·67 hours per year. The table shows that the cost is mainly determined by the no-load losses, and on this account a tariff should lay the greatest importance

Table II.—*Cost of Operation with Cells.*

Type of cell.	Dimensions in cm.	E.M.F., new volt.	Rated current. amps.	AH. Amp. hr.	Average life H. hours.	Output WH. watt-hrs.	K_1 fr.	K_2 fr.	K_3 fr.	K_4 fr.
Leclanché Small.	16×9	1·55	0·14	10	50–20	9–10	1·75–1·95	1·00–2·50	2·0–3·5	4·0–12·0
Leclanché Large	24×10	1·55	0·20	22	110–44	16–18	2·70–3·00	1·25–2·25	2·5–4·0	4·8–15·0
Mammut	28×13×19·5	1·6	50	1,300	6,500–2,600	1,300–1,500	19·8–20·5	2·00–6·00	3·6–6·0	5·0–20·0
Dry cell ... Small.	9×6	1·5	0·1–0·5	23	115–46	20–35	1·4–2·2	1·40–2·20	2·2–3·2	3·5–12·0
Dry cell ... Large.	17×7·5	1·5	0·2–1·0	70	350–140	60–100	2·0–2·8	2·00–2·80	2·5–3·3	4·0–16·0

Table III.—*Cost of Operation with Transformers.*

Type.	No load. Watts.	No load. Amps.	K.-w.h. per annum.	Cost per K.-w.h. cts.	Cost of energy to consumer per annum in francs. For no-load losses.	For load taken at 0·2–0·5 ampere at daily period of service of 5 min.	10 min.	20 min.	Total yearly cost at daily period of service of 5 min.	10 min.	20 min.
C	1·39	0·106	12·18	40	4·88	0·043–0·091	0·085–0·183	0·17 –0·365	5·00	5·1	5·25
				60	7·39	0·064–0·137	0·128–0·274	9·256–0·55	7·55	7·65	7·95
D	0·55	0·0131	4·825	40	1·93	0·0274–0·061	0·055–0·122	0·11 –0·245	2·00	2·05	2·20
				60	2·82	0·041–0·091	0·082–0·183	0·165–0·365	3·00	3·10	3·30

Table IV.—*Estimated Annual Costs for 1,000 Bell-Transformers.*

Type.	No load. Kw.	No load. Amp.	Line losses. Kw.	No load energy per annum. K.-w.h.	Line losses per annum. K.-w.h.	Total energy per annum. K.-w.h.	Cost of generating per annum. Total energy at 4 cts./K.-w.h. Fr.	Line losses at 4 cts./K.-w.h. Fr.	Income from no load K.-w.h. at 60 cts./K.-w.h. Fr.	Net profit. Fr.	Extra profit if line losses are also charged for. Fr.
C	1·39	106	5·625	12,320	49,300	61,620	2,464·8	1,972	7,392	4,927·2	29,580
D	0·55	13·1	0·086	4,880	753	5,633	225·3	30·1	2,928	2,702·7	451·8

Digitized by Google

on this consumption. It appears that the worst transformer does not give rise to an appreciably larger cost per annum for the units supplied than a battery of three to five cells, and that the type D is more economical than a battery, of which the cost of upkeep is greater than that of a transformer. Furthermore, it should not be forgotten that if the cost be reckoned over a series of years, the cost of upkeep of the battery would have to be increased from year to year, and might reach in the second year four to five times the magnitude that is assumed for the first year, if the depreciation of the battery is allowed for. The initial cost of a transformer is not much greater than that of a battery, being between 14 and 24 francs. As the small consumption of a transformer cannot be measured by an ordinary meter, the tariff must be based on the characteristics of the transformer without the use of a meter, and must be so adjusted that the cost compares favourably with that of a battery, not forgetting that a large no-load current causes heavy losses in the line.

If we assume that 1,000 transformers are installed, and that the cost of generating energy is 4 cts. per kilowatt-hour, the sale price for lighting being 60 cts. per kilowatt-hour, and, further, that the line resistance is about 0·5 ohm, we obtain the figures of Table IV., which may act as a basis for the determination of a suitable tariff. It will be seen that with the poor transformer C the magnetising current gives rise to excessive line losses, and that these are far greater than the no-load transformer losses. This gives a generating cost of 2,464·8 frs., as against only 225·3 frs. for the improved type D. It is, therefore, clear that if the consumer is charged with the line and no-load transformer losses the cost becomes so high with the transformer C that it cannot compete with a battery. On the other hand, if the consumer is charged only for the no-load transformer losses, the supply company has to bear the excessive cost of the line losses. The net profit in column 11 is obtained as a difference between the charge to the consumer in column 10, if he pays only for the no-load losses, and the total cost of generating given in column 8. If the consumer were called upon to pay in addition for the energy lost in the line, there would be an extra profit to the company of the amount set down in the last column. This figure shows the great importance of the no-load current in fixing a fair tariff.

From Tables II. and III. we see that for a transformer with small no-load current the tariff should lie between 4 frs. and 6 frs. per annum per transformer in order to compete favourably with a battery. If the no-load current is large, an allowance for this must be made in fixing the tariff.

It is suggested that the cost in francs per annum per transformer should be calculated from the expression $p+xI^2_0$. The constant price p may be fixed in any suitable manner; for instance, it may be made to depend on the yearly cost of the no-load losses, and if the value of x be taken as 1,600, the penalty for large magnetising current would be 1 fr. for a magnetising current $I_0=0·025$, and would increase rapidly with I_0.

NEW CONCENTRIC STANDARD DYNAMOMETER WATTMETER FOR HEAVY CURRENTS: AND CONCENTRIC NON-INDUCTIVE STANDARDS OF LOW RESISTANCE.*

BY A. E. MOORE.

The object of the work outlined in this Paper was to provide, in the Standardising Laboratory at the School of Technology, Manchester, a precision watt standard for dealing with load currents of upwards of 1,000 amperes, suitable for the verification of sub-standard and other wattmeters and watt-hour meters, &c. A Kelvin watt balance for currents up to 1,000 amperes was obtained, but neither this nor other balances fulfilled the necessary requirements exactly, and in the meantime the author had in mind a form of current coil which appeared to be worth developing for a dynamometer-type wattmeter.

Many so-called standard dynamometer wattmeters of the straight-through type designed for currents exceeding 100 amperes are unsatisfactory except for use on circuits of approximately unity power factor. The defects are mainly due to eddy currents and skin effect. Eddy currents in the metal forming the main conductors, and in any other metal-work used in the construction of the instruments, cause the active part of the flux in the main-current coil to be out of phase with the main current, while the skin-effect may cause variations in the distribution of the current over the cross-section of the main conductors with changes in frequency, and this may consequently affect both the magnitude and the phase of the active part of the main-coil flux. The active conductors of the pressure coil cannot be made to embrace more than a small portion of the main-coil flux, and for successful working this portion must always be a definite fraction of, and in the same phase as the whole flux. It is not very difficult to eliminate eddy-currents by avoiding the use of metal supports, &c., and having the main coils formed of stranded conductors, each strand being insulated; but in order that the current distribution may be maintained constant independently of changes in the frequency of the current, it is necessary that every strand of the conductor have the same time-constant (L/R). There are many difficulties in the way of the satisfactory stranding of the conductor, if it is intended for currents of upwards of 1,000 amperes.

In the wattmeter now to be described the author has made use of the concentric magnetic field which is formed between two concentric conductors when a current is maintained in them in opposite directions.

If a wire be wound uniformly over the surface of a ring as shown in Fig. 1, the magnetic field produced when a current is maintained in the wire is symmetrical about the principal axis of the ring. So that every turn of the wire encloses the same magnetic flux, and, presumably, has the same ohmic resistance, and therefore the same time-constant. If all the turns are cut and their ends securely connected to copper end-plates (Fig. 2), the turns will be connected in parallel instead of in series, and the time-constant of any one turn will still remain the same as that of every other turn, since each will be of the same resistance and will embrace the same flux. Therefore, if an alternating current be maintained in the coil thus formed it will be uniformly distributed over the turns, and the uniform distribution of the current will be unaffected by changes in the frequency. The winding must be perfectly symmetrical.

Fig. 3 illustrates how the pressure coils may be arranged within the current coil. Two coils are used in order to render the system astatic to uniform stray magnetic fields. The magnetic axes of the pressure coils are nominally perpendicular to the direction of the flux produced in the main coil, and the result is a turning moment about a vertical axis.

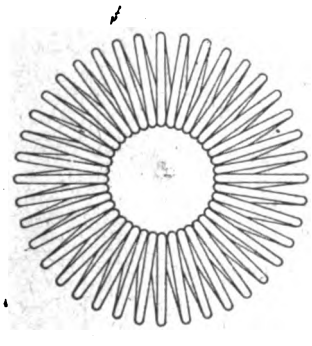


FIG. 1.—CLOSED RING WINDING; MAGNETIC FIELD CONCENTRIC WITH AXIS PERPENDICULAR TO PLANE OF PAPER.

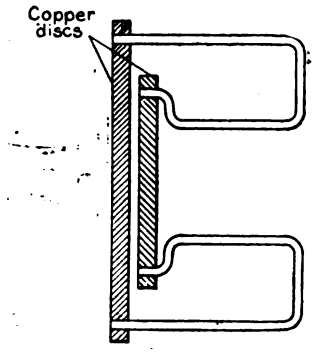


FIG. 2.—SECTIONAL VIEW SHOWING HOW TURNS OF RING WINDING MAY BE ARRANGED IN PARALLEL. TWO TURNS ONLY SHOWN.

* Abstract of a Paper in the "Journal" of the Institution of Electrical Engineers.

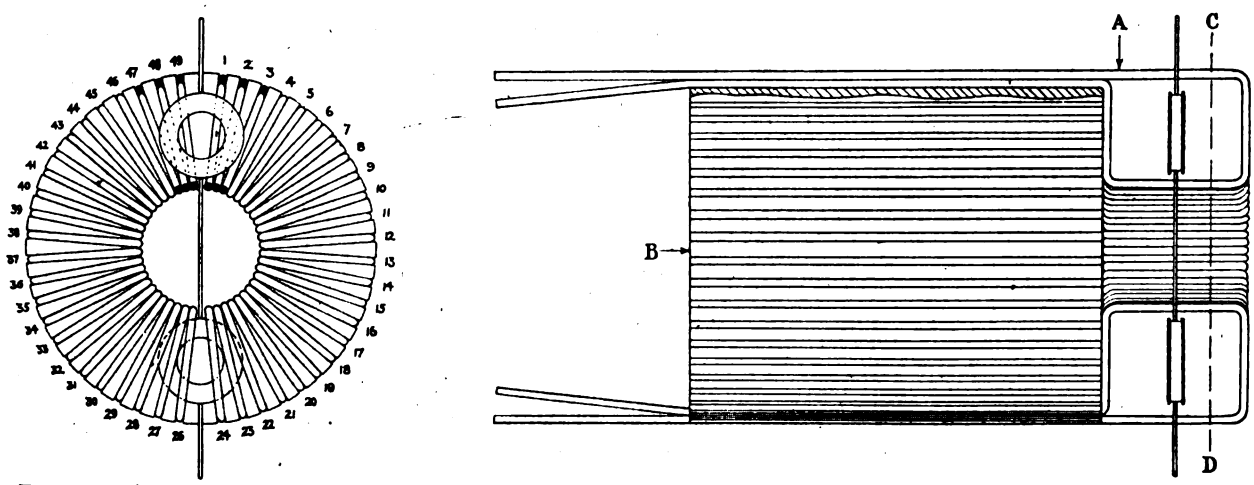
Digitized by Google

CONSTRUCTION OF THE CURRENT COIL.

The difficulties met with in the production of a concentric-field wattmeter are :—

1. The construction of a current coil in which the phase difference between the flux and the current that produces it is negligibly small.
2. The making of a mechanical joint in the current coil, which permits of the easy insertion of the pressure coils, but does not introduce a phase error in the current coil.
3. The design and construction of the most suitable form of pressure coils.

Various difficulties were met with and in the original Paper the author describes five different models which were successively constructed.



End view and Part section on CD

Side view. *Half of the coils removed*

FIG. 3.—CURRENT ELEMENT FOR CONCENTRIC WATTMETER, MADE UP OF FORMED COILS A, MOUNTED ON A SLOTTED WOODEN CYLINDER B.

The final model is shown in Fig. 5, and was made up in such a way as to avoid, as far as possible, the defects of the previous models. The resistances of the joints are comparable with the resistances of the tubes and wires, and the new model is designed to make the resistances of the joints as uniform and as low as possible. The coil resembles a squirrel cage. The inner conductor is formed of a straight copper tube *A*, 1½ in. outside diameter and $\frac{1}{16}$ in. wall. The outer conductor is formed of 40 No. 10 S.W.G. copper wires arranged symmetrically around the inner tube. The ends of these wires terminate in the heavy brass end-plates *B* and *C*, and an additional tube *D* is used for conveying the current to the end-plate *C*. Heavy terminal blocks *E* and *F*, fitted with copper strips, are secured to the ends of the tubes. Although the tubes are solid drawn, it was thought desirable to bore and turn them. The end-plates are made ½ in. thick, and are provided with bosses where they fit on to the main tubes, thus giving the joints a large cross-sectional area, and all the joints are soft soldered. Very good results were obtained with this coil and the phase error as compared with the Duddell-Mather 100-ampere instrument was of smaller dimensions than one minute (actually 0·0002 radian).

Two instruments were made up with these coils, one a reflecting type with bi-filar control, and the other a torsion-head instrument.

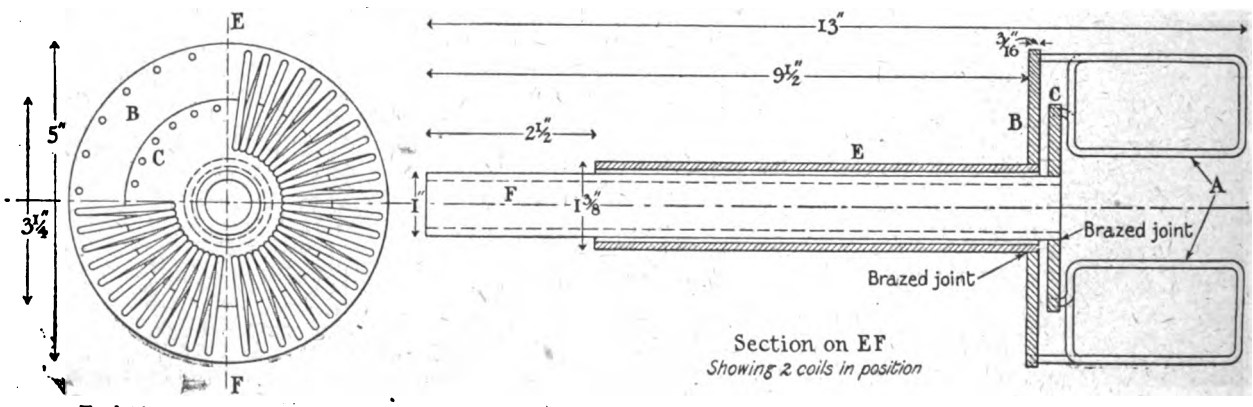
The current-carrying capacity of the current coil is limited largely by the carrying capacity of the inner conductor. This conductor may be solid instead of tubular, but with the tubular construction the carrying capacity may be much increased by maintaining a stream of water through the tube. The current element described above will carry a current of about 1,500 amperes for a short time without undue heating. and the torsion-head instrument was always used without water cooling.

MECHANICAL JOINTS IN THE MAIN COIL.

Although the results of the tests showed that instruments constructed as described above are electrically satisfactory, the constructional advantages to be gained by having a joint in the cage were never lost sight of. Experiments in this direction were made more recently and a quite successful joint has been made.

The end-plate *C*, Fig. 5, was unsoldered from the 40 wires forming the outer conductor, and 40 new pieces of wire, each 2 in. long, were soldered into this plate. A new pressure coil was slipped over the inner tube and then each pair of wires was joined by means of short pieces, each 1 in. long, of copper tubing and soldered, as shown in Fig. 6.

From the results obtained in various tests, and from the fact that any buckling of the wires in the outer cage did not measurably affect the phase error, the author concluded that a well-made mechanical joint in the outer cage would prove permissible, and actually it did so.



End view. *Showing 6 coils removed*

FIG. 4.

According to the final method of making the joint, the 40 wires forming the outer cage are soldered into an end-plate *A* at one end, and into a brass ring at the other end. The contiguous faces of the ring and the other end-plate *B* are machined for a true fit and the end-plate is centred into the ring and fastened to it by means of 20 screws. In a future construction it is intended to make the joint in the middle of the cage.

PRESSURE COILS FOR CONCENTRIC WATTMETER.

The form of pressure coil used in the wattmeter before it was found permissible to construct the main cage in two separate parts is shown in Fig. 7. It is made up of two coils *A* and *B*, wound on

Digitized by Google

flat ebonite bobbins, the length of the bobbins being such as to admit of their being passed between the wires forming the outer cage. The bobbins were joined together by the ebonite strips *C* and *D* by means of "Eureka" pins. One of the strips was fixed in position before the coil was put into the cage, and the other was pinned in afterwards. The pieces of ebonite *E* and *F* were also secured to the bobbins by means of Eureka pins and support the

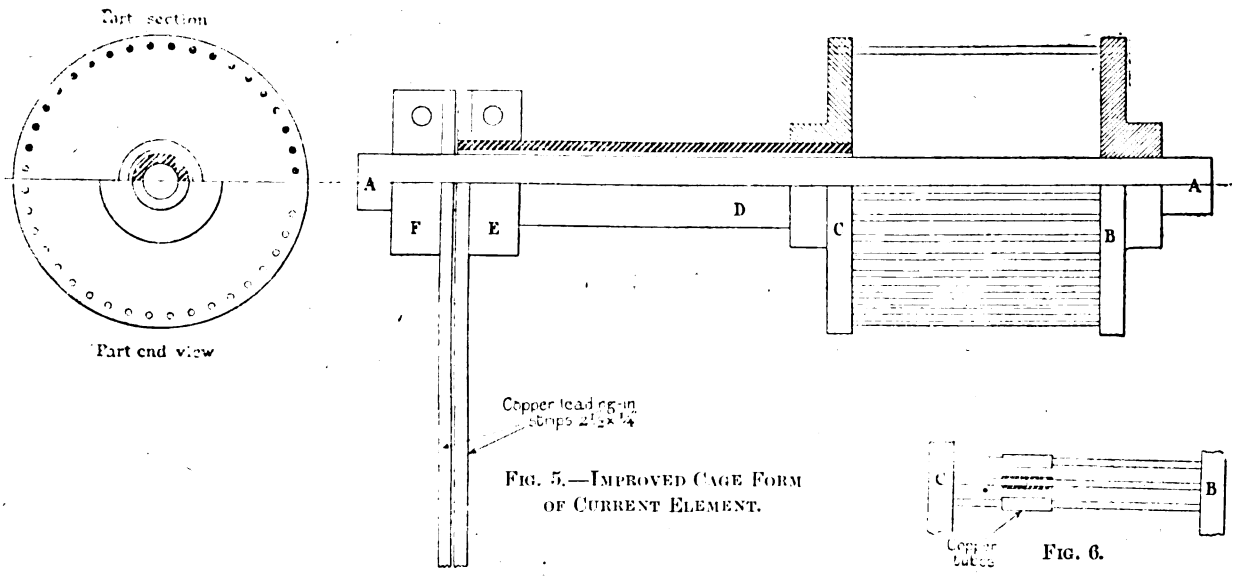


FIG. 5.—IMPROVED CAGE FORM OF CURRENT ELEMENT.

FIG. 6.

Eureka wires *G* and *H* which serve for the suspension and the damping vane respectively. Each coil consists of 500 turns of No. 36 S.W.G. silk-covered copper wire, and the coils are connected permanently in series with each other to the ligaments forming the bi-filar control. These coils served for all the tests made on the instrument before the cage was made in two separate parts. The defects in these coils were due largely to its being necessary to build them up within the cage. They are heavy and not quite so rigid as is desirable for a reflecting instrument.

A second coil, constructed after the cage was made in two parts, yielded considerable improvement due to the smaller weight, greater rigidity and smaller self-induction. With regard to rigidity, however, this coil had some defects.

In an instrument made with another type of coil the torque varied very considerably with variation in the angle between the magnetic axes of the main and movable coils.

The author presents curves showing the relation between the torque factor and the displacement *h*, for coils where $x = 3$ cm., and for different values of *a*. The best result obtains when $x = \sqrt{3}a$.

SOME COMPARATIVE TESTS MADE BETWEEN THE CONCENTRIC AND DUDDELL-MATHER INSTRUMENTS.

The following results were obtained by comparing the readings on the author's instrument with those on the Duddell-Mather.

Tests for phase difference between flux and current in the main coil.—The main-current coils of the two instruments were connected in series with each other and a suitable resistance, to one generator of a double alternator set, and the pressure coils of the two instruments were also connected in series with each other and a non-inductive resistance to the second generator. The phase of the current in the pressure coils was then adjusted until the reading on the concentric wattmeter was zero, and the readings of the main-coil and pressure-coil currents, and the indication on the Duddell-Mather instrument were noted. These observations were:—

Main-coil current, 100 amperes.
Pressure-coil current, 0·1 ampere.
Resistance of pressure-coil circuit, 1,000 ohms.
Watts indicated by concentric instrument, 0.
" " Duddell-Mather instrument, 2.
Frequency of the current, 50 periods.
Total volt-amperes $= 100 \times 0{\cdot}1 \times 1{,}000 = 10{,}000$.

If it be assumed that the flux in the main coil of the Duddell-Mather instrument is strictly in phase with the main current, and if θ be the angle between the flux and the current in the concentric instrument, then

$$\text{Sin } \theta = \text{Watts/Volt-amperes} = 0{\cdot}0002$$

and $\theta = 0{\cdot}0002$ radian.

This is a very small phase error and the wattmeter would only need correcting if it were used on a very low power factor. For example, if the power factor were 0·1 the correction would be about 0·2 per cent. The cages of the two concentric wattmeters have since been rebuilt, each in two parts, and tests carried out on them indicate that the phases of the fluxes in the concentric and Duddell-Mather instruments are in exact agreement.

Observations were made at power factors of unity, 0·5, 0·3 and 0·17, with leading and lagging currents. When corrections were made for the pressure-coil lag the two instruments agreed as nearly as they could be read. The ratio of the deflections on the two instruments remained constant and independent of the power factor.

Another series of observations was then taken with the resistances of the pressure-coil circuits increased so that the error due to pressure-coil lag was negligibly small in both cases. The resistance of the Duddell-Mather instrument was made up to 20,000 ohms and that of the concentric instrument to 40,000 ohms, and comparisons were made down to zero power factor. In this case also repeated tests on the instruments confirmed that however the power factor was varied the indications of both agreed as nearly as they could be read.

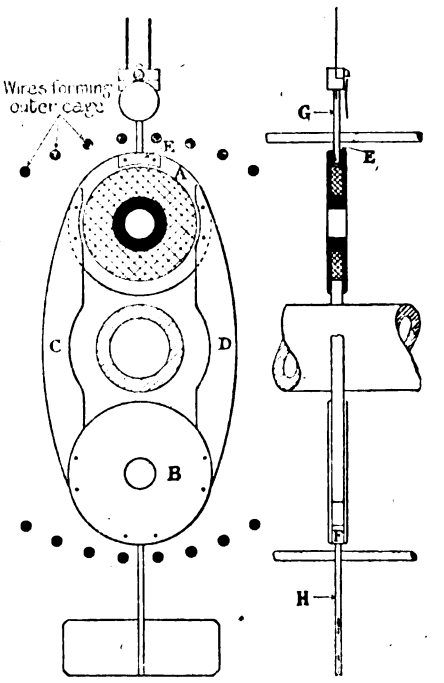


FIG. 7.—MOVABLE SYSTEM WITH COILS MOUNTED ON EBONITE BOBBINS.

Weight of movement = 56 grammes.
No. of turns per coil = 500.
Size of wire = No. 36 S.W.G.
Inductance of two coils in series = 13·6 millihenries.

(To be continued.)

Digitized by Google

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

The annual general meeting took place on Friday last, the Hon. Arthur Stanley, M.P. (Chairman of Council), presiding.

The CHAIRMAN, in his statement on the year's work, referred to the Association's negotiations with the War Office, which resulted in some of their old employees having been returned to them. The Council hoped that as the result of their representations the Government Departments would soon be able to allow them increased rations of materials. There was all the more reason to believe this after Dr. Addison's recent speech. The Government had also assisted them by holding back materials originally intended for abroad and giving the home tramway undertakings a chance to utilise them. The Government had also granted certificates for material to be imported from America. A Committee of the Association had been occupied for a year with committees of four other Associations in getting the Inland Revenue authorities to fix standard rates for motor omnibuses, in which they had been successful. The Board of Trade Committee on the supply of electricity might ask the Association to send a representative on behalf of the Association. The new list of Certified Occupations raised the age limit of some of the tramwaymen, and deprived the undertakings of their services, so that the question of extending the employment of women must occupy the serious attention of the managers. They had, however, been able to maintain and improve their services in the face of all difficulties. He thought the year's experience showed they were right some years ago in deciding that the Association should go on.

The accounts were then passed.

Mr. R. J. Howley was elected vice-chairman in the place of Mr. Harry England, who was thanked by the Chairman for his untiring services during the past five years.

The CHAIRMAN said in addition to Mr. England they were losing Mr. Mallins, Mr. Greene, Mr. Mason, Mr. White and Mr. Bland from the Coumcil.

The following were then elected to the Council :—Messrs. A. Good (director of Cammell, Laird & Co.), G. W. Holford, W. E. Hardy, C. G. Tegetmeier, T. B. Goodyer and W. Tham.

The hon. auditor, Mr. A. W. Chambers, was then re-appointed and a vote of thanks to the Hon. Arthur Stanley for presiding was passed.

ANNUAL CONGRESS.

The Ninth Annual Congress of the Association was then opened with the President (the Rt. Hon. Viscount Chilton) in the Chair.

The PRESIDENT first welcomed Mr. A. L. C. Fell back after his long illness and went on to say he thought it was remarkable that at a time of stress such as the present so many gentlemen carrying out tramway work under the existing difficult conditions should be able to come to town to that Congress. The difficulty of obtaining labour and materials and the necessity for re-organising their forces were causes which might have kept them away. The difficulties caused by the war showed how necessary tramways were to carrying on the traffic of the war. In many munition areas it would have been impossible to have got employees to and from the factories had not the tramways existed.

The following Paper was then read by the author:—

Manufacture, Life and Maintenance of Tramway Car Tyres.*

BY ARTHUR NORTON.

The author deals generally with the subject, starting with a consideration of the steel ingot from which the tyre is made, and then passing on to the machining and gauging of the tyre. The accurate gauging of the bore is of extreme importance, the standard shrinking allowance being one-thousandth of the diameter of the wheel centre, and this should not be diminished or exceeded. A graphical record is given of the expansion obtained at various temperatures, and it is pointed out that if a tyre is put on at a "black heat" the actual temperature may vary considerably up to 500°C. to 600°C. according to the lighting of the shop through errors in judging visually. The whole effect of the operation may be nullified by exceeding the safe temperature of 400°C. to 420°C., and if the temperature is allowed to rise it may reach the recalescence point when the condition of the steel is changed and quenching has the effect of hardening the tyre. This hardening may take place at only certain parts, with the result that flats are developed in those places which are left softer. Actually, an expansion of 1/16 in. takes place at 250°C., and the tyre can be readily gauged when heated. Details are given of arrangements for heating and shrinking on.

Referring to the maintenance of flanges, the author points out that wheel flanges play an important part in steering the car. Therefore, it is important to see that the flanges are properly maintained. By so doing, the amount of side play is reduced and thus the wear on both tyre and rail is decreased. It is, therefore, advisable to re-turn the wheels at that point in their lives when the flanges can be re-formed with the least possible loss of metal. At Belfast this is done when the following conditions obtain :—

1. When the tyres on one pair of wheels have worn to different diameters.
2. When the inside of the flange becomes approximately at right-angles to the tread, thus forming a definite corner on the tyre.
3. When the flange becomes more than 3/16 in. above or below the standard section of the flange of the original tyre.
4. When the flange at its base is less than $\frac{7}{8}$ in.
5. When the tread of the tyre is worn with a considerable hollow.

In re-turning worn tyres, it is not the general practice to re-form the profile to its original contour, as it is argued that if this were done it would necessitate cutting away too much valuable material, which, in turn, would shorten the life of the tyre. It should be borne in mind, however, that the rate of wear increases as the width of the flange decreases.

The author gives the following reasons for the excessive wear which is sometimes experienced :—

1. Systems which operate in very hilly districts.
2. Systems which operate in narrow streets, and where very sharp curves obtain.
3. Narrow-gauge tracks.
4. Single-tracks with loops.
5. Worn conditions of tracks, and, with special reference to the present time, the impossibility of effecting repairs to such tracks until after the war.
6. Maintenance of car frames.
7. Motors running against each other.

In dry weather, lubrication of the rails and sharp curves should effect a considerable saving in flange wear, as the mud which is formed makes an effective lubricant. It is also important that cars should be turned frequently, so that they shall not be always running on the same rails. The maintenance of car frames has a considerable bearing on the question of tyre wear. The author gives a number of diagrams showing the wear of the tyres and quotes figures illustrating the differences obtained. The life of a tyre is generally concluded when its thickness is reduced to $\frac{1}{4}$ in. or $\frac{7}{8}$ in. Some results are given of the falling weight test as specified by the L.C.C.

The author refers to the great disparity of wear shown in certain cases. In comparing four pairs of tyres in one instance it is noted there is a difference of $\frac{1}{8}$ in., $\frac{3}{8}$ in., $\frac{1}{8}$ in. and 5/16 in. between the diameter of one wheel as compared with its fellow on the same axle, showing the greater disparity that exists, the greater the wear, for, while the average mileage obtained for the tyres on No. 1 end of car No. 569 was 9,234·5 miles per $\frac{1}{8}$ in. radial wear, only 6,470·5 miles was obtained in respect of the tyres on No. 1 end of car 245, whilst the difference in loss of weight of material is 49 lb., and it may be noted that both these sets of tyres are in service on the same route. Does not this fact again emphasise the great importance of more frequent turning of tyres (that is, of course, when normal times come round again), when the diameters are found to be unequal, with the consequent reduction of the width of the flanges, when tyres are run in that condition?

The grinding away of one tyre by the other not only affects the question of the tyres themselves, but also has a considerable bearing on the question of current consumption, wear to rails, including rail corrugation.

Referring to this latter, Mr. Stephen Sellon, in his excellent Paper on "Rail Corrugation and its Causes," read before the Institution of Civil Engineers in 1914 (Minutes of Proceedings, Vol. CXCVII.), referred to an estimate made by the Chief Officer of the City of Glasgow Tramways that rail corrugation costs that undertaking at least £10,000 per annum, and other systems have no doubt heavy charges in the same direction.

There can be little doubt that the maintenance of the tyre sections, flanges and diameters should receive more frequent attention during their life than at present appears to be the case. Admitting it may be necessary to cut away a little more material from the tread to

* Abstract.

Digitized by Google

re-form the flanges, with the consequent charges for labour, loss of material, &c., the other side of the account would be more than balanced by the reduction of rail wear, current consumption and a helping hand to our old friend, "rail corrugation."

In 1915 a special Committee of this Association was appointed to consider the question of securing an adequate supply of tram-tyres in the difficult times we are living in, and, with this end in view, a meeting was arranged with the tyre manufacturers. It was at once suggested that if three standard sections (details of which are given in the Paper) could be generally adopted it would greatly facilitate matters. Three different widths, viz., 3 in., 2¾ in. and 2½ in., were adopted, and it is pleasing to record that the Standard Section has been generally adopted, but if there are any managers who have not yet seen their way to adopt it, it can only be hoped they will give the matter their urgent consideration.

The question of standardisation as regards the wheel-centres is, unfortunately, a more difficult one, owing to the fact that one has to deal with what is already actually existing, but, with regard to new work, the consideration of this most important question should not be lost sight of, as it would enable manufacturers to roll for stock, when immediate necessities could be supplied at once.

Mr. A. GOOD, who opened the discussion, said the advice given by the author was long overdue. The managers usually blamed the tyre makers if one tyre of a pair of wheels wore more rapidly than the other or if a tyre burst. The fault might lie nearer home. The frames might not be in true alignment, the drivers might be inefficient, the tyre might be put on too tightly, or the bogie pivots might have seized and the bogie refuse to swivel. The author said "the standard shrinking allowance of 1/1,000th of the diameter of the wheel centre shall not be above or below the limit fixed." The smaller the amount of nip put on the tyre or the lighter the tension left in the tyre when it was cooled down the better. In a system with which he had to deal in the past they gave the tyres 3/64ths nip and when hard tyres were tried and they gave them 3/64ths nip one or two of them burst. The suppliers advised them to try 1/64th. They did and they had since had thousands of tyres and not one had broken or come off. The cooling down of tyres with water was a primitive and a dangerous method, particularly with hard tyres. With tyres of 70 tons tensile strength or above, cooling down rapidly was a great danger, and had a great effect on the hardness.

Mr. HY. MOSLEY (Burnley) said four-wheel cars were not used on his system. They were all bogie cars and the variation of the wearing diameter in his experience was negligible. The flanges gave no trouble and they had some of the trucks which they began with in 1901-2 and used their own truck, which gave remarkable results. It was a wonder to him to see the important systems on which four-wheel cars existed.

Mr. W. WORBY BEAUMONT said apparently the experiments with the heated tyres, referred to by the author, were made with some inconvenience, owing to the high temperature to which the tyres were subjected. He had made the necessary calculations to see what was the relation between the dilatation of the tyres and what they had been accustomed to use in other calculations in regard to expansion and contraction with rise and fall of temperature, and he found if they took the whole of the measurements and made the assumption that the temperature of the tyres before heating was 60°, and if they took the machine measurements, the experiments gave a co-efficient of dilatation—taking the first measurement, which he supposed was the most likely to be accurately made—of 3/64 in. of expansion at a temperature of 220°C. The co-efficient obtained from the author's figures agreed with that which others had made and those which he (Mr. Beaumont) had ascertained some years ago in connection with a similar subject. The same might be said approximately of the results obtained by examining the whole range of the author's experiments, viz., up to 600°C. There the co-efficient at the later stage came out larger, as one would expect. He noticed the smaller experiments were in themselves wrong or their temperatures were wrong. Was the author satisfied as to the accuracy of these? In one—the fourth—he mentioned 5/32 in. full. When dealing with 1/32 in., to speak of it as being "full" meant something more than the thickness of the finest line of his measurement apparatus. Taking those measurements by themselves one got a co-efficient which was at least ten times too much in one of the cases. Perhaps he might add, if the author had made use of the coefficient of dilatation known, it would have saved him all the trouble of making the experiments. With regard to the tyres which had been allowed to wear so differently that there was a difference of ¼ in. between two tyres on wheels running on one axle, that meant something like a whole mile of slipping in a 57-mile day, and one need not be surprised if there were a good deal of grinding of rails and flattening of wheels. Might he ask what the author meant by "satisfactory results" in regard to the differential axle? He supposed it meant that corrugation was less.

Mr. A. R. FEARNLY (Sheffield) said the tramway systems that had assisted Mr. Norton with facts had not hesitated to have the worst cases shown on the screen, with a view to guiding members in improving tramway working arrangements. Every care should be taken before a standard section of rail was decided upon. A good deal of the trouble shown on the screen was due to a bad section of rail put down 17 years ago, and they had a large quantity of it left, and were still working with the narrowest tread of tyre in the country. It would be years before they could get rid of it and get a reasonable section of tyre. Most of the rolling stock men insisted on turning up tyres before putting them into service, and probably that was the correct thing to do. He agreed with Mr. Norton in regard to gauges. He had not found it necessary to heat tyres to get them off. They could be sawn off quickly. They did not have studs in the tyres at Sheffield, and had not found them necessary. The points made in the Paper with regard to the maintenance of flanges were important. There were cars about the country with a considerable amount of side play. At Sheffield they insisted upon having 5,000 miles per ⅛ in. wear, and they obtained from those shown on the screen 7,000 to 8,000 miles. Mr. Norton turned his tyres at least once to obtain the same margin, so that turning up tyres did not seem to secure longer running. With the very hard tyres they obtained 6,156 miles, but they had anticipated at least 8,000.

Mr. W. E. IRELAND said he had found few tyres true enough to put on the road without turning. With regard to gauging, he agreed with most of the author's points. In the L.C.C. shop they used limit and check gauges for all the turning operations. He also agreed with the author in regard to shrinking. He had tried to keep the temperature down to 400, and frequently below 400, with marked results. Cooling with water was dropped some years ago. Unequal wear was experienced by most tramway operators. Two tyres from the same cast gave different results. A ½ in. difference in diameter was sometimes developed in a short time. Excessive boxing and rolling was usually stopped by turning up the tyres. Would the author explain the reference to the motors running against each other? They made experiments some time ago with the heating of tyres, with the following remarkable results:—

Treatment.	Tensile test.			Brinell hardness figure.	Abrasion test.*
	Tons per sq. in.	Reduction of area, %	Elongation on 2 in., %		Grammes removed.
None	55·35	18·4	12·0	192	2·14
Tyre heated to 1,500°F. dipped in oil 60 secs., then cooled in air	78·03	33·6	14·0	262	1·42

Mr. R. H. WILKINSON (Huddersfield) said he had fully expected that differential gears would give a substantial reduction in the wear of tyres and the consumption of electricity, although that was not the object of fitting them. There was practically no saving in the wear of tyres fitted with those gears compared with the ordinary type of car. It amounted to about 3,000 miles in the life of the tyre. It might be more pronounced if the cars were working on a route all double track, but the track on which they were working was nearly all single. With the differential gear the flanges all wore out in the same manner, and the diameter of the tyre remained practically the same throughout their life. He did not use studs, but he caulked the tyres on the inside. They had two cars without brake mechanism acting on the periphery of the wheel, and the life of the tyres on those cars was practically double the life of those on the other cars, and there was no sign of corrugation on the route on which they ran. But they had no serious trouble with corrugation in Huddersfield, so perhaps theirs was hardly a sufficient test.

Mr. NORTON said he would reply to the discussion in the "Journal."

Mr. A. V. MASON (South Metropolitan Electric Tramways) then read the following opening of the discussion on "Return Fares."

Return Fares.†

BY A. V. MASON.

The war has taught me many things—that women make excellent conductors, and that the average woman is quicker in taking fares than the average man; that passengers unconsciously connive at dishonesty apparently under the impression they save the girls trouble by saying "Don't worry about a ticket"; that half fares for children are popular and remunerative. Another is that a lot of time can be saved and accidents avoided by collecting fares on the platform; that return tickets are a convenience to passengers as well as to conductors, and that the same thing applies to weekly tickets. I am also of opinion that the odd halfpenny values on the 1½d., 2½d., and 3½d. tickets for single journeys can with advantage be discarded.

After the war receipts are bound to drop, but I rather think that expenses, certainly labour, will remain high. Where is the money to come from? The obvious remedy is to raise all fares to the statutory limits. This is all very well in theory, but is it expedient? I would curtail the 1d. fare to its statutory mile, divide this mile into four portions so that overlaps were frequent, and then issue single fares at the sums of the penny stages—no odd halfpenny values—and return journeys; cheap return tickets would be issued for all fares above the penny. Here automatically the odd halfpenny values would reappear in the 3d. and 5d. returns. I think that I

* Rate of travel, 1,200 ft. per minute. Total travel, 10,000 ft. Size of specimen, ½ in. by ½ in. by 1½ in.

† Abstract.

Digitized by Google

am correct in saying the penny fares are generally over 75 per cent. of all the fares taken, and in practice it will be found that the bulk of this traffic rides within the statutory limit of one mile, so that any suggestion of getting more out of the public must be fairly drastic. The 2d., 3d. and 4d. fares would be the sum of the penny fares, but these passengers could always take return tickets at greatly reduced charges, especially to joy riders: *e.g.*, a 2d. single would be 3d. return. By this means the passenger returning on the same day would get a reasonably cheap ride. There might be a little fraud, but this would not be important. The next objection is Method. The L.C.C. have featured the return fare in another direction on many lines, and their method of cancelling the ticket with a separate punch seems to get over most of the abuses.

I would give the workman the concessions provided for in the Act for the single journey with a further concession for the return journeys, and nothing more, on the basis of twice the number of stages as the ordinary passenger, and any one would get the facilities that got up early enough. We now pass on to the shop assistant and school marm, who should be provided for by cheap fares, and who can be dealt with by a weekly ticket—travel one way before 10 a.m. and home any time. The ticket is simple, but the punch register is destroyed unless clippers are used. I use clippers.

Mr. C. D. STANLEY said the fares ought to bear a definite relation to the cost of giving the facility, and it cost no more to carry a man at nine than at six o'clock. They should not give an advantage to any class. It caused a great deal of resentment on the part of other passengers.

Mr. H. ENGLAND said, in his opinion, the foundation of the Paper was wrong. Why should a man be allowed to pay lower fares because he got up early? In his opinion women did not make good conductors. They were excellent at the beginning, but were now 75 per cent. worse. He did not believe in half fares for children, nor in return tickets. It was the wrong spirit to experiment violently with fares. He did not agree that receipts would necessarily drop after the war. Where an increase was obtained it was generally maintained. Men earning £4 or £5 a week should not be carried at workmen's fares.

Mr. G. W. HOLFORD (Salford) said overlapping stages of 440 yds. each would lead to fraud on a fairly large scale. He hoped to make all fares on one basis. Salford and most towns in the north were shortening their stages, and had reached the limit allowed by Parliament. He did not think Mr. Mason would get satisfactory returns if he made the concessions he mentioned.

Mr. R. J. HOWLEY (B.E.T. Co.) said they knew expenses were going to be higher after the war, both in wages and materials. He thought the only industry that had not been able to meet the increased cost of operation by an increase in the sale price of the commodity had been tramways. It did not seem right that the limitations imposed in Acts of Parliament and Orders last century should remain for ever, and could not be varied when everything in the country was in a state of change. The Board of Trade should have the power to review the maximum charges. Negotiations to obtain that object were in hand.

Mr. E. H. EDWARDES then opened a discussion by reading a short paper on "Standardisation of Conditions of Labour and Rates of Pay." We give this Paper below in brief abstract.

Standardisation of Conditions of Labour and Rates of Pay.

BY E. H. EDWARDES.

You all realise that the great question we shall have to deal with after the war is that of labour. Labour long ago came to the conclusion that the best and most satisfactory method of dealing with conditions of labour and rates of pay is to become united. I think we may safely say that amalgamation amongst workers has come to stay, whether we like it or not. What we now have to consider is the best and most business-like method of dealing with the problem.

It must be admitted that the tramway industry throughout the country is most disjointed. What I should like to put before you is the possibility of forming a united tramway federation to deal with these complex problems. There is nothing original in the idea, as it is already in force in most great industries in the country, and I see no reason why it should not be accomplished in the tramway industry, which is becoming more and more important every year.

It must not be assumed that the proposal is that a standard rate of wages should be established for the whole country, but that the country should be divided into areas, and the rates of wages fixed in such areas in accordance with the cost of living, &c., in such localities. This is the system adopted by such trades as engineering, building, &c.

Do not imagine that, by forming a united tramway federation, the object in view is to quash or oppose the various unions of workers, but simply to treat with them on a uniform basis and in a business-like manner, in the same way in which they treat with us.

At the suggestion of the Committee on Production, such a federation is in course of formation, the authorities in question comprising Lancashire and Cheshire Municipal Tramways, and practically all the undertakings in that area, including the companies, have promised to join; and a sub-committee has already been appointed, of which I am a member, to formulate a scheme; and I feel confident that the great majority of tramway undertakings throughout the remainder of the country would be equally pleased to join a central federation should one be formed.

Mr. HOLFORD said he was jointly interested with Mr. Edwardes in the newly formed conference of the municipal tramway authorities and company authorities in Lancashire and Cheshire. It had been most successful up to date. It was in the interests of the undertakings and of the men that matters relating to conditions and rates of pay should be settled over areas, and not between one small authority and a small branch of the union. Perhaps they could not get a central organisation at present, but it could be done by counties. The system was in vogue in the engineering and other industries.

Mr. HAWLEY said it was within the scope of that association to deal with conditions of labour, but he was doubtful whether it was right for it to deal with questions of pay or arbitrations on wages. On the conditions of labour they and the Municipal Association might work together.

Mr. H. L. WHITE (Great Grimsby Tramways Co.) said it was desirable that there should be a close association between corporation and company concerns, but it would be difficult to bring their interests into line. The trade unions seemed apt to take advantage of the fact that municipal concerns had the rates to fall back on. Uniformity of holidays and overtime pay should be aimed at.

Mr. W. T. ROBSON (Southampton) said he did not think Mr. Edwardes suggested that any proposition as regarded standardised rates of pay should go forth from that meeting, but he hoped the matter might be considered by the Council.

Mr. EDWARDES said the questions of leave and pay were bound up together. If a man was given seven days' leave instead of three, or if more time was allowed for signing on, he was being paid more. He did not assume that wages throughout the country should be the same. What he proposed was done in other industries and could be done in theirs.

WOMEN DRIVERS.

Mr. ARCHIBALD ROBERTSON (Greenock & Port Glasgow Tramways Co.), in opening a discussion on this subject, said his system was one of the first to employ women drivers, because men could not be got. About 70 to 80 per cent. of the traffic was munition workers' traffic, so stoppage would have been disastrous. After four weeks' training, half a dozen women were put on the road as drivers early in 1916. They had now 80 per cent. of females on the running staff and 62 of the drivers were females. They were superior to the men procurable now. He did not claim, however, that women were as good in emergencies as well-trained men.

Mr. FRED COUTTS (Paisley District Trams Co.) said he started training 39 women as drivers, only 13 of whom qualified, and only one of whom was left. The trouble was, he thought, that the strain of the work caused racked sides, though there were some women who were not injuriously affected by the work. Observations made by him at various points in Glasgow showed that of the cars that passed, 8 per cent. were driven by women. That was nothing to make a great noise about. If 8 per cent. were obtained in two years, the war would have to last 20 years to get all the cars driven by women.

Mr. STANLEY said there was also a labour difficulty. A London manager told him his men would go out if he employed women drivers.

Mr. MASON was pleased to hear Mr. Robertson had been so successful. At present they could not have women drivers, although he thought the mechanism could be made with the leverage increased, so that it would only take 50 lb. to stop a car. If Scotland Yard would not allow C3 men to drive, they would have to consider employing women soon or shutting down.

Testing Rubber Gloves for Linesmen.—The rubber gloves used by linesmen for high tension work require constant supervision and testing. In the "Electrical World," Mr. C. W. Ward describes the method employed for testing their insulation at regular periods of a fortnight. The pair of gloves is fitted over copper conductors and each is filled with water. The stands are then immersed in water and a potential difference of 10,000 volts is applied between the exterior and interior of the gloves. As the gloves act as condensers a small but appreciable capacity current flows through, but at 11,000 volts this is only 17–37 milliamperes according to the frequency. The leakage current is, in general, extremely small, of the order of 0·25 milliampere only. If the gloves withstand the pressure for one minute they are considered safe. The water is then poured out and they are mounted on wooden stands and thoroughly dried, first with towels and then with an electric fan. After this, each pair of gloves is sealed up in an envelope before being issued to employees. These periodic tests are claimed to have reduced the number of defective gloves to an absolute minimum.

Digitized by Google

MICA AND COMMUTATION TROUBLES.

BY FREDERICK MURGATROYD, B.SC.TECH.

Although a complete list of causes of commutation troubles appears formidable enough, yet with machines which are not abnormal, experience shows that in the majority of cases these troubles are traceable to but one or two causes. For in machines possessing good electrical constants and in which, therefore, the conditions tend to foster good commutation, it is found that the source of trouble is nearly always the condition of the mica. In fact the experienced engineer in diagnosing commutation trouble, whatever the machine, will always pay primary attention to this factor. The difficulty of maintaining the mica perfectly flush with the copper segments has been recognised by all designers. A few manufacturers insist on using either best soft green Indian mica or Canadian silver amber mica, and they rightly regard recessing as an expedient to be adopted only in very special cases. Most manufacturers, however, use either white mica or preferably micanite.

White mica has a hard brittle nature, and is therefore rather obstinate to all but the most abrasive of brushes. Micanite, which is used to a very large extent, is of course heterogeneous. Its hardness is sometimes a varying quantity, and as the copper segments wear down, the " hard spots " in the micanite remain proud, causing bad commutation.

The troubles due to proud mica all arise from the brush not making intimate contact with the commutator. This either results in sparking or chattering. In the former case the brush gradually disintegrates and wears away quickly, and in the latter case the chattering tends to produce brush chipping, or grooving and flatting of the commutator. In all cases the heating of the brushes and commutator is generally increased, and where there is a tendency to pick up copper this is accelerated. In many cases of proud mica the contact surface of the brush becomes pitted with a large number of minute craters resembling pin-pricks, and in diagnosing commutation trouble the occurrence of this peculiarly pitted contact surface may nearly always be taken as evidence of proud mica.

There is no hard and fast rule regulating where to recess, but it may be taken as advisable in the following cases :—

(*a*) Where the use of a soft graphitic brush is required in order either to reduce the brush losses or to provide a brush possessing natural lubricating properties.

(*b*) On commutators having a high peripheral speed.

(*c*) Where the ratio of mica thickness to segment pitch is above 20 per cent.

(*d*) Where the mica is so hard that no brush suitable for the electrical conditions is capable of dealing with it.

It is essential that the utmost care be taken in the recessing of the mica. Time spent on this operation is well repaid in increased brush life and more perfect commutation. It must never be forgotten that a poorly recessed commutator produces equally as bad results as does proud mica itself. If possible a motor-driven cutter should be used, but for small machines a hand cutter is found quite as economical and produces good results. The hand cutter is made by fitting a piece of hack-saw blade into a suitable block of wood. The general practice is to recess to a depth of 1/32 in., and experience has shown that the best shape of groove to adopt is a square one. For if the groove is cut convergent, the mica will adhere to the side of the segments, and as the latter wear, sharp pieces of mica will project and cause very bad chipping. The mica should, therefore, be cut to leave the edges quite clean so as to allow a full 1/32 in. wear of the commutator before any pieces of mica can possibly project. The edges of the segments should then be filled slighty at an angle of 45° to the tangent, and finished off with a piece of agate or smooth steel. This latter precaution will prevent the occurrence of burrs on the edges of the segments.

If the recessing is well done the use of a commutator filler should not be necessary unless commutation is such that an external lubricant has to be applied to the commutator, and this, combined with carbon dust from the brushes, happens to fill up the slots and cause sparking or flash-overs. A commutator filler composed of Plaster-of-Paris and dextrine has been used successfully, and it is found that this is unaffected by oil. At peripheral speeds of 4,000 feet per minute or over the filler becomes unsatisfactory as, owing to the effect of centrifugal force, it becomes difficult to retain it in the slots. Also at high peripheral speeds such as obtain with continuous-current turbo-generators, the slots are automatically kept clean by the action of centrifugal force, and this obviates the necessity for a filler. If possible, the use of a filler should be avoided even at lower peripheral speeds, and should be found unnecessary, providing the mica is well recessed, that no oil is applied to the commutator, and especially providing the slots are brushed out occasionally.

The selection of a suitable type of brush is largely a question of the mica conditions. If the mica is not recessed it is generally advisable to use a hard brush having slightly abrasive properties in order to maintain the mica flush with the surface of the commutator. If the brush is not sufficiently abrasive to prevent the mica becoming proud, the commutator should be scoured periodically with carborundum cloth. In cases where there is any tendency to spark, to pit due to mica, or to crater due to circulating currents, an electro-graphitic type of brush should be chosen owing to the highly refractory nature of this class of brush. If the mica is recessed it is generally advisable to choose a non-abrasive graphitic brush, although in cases of blackening trouble the use of a brush possessing slightly abrasive properties often tends to promote clean running.

Finally, it must be remembered that, in general, recessing is adopted in order to increase the efficiency of contact between the brush and the commutator. Though this eliminates troubles due to bad contact, it correspondingly exaggerates troubles due to circulating currents. The latter may, however, be minimised by reducing the circumferential thickness of the brush, providing the current density is low enough to permit this. Otherwise a brush of high contact resistance would have to be chosen.

THE METRIC SYSTEM.

We have received from the Decimal Association a statement (part of which we reproduce below) controverting some reasons set forth by the American Institute of Weights and Measures against the metric system.

The American Institute of Weights and Measures has issued a statement giving reasons why metric weights and measures should not be mad ecompulsory. The fears expressed therein are groundless so far as the proposed metric legislation is concerned. The Bill of 1904 contained a clause limiting the operation of the Act to contracts of buying and selling only, but was sufficiently ambiguous to permit of misapprehension, thereby giving an opportunity for opponents of the Bill to raise opposition amongst the engineers.

The Chambers of Commerce Bill, recently drafted, contains a special clause which allows of no ambiguity. It provides that " nothing in this Act shall affect the manufacture or use of any machinery, tool, pattern, sieve, template, or other article made by measures other than metric measures."

If, therefore, the Bill were passed and the metric system were compulsory to-day, the engineer would not be affected in any way except in dealings based upon quantity prices. He could still make everything which he now makes and sell the product, although its dimensions were on the old measures. If, however, he quotes or supplies anything at a price per lb. or per foot, he would be in trouble. For instance, he could sell 1,000 ⅛ bolts 5 in. long at (say) 1 cent each, but he could not sell them at 7 cents per lb. Articles could be described in terms of the old measures but, where the payment is proportionate to their aggregate weight or length, the new measures must be used.

Reference is made in the American statement to the unchangeableness of standards, but standards are not so immutable, especially in the matter of literature on technical subjects. Even publications of a few years ago are now quite out of date, as the engineering industry, like others, advances so rapidly. Standards also are not so sacred as some opponents of the metric system would have us believe. The Engineering Standards Committee recognise this, and provide that each Sectional Committee should meet once a year to consider whether any revisions in the specifications are desirable.

If the metric system were made the only legal one for buying and selling in this country, as their machines, gauges, &c., wore out, most manufacturers would replace them by those made to metric measures, at little, if any, greater cost than would be incurred in purchasing apparatus made to the old measures.

The fact that a large number of well-known engineers are in favour of the metric system is sufficient proof that they consider any cost of changing machinery in their works, if necessary, well repaid by the increased ease in calculation, and consequent saving of time.

Digitized by Google

The Electrician.
FRIDAY, JULY 6th, 1917.
Editorial and Publishing Offices:—
8, BOUVERIE STREET, LONDON, E.C. 4.
Telephone: City 9853 (4 lines). Telegrams: "Benbrotric Fleet London."

SOME RECOMMENDATIONS OF THE RECONSTRUCTION COMMITTEE.

Last week there was issued an important Report of the Sub-committee of the Reconstruction Committee on the relations between employers and employed. This report has been sent to the leading employers' associations and trade unions for criticism, along with a covering letter from Sir D. J. SHACKLETON, in which attention is drawn to the fact that the Sub-committee is composed mainly of prominent representatives of employers' associations and trade unions. From the brief abstract of the proposals which we give elsewhere it will be seen that the key note of the Report is co-operation. Evidently the vital necessity that employers and employed should pull together after the war has been clearly appreciated. It is pointed out that, in order to secure improvement in the relations between employers and employed it is essential that any proposal should offer workpeople the means of obtaining improved conditions in employment and a higher standard of comfort generally. In order to secure these ends it is suggested that a number of joint standing industrial councils should be set up forming a triple organisation—*i.e.*, for dealing with questions from the standpoint of (1) workshops, (2) districts and (3) nationally. The Government is asked to propose, without delay, to the various associations of employers and employed, the formation of such councils in the several industries composed of representatives of employers and employed. It is suggested that there should be a chairman for each side of the council; a chairman and vice-chairman selected from the members of the council (one from each side); a chairman chosen by the council from independent persons outside the industry, or a chairman nominated by such person or authority as the council may determine, or, failing agreement, by the Government. Presumably, the same character of council is to be adopted in each part of the triple organisation to which we have referred. The committees for workshops would no doubt deal with such matters as are of direct interest to those working in the shops of any firm forming such a committee; the council for a district would decide matters on broader lines, as affecting the industry in the district, so that there would be reasonable uniformity; and, lastly, the national councils would decide on the broadest lines all questions affecting the industries of the country as a whole. The respective functions of these committees and councils are not laid down, but it is pointed out that care will be necessary to delimit accurately their functions in order to avoid overlapping and resulting friction.

It will be seen that these proposals are on the lines suggested by the Garton Foundation in their "Memorandum on the Industrial Situation After the War," to which we have referred from time to time. Suggestions in the same direction have been made by others, notably by Mr. E. J. P. BENN. The proposals now made are comprehensive, and it appears to us that some such scheme is the only one which will be at all practicable. It is noticeable that the Committee is in favour of trade organisations, and looks upon these as the only suitable means of arriving at definite results. Here again we think it will be allowed that a permanent settlement at any time can only be reached by such organisations if they are thoroughly representative. It is suggested, further, that the Government should offer to be represented in an advisory capacity at the preliminary meetings of any council if so desired; in other words, the Government will assist, but will not dictate—which is to the good.

Much interest attaches to the questions which it is suggested the national councils shall discuss. Among these are the restoration of trade union rules, the conditions under which work is carried on and the settlement of the general principles governing conditions of employment, having regard to the need for securing to the workpeople a share in the increased prosperity of the industry. There is also the consideration of matters affecting the progress and well-being of a trade, "so far as this is consistent with the general interest of the community." This last point may, to some extent, prove a stumbling block, as it is very difficult to convince all parties what is and what is not to the general interest of the community. The settlement of such questions will involve a certain amount of give and take, and probably necessitate some educational effort before the facts can be fully appreciated. Another item is the "provision of facilities for the full consideration and utilisation of inventions and improvements designed by workpeople, and for the adequate safeguarding of the rights of the designers of such improvements." Here we come to a subject of very considerable difficulty. It is often far from easy to say just what reward should be given to any person suggesting an improvement or how far the final result is due to this particular individual. The inventor very often feels that much more is due to him than really is the case, and this leads to difficulties. On the other hand, if it is felt that there is no reward to be gained by suggestions of this kind, much may be lost. We are inclined to think that such questions would often be decided most satisfactorily by a small "neutral" board in every works, which would act in the nature of an arbitrator, and decide what reward should be given.

Lastly, we notice that the Committee expresses the conviction that permanent improvement in the relations between employers and employed must be founded upon something other than a cash basis. In other words, the workpeople should have a greater say in the adjustment of any conditions by which they are affected. We agree with this view; but we also feel that the cash basis is necessarily the most important part, and from this standpoint it will be necessary for both sides of the various councils to appreciate what is practicable and what is impossible.

REVIEWS.

Some Modern Methods of Ventilation. With numerous Illustrations, Charts and Tables. By R. GRIERSON, A.M.I.Mech.E., &c. (London: Constable & Co.) Pp. xiv.+187. 8s. 6d. net.

Air Supply to Boiler Rooms of Modern Ships of War. By R. W. ALLEN. (Bedford: R. W. Allen.) Pp. 57.

The object of the first of these books, as explained in the author's "Foreword," is to supply information to "health authorities, architects, heating, sanitary and electrical engineers, metal plate workers and others called upon from time to time to deal with ventilating apparatus . . . . . intelligently to apply, and with greater efficiency than hitherto, the apparatus placed at their disposal by the various manufacturers."

The author proceeds to say that "the subject is a complex one, and because of its many intricacies cannot be fully dealt with," nor has any "attempt been made to deal exhaustively with the theoretical principles involved in the treatment of air, the design of fans, air washers, &c."

The author has had clearly in mind a very definite object when writing the book, viz., to help those who in practical life have to deal with the problem of ventilation. It

Digitized by Google

seems to be nobody's particular "job" to see that factories, works, public buildings and even dwelling houses are properly heated and ventilated—even if it were, the term "properly" would take some trouble to define. Hence it is that architects and engineers of all grades are faced with the problem in different aspects, and the object of this volume is to help on every possible occasion. This seems the author's sole intention and he has filled the bill extremely well.

The 15 chapters taken in order are:—I. The General Principles of Ventilation; II. The Apparatus Employed; III. The Considerations to be Observed in the Design of the Air Circuit; IV. Ducts and Registers; V. Fans; VI. Air Washing and Humidifying Plant (Filters); VII. Heaters; VIII. Ozone; IX. Instruments; X. Guarantees for Complete Installations; XI. Tests; XII. Motor Drives; XIII. Suggested Schedules for Designing Complete Installation; XIV. Purchase Specifications; XV. The Applications of Wet Air Filters to the Cooling of Electrical Machinery.

The contents give a very complete idea of the range and value of the work, and we can thoroughly recommend it as a sound, commonsense, practical treatise. Further, the author is dealing with a "Complex subject"—one in which diversity of opinion and treatment are outstanding features. The author is particularly fair in his review of all the systems, but does not hesitate to state the system he prefers. Thus, in the chapter on "Heaters," the author states that he is in favour of the "direct heating system" as against the "indirect" method and, moreover, he gives his reasons.

To the publishers, however, we suggest that such practical and valuable books as the one under review would be all the more valuable if edited by a scientific man. Thus, on page 13 under "Cooling by Mechanical Refrigeration," the author makes a peculiar slip, while supporting his view against the value of mechanical refrigeration for general cooling purposes and *compares* the "ton of refrigeration," which he gives as "318,080 B.Th.U. *against* 29,120,000 B.Th.U. contained in one ton of fuel." Not only is the comparison absurd, but no mention is made of "co-efficient of performance," which would indicate that a good refrigerating machine, under the conditions in the mind of the author (cooling high temperature rooms), would remove at least 5 B.Th.U.'s for every B.Th.U. expended. Thus the equivalent of a "ton of fuel" expended in the machine would result in (say) 150,000,000 B.Th.U.'s being removed from the high temperature air.

Then again, the book opens with a definition of ventilation—"Ventilation is defined as the art of passing a pre-determined volume of *conditioned* air into the space to be ventilated, and out of it again, and the proper distribution of the air during its passage through the ventilated space."

Why should the *conditioned* air be taken out again? A definition worth giving is worth giving properly, but the quibble just raised is not our real objection. The paragraph immediately following the definition states that—

"Ventilating systems are installed to:—

(*a*) Maintain certain predetermined standards of purity, temperature and humidity within the apartment to be ventilated;

(*b*) To remove from and prevent the formation therein of objectionable or insanitary odours."

The definition (quibble ignored) may be held to cover (*a*), but in no sense does it cover (*b*)—which in many cases is the one real problem.

There are many similar points throughout the book that careful editing would have removed—no doubt the editor would have reduced the cap. M and T after (*a*) and (*b*).

Apart from these small blemishes the book is of sound practical value.

The second volume before us is evidently the work of a scientific expert. It deals, in its fourteen chapters, with the main points in the theory of air currents and the application of this theory to design. Questions of the adoption of deflectors and the direction of rotation, together with the proper arrangement of fans, are also treated.

Yet when one reads it through and sees the well-reasoned reasons for this or that and changes that have been made in certain of H.M. ships, one wonders why the Admiralty does not leave all such work *to* an expert.

We say in the very best faith, that if any of our readers have to attack the problem—consult Mr. Allen.

To the Admiralty we would say make Mr. Allen your consulting expert.

J. WEMYSS ANDERSON.

Manufacturing Costs and Accounts. By A. HAMILTON CHURCH. (London: Hill Publishing Co.) Pp. viii. + 452. 21s. net.

The author of this very complete text-book on factory costs is an efficiency expert well-known in the United States of America, and the book sets out very clearly and concisely the theory and practice of manufacturing costing. Of the three sections into which the book is divided, the first gives a general outline of manufacturing accounts; the second section deals with cost accounting, and the third with factory reports and returns. Particulars of forms and schedules recommended by the author, suitable for the methods of accounting and costing which he describes, are given.

Three methods of costing are considered. These are: (*a*) all wages, material and expenses are merged and charged to unit quantity of product on a time basis; (*b*) productive wages charged to unit quantity—overhead expenses averaged and charged as a percentage on the productive wages, or on the productive hours; and (*c*) productive wages charged to unit quantity and overhead expenses charged by means of machine hour rates.

Detailed diagrams show the methods employed in each case.

Whilst the book is written chiefly for accountants, and deals with the cost accounting side of a factory, it contains much matter interesting for the works manager and foremen, and especially emphasises the value to the production department of immediate cost figures, so that investigations may be conducted whilst the circumstances are fresh in everyone's mind.

The difficulty with most cost systems is that the cost information is to hand too late for proper investigation to be made.

There are one or two omissions in the book, particularly the method of charting returns, for whilst tables of figures may be more intelligible than a chart to the accountant, the engineering management gets a better picture of what is happening by seeing the figures put into chart form.

Another omission which one would hardly expect in a book of American origin is that no mention is made of automatic tabulating machine methods which are much used in that country, and by which so many short cuts can be made in accounting.

Some of the tables in the first section of the book require careful auditing, as there appear to be a number of mis-prints and numerical errors. These make the argument difficult to follow in places.

Most British engineering works are weak in their stores system, which is too often run by badly-paid and badly-educated men, but Mr. Church discusses this matter very fully and sets forth a relatively simple system of stores control.

In organising a cost system, one has to consider how much it is going to cost to obtain costs, and in a country where relatively inexpensive (in first cost) and inaccurate cost systems are employed, we feel that most engineering employers making a varied product will be horrified to see the number of books and forms which Mr. Church considers should be kept to obtain accurate costs for each kind of product manufactured.

Mr. Church insists on the importance of giving to the foremen a daily return showing what money has been expended in his department the previous day, not only in productive labour but also in overhead expenses and also showing how much has been lost owing to machines standing idle. In the opinion of the reviewer this is a very good method and is directly opposed to the usual method of keeping the foreman in the dark, and not letting him know how his department expense is fluctuating.

Digitized by Google

NATIONAL PHYSICAL LABORATORY.

(*Concluded from page* 512.)

In what follows we give some extracts from the Report of the Director giving details of the work that has been carried on in the various departments and the work that is proposed for the year 1917-18 :—

PHYSICS DEPARTMENT.

I. ELECTRICITY.

Fundamental Units.

Most time has been spent in confidential work, especially wireless telegraphy and vacuum amplifiers and wireless transmitters.

Electrical Standards.—The standards of resistance have been compared from time to time and a few new Weston normal cells have been set up.

Magnetograph Records.—Disturbances due to the electrification of the London & South Western Railway have been excessive, and a number of 24 hours' records have been taken.

Compasses.—Help has been given to a large number of manufacturers of military pattern prismatic compasses, and a declinometer of the N.P.L. type has been erected at Woolwich. Assistance has also been given to R.E. Stores, Woolwich, in improving the methods of tests. Ships' compasses are also being investigated.

General Electric Measurements.

Self Inductances of Small Resistances.—By appropriate compensating arrangements low resistance shunts may be so designed as to reduce the residual self inductance to zero or even to a negative value. A good ordinary shunt of 0·001 ohm resistance might have a self-inductance of a few thousandths of a microhenry ; in general the time constants to be dealt with are of the order of 0 up to 10 microseconds. By mutual inductometer methods such small inductances for resistances with only two terminals can be measured, but for shunts with potential terminals (*i.e.*, four-terminal resistances) new and simple methods have been devised and tested. A description of them will be published shortly.

High Inductance.—A number of standard coils, of value in radiotelegraphic work, were constructed having self inductances of 0·5, 1 and 2·5 henries respectively. They show satisfactory constancy for ordinary variations of frequency.

Many-turn Transformers.—Various small transformers were built with many thousands of turns for use at telephonic frequencies.

Work has also been undertaken on measurement of telephonic frequencies, resistance boxes, wavemeter coils, high-frequency currents, magnet steel research, and high magnetisation.

Horse-shoe Magnets.—The testing of the horse-shoe magnets used in magnetos is a difficult matter, mainly because of the want of uniformity at various regions of the same magnet. The section is never uniform, as there are always relatively large holes through the limbs, and the magnetic hardness may vary from point to point. We have improved our method of testing by using (for H) two arched search coils lying as close as possible to the inner and outer surfaces of the magnet, excluding the portions pierced by the holes. In this way an average is obtained for the more uniform portion of the magnet beyond the holes.

II. ELECTROTECHNICS.

General Work, including Photometry.

Investigations in connection with the war included the development of apparatus for use in anti-aircraft gunnery, magnetos for aircraft—insulation for special purposes—wireless generator tests, radium luminous compound for gunsights and aircraft instrument dials. The work on radium luminous compound is now carried out for both Services, and over 10,000 luminous dials have been measured for luminosity. The method consists in placing the dial to be tested between two metal stencils cut out so as to be an exact replica of the luminous markings of the test dial. Behind the stencils is a translucent screen illuminated from behind by the light from a lamp passing through a suitably coloured green filter. The brightness of the screen is varied by adjusting the current through the lamp until the luminosity of the stencils matches that of the dial markings. The value of the current in the lamp is then a measure of the brightness of the dial markings. The markings of dials painted with compound containing 0·4 mg. of radium bromide per gramme of zinc sulphide must have a luminosity of not less than 0·0075 equivalent ft.-candles. The figure for the number of rejections has greatly improved since the testing was initiated.

Many samples of radium compound have been kept under observation, and the rate of decay of luminosity has been determined over a period of about 15 months. For any given sample the luminosity curve will become asymptotic with time. Whatever the initial radium content (above about 0·1 mg. per gramme) the final limiting luminosity, assuming the same zinc sulphide, is virtually the same for all samples. The rate of luminosity decay during the first few months of the life of the 0·4 mg. compound is between 4 and 5 per cent. per week, and in six months the luminosity is down to half its initial value. When articles are liable to lie in store for several months it is obviously useless to employ a high radium content. A great saving of money and no sacrifice of efficiency result from the adoption of the lower standard (*e.g.*, 0·2 mg.).

The National Physical Laboratory luminosity standard for 0·4 mg. luminous compound is 0·03 equivalent ft.-candles—*viz.*, four times that of the compound when mixed with varnish. The limiting value for all compounds containing 0·2 mg. of radium bromide per gramme of zinc sulphide is of the order of 0·01 equivalent ft.-candles.

Continuous Current and Resistance Measurements.

A number of special investigations of the qualities of insulating material, dry cells, &c., have been carried out for the Admiralty and the Munitions Inventions Department.

Buried Cables Research.—The Committee of the Privy Council for Scientific and Industrial Research has made a grant towards the cost of carrying this investigation. The County of London Supply Co. generously undertook the drawing in and jointing of the large (0·5 sq. in. concentric) cable, one of the three lengths which they lent for the purpose of the tests, and by the staff of the Laboratory dealing with the jointing and laying of the other cables.

The experimental cables laid are as follows: All paper-insulated cables:

(*a*) Armoured cable laid direct in the ground, 0·1 sq. in. concentric, 0·2 sq. in. concentric.

(*b*) Cables laid solid in bitumen, plain lead-sheathed, in one trough, two 0·1 sq. in. single cables, and two 0·1 sq. in. concentric cables ; and in another trough, one 0·2 sq. in. single cable, and one 0·2 sq. in. concentric cable.

(*c*) Cables drawn into a six-way stoneware duct, 0·5 sq. in. concentric, 0·2 sq. in. concentric, 0·1 sq. in. concentric (two lengths).

The latter cables were lent by the County of London Electricity Supply Co. for the purpose of the investigation, and there are also five lengths of three-conductor cable lent by the Newcastle-upon Tyne Electric Supply Co.

While the construction of the concrete block ends and the covering huts and the laying of the six-way duct were in progress, heating curves were obtained for all the cables when laid out along the floor of the room, the thermal constants of the insulating and covering materials determined the conductors examined for conductivity and samples of the insulating paper examined microscopically.

Considering the different types of cable, the results are in very fair agreement with those previously obtained in connection with the Wiring Rules Tables.

Other points dealt with in these tests were the extent to which the temperature rise was affected when the lead sheath was painted with black and white paint, and the determination of the temperature coefficient of the lead sheath.

The experimental cables are now, with the exception of the three-core, all laid and connected, the installation of apparatus, &c., in the huts is complete, and regular observations are in progress.

The tests, pending satsifactory arrangements for the supply of continuouscurrent, are being made with alternating current at 55 cycles, the measurements of conductor resistance being made by superimposing a small continuous current (about 20 amperes) supplied by three portable accumulators connected in parallel, which can be put into series with the secondary of the transformer and the cable under test by means of suitable switching arrangements. The instruments respond to the continuous current only, the vibration due to the alternating current being slight, while the accumulators are apparently unaffected by the large alternating current which is passed through them.

The galvanometers are set on the concrete floor of the hut, the light spots being brought up by means of mirrors to scales placed at a convenient height above the table on which stand the resistance bridges and distributing keys.

Corrosion of the Lead Covering of Conductors.—At the request of a Subcommittee of the Institution of Electrical Engineers, a report was drawn up dealing with the question of corrosion of the lead sheathing of cables used for internal wiring. The sub-committee desire that an investigation shall be commenced to determine, if possible, the extent of any such corrosion under normal conditions of cable-laying in various materials, such as plaster wet and dry, attention being given to the questions of bonding and earthing with suitable materials.

III. HEAT.

High Temperature and General Work.

High Temperature Scale.—An investigation connected with the high temperature scale has been proceeding.

Two optical pyrometers of the polarising type were purchased from the Cambridge Scientific Instrument Co., and were calibrated to a temperature of 1,600°C. by comparison with standard thermocouples. A new platinum 10 per cent. rhodium-platinum thermocouple was standardised up to a temperature of 1,550°C., its E.M.F. being determined at the boiling points of water, naphthalene, diphenylamine and sulphur, and the freezing points of tin, zinc, antimony, silver, gold, copper, nickel and palladium.

Very considerable difficulty was experienced in getting satisfactory determinations at the nickel and palladium points (1,452°C. and 1,549°C. respectively).

A satisfactory freezing point was eventually obtained by melting the nickel in a refractory fireclay crucible placed in a furnace without any liner tube, the surface of the metal being protected by a thin layer of fused borax.

In the case of palladium, the question of expense precluded the possibility of taking cooling curves, so that resort was had to the "wire method." The two arms of the thermocouple were connected by a short piece of palladium wire. The couple was fixed in the centre of a porcelain tube which was inserted into a carbon spiral or carbon tube furnace. The temperature of the furnace was raised gradually and the E.M.F. of the couple observed until the melting of the palladium wire broke the circuit.

Digitized by Google

After the observations had been completed on the thermocouple, its temperature scale was computed. The curve connecting E.M.F. and temperature was found to be approximately a cubic up to 1,000°C., and above that a parabola. It is generally accepted that, in the case of platinum alloy thermocouples, the curve is of the nature of a parabola or a cubic.

Series of observations were made by sighting the optical pyrometers on a "black body" furnace, the temperature of which was given by the couple. Temperatures up to 1,600°C. were dealt with.

Observations were made on five separate furnaces—a carbon tube and a carbon spiral furnace, and, for temperatures below 1,350°C., three platinum wound furnaces. The results obtained from all the furnaces agreed within the limits of error and from them the temperature scales of the pyrometers were calculated.

Some experiments were subsequently made to confirm the scales by direct observations of melting points under "black body" conditions.

Total Radiation Pyrometers.—In connection with the work of the maintenance and verification of the laboratory standards, a large number of observations have been made with the three standard "total radiation" pyrometers.

The comparisons were made under "black body" conditions with a standard platinum—platinum, 10 per cent. rhodium thermoelement, employing a 4 in. aperture furnace fitted with diaphragms. The highest temperature to which the comparisons were taken was about 1,300°C. For work at still higher temperatures (up to 1,600°C.) it is proposed to employ a gas fired furnace with a refractory lining of carborundum; this is now under construction.

Other matters dealt with include thermal conductivity of materials used for cold storage work (slag wool, granulated cork and slab cork), thermal conductivity of and thermo-physical tests on refractory materials, *e.g.*, the softening point under load of refractory bricks.

A special type of carbon tube furnace has been constructed capable of temperatures exceeding 2,000°C. Temperatures are measured by means of the polarising type of optical pyrometer. Methods of testing physical properties of refractory materials are at present being developed.

Thermometer Testing.

The "precision" thermometers tested number 461, of which 263 are high-range instruments. The "Kew" class or meteorological thermometers tested during the year number 3,164, a decrease of 300 on last year's figures. The total number of clinical thermometers received is 24,272 as compared with 16,137 for last year, the largest number dealt with in any one year since the testing of clinical thermometers was transferred from Kew to Teddington.

IV. METROLOGY.

There has been a considerable growth of the work of gauge testing undertaken in the summer of 1915 at the request of the Ministry of Munitions.

Difficulties encountered in connection with screw gauge work during the war have led to the re-construction of the various Screw Gauge Committees of the Engineering Standards Committee, which, under the chairmanship of Col. R. E. Crompton, R.E., C.B., replacing the late Sir Frederick Donaldson, are now taking up the re-consideration of questions of tolerance and thread form. A good deal of experimental work may be required in this connection in the coming year.

A number of the new standard hydrometers acquired last year have been calibrated, and the division has been asked on several occasions to assist glass makers in the production of graduated glass-ware.

The testing of taximeters, and also of watches and chronometers, remains much at the same level as last year. During the year 340 watches and 118 marine chronometers have been entered for trial, as compared with 379 and 84 entries respectively in 1915-16.

The following figures show the percentage number of watches obtaining the distinction "especially good" as compared with the total number obtaining Class A certificates :—

Year	1906.	1907.	1908.	1909.	1910.	1911.	1912.
	47·5 ...	43·0 ...	56·8 ...	54·7 ...	37·7 ...	44·9 ...	47·8

Year	1913-14.	1914-15.	1915-16.	1916-17.
	67·8 ...	70·7 ...	58·4 ...	71·2

Marine Chronometers.—There has been a very steady demand for these trials throughout the year, and the total received has arisen to 118, as compared with 84 last year. Of these 86 obtained certificates and 32 failed to pass, the percentage of failures (27 per cent.) being slightly above the average.

V. OPTICS.

The tables of the numbers of binoculars and telescopes tested again show a considerable increase, and the same applies to the determination of the refractive and dispersive properties of glass. Improvements have been effected in the apparatus employed in obtaining a bright hydrogen spectrum, and the tests have continued to be made on a Pulfrich refractometer. Quite recently, however, a strongly supported request for measuring all dispersions to an accuracy which will make the ratios of the partial dispersions reliable in the third decimal place has been put forward. A special instrument which will give these ratios to the desired accuracy and a new spectrometer for this work are under consideration.

Another question which has received considerable attention in the same connection is the measurement of lens curvatures, and data on small telescope objectives have been obtained.

Other experimental investigations relate to the compensation of the chromatic aberration of the eye to enable measurements of certain kinds to be made with increased accuracy and to signalling apparatus.

The Division has continued as in previous years to draw up specifications for optical instruments required by the Admiralty and to advise Government Departments and private firms in optical matters.

A comprehensive scheme for researches into optical instruments at the Laboratory in connection with the optical manufacturers of the country has been drawn up and discussed with representatives of the trade.

VI. RADIUM AND X-RAY WORK.

Radium Testing.—The number of samples tested during the year is 31, their approximate total value being £8,000. The decrease in the amount submitted for examination is to be expected as under present conditions institutions are not generally in a position to make large purchases of radium salts for medical work.

Radium Luminous Compounds.—In addition to the samples of radium salts of high concentration referred to above, 11 samples of radium luminous compound have been examined for radium content. In connection with this work an extensive series of tests on the absorption of gamma rays in zinc sulphide has been made.

ENGINEERING DEPARTMENT.

RESEARCH WORK. A. GENERAL INVESTIGATIONS.

The Methods of Notched Bar Impact Testing.—Although the Charpy form of test specimen was standardised by the International Association for Testing Materials in 1909, the form of notch recommended has not been on the whole favourably received. In several testing laboratories is has become the custom, while preserving the external dimensions and span of the specimen, to use a rounded Vee notch instead of a Charpy notch, and thus double the amount of work absorbed in fracture. In view of these considerations it was decided in July, 1916, that an extensive series of tests should be undertaken at the Laboratory in order to determine the best form of notch to standardise, having regard to :—

1. The form giving the most definite indication of brittleness.
2. The relative consistency of results obtained from specimens of the same size and material.
3. The relative cost of production of the specimens.

The first report on the tests was communicated to the Panel Committee on December 13, 1916. The forms of notch dealt with in this report were :—

1. The International Charpy Notch.
2. The 90 deg. Sharp Vee Notch.
3. The 90 deg. Rounded Vee Notch.

The materials used for the construction of the specimens were a mild steel of 0·19 per cent. carbon content and a hard steel of 0·654 per cent. carbon content.

The results of the tests on the mild steel showed that a satisfactory degree of uniformity could be relied upon from all three types of notch, and further that the work absorbed in fracture was not appreciably affected by the sharpness of the notch.

In the tests of the hard steel, on the other hand, the uniformity of the test results was much less satisfactory, and a further series of tests was accordingly undertaken on a large number of specimens prepared from carefully heat-treated material. It is proposed to compare the results obtained from them in the Laboratory testing machines with those given by other testing machines in the country.

Hardness Tests Research.—A large number of tests were carried out during the year on the sliding abrasion testing machine described in last year's report. The principal points dealt with were :—

(*a*) A comparison between the effect of dry rolling abrasion and dry sliding abrasion.

(*b*) Ratio of the Brinell hardness number to the Shore Scleroscope number.

(*c*) Relation between resistance to sliding abrasion and the Brinell hardness number.

The general results of the research showed clearly that with a miscellaneous collection of steels the Brinell hardness number was not a safe guide to their relative resistances to wear.

The research is being continued with the object of investigating the effect on the wear of the specimen of variations in velocity of sliding and the pressure on the surfaces.

Experiments were also conducted on the fatigue resistance of materials under combined stresses, and on the effect of surface roughness on the heat transmitted from hot bodies. It is anticipated that the latter experiments, when complete, will demonstrate that for the degree of roughness of the pipe used the Reynolds' theory can be applied for all practical purposes.

In the section on Aeronautics the work has been mainly in the direction of further experiments on airship models, and on models of wings, suspensions, &c. Tests have also been made of stability of kites and kite balloons, and on the effect of varying the design of propellers. There have also been special supplementary investigations on full size machines.

Other matters dealt with include the measurement of the rate of growth of cracks in buildings, tests of timber sleepers and varied researches on such questions as annealing, quenching and tempering, optical glass and special alloys in the metallurgical department. The latter have included experiments on aluminium alloys undertaken for the Advisory Committee on Aeronautics and the various Admiralty and Army authorities. Additional electric furnaces of a new carbon resistance type have been added, and the existing foundry space has been approximately doubled.

Most of the work on the Froude National Tank has been of a confidential nature, but there have also been a number of tests for the mercantile marine. On the other hand, purely research work has been necessarily deferred until the termination of the war.

Digitized by Google

THE INSULATOR SITUATION.*

BY W. D. PEASLEE.

Summary.—This Paper gives a résumé of the insulator situation as it exists at the present time, and shows the gradual increase in requirements that have been held essential to a successful insulator. A statement of the apparent causes of the very rapid deterioration of insulators, even when stored and subject to no electric stress, is given, and the conditions necessary to the production of an insulator that will reduce this deterioration cost are discussed.

The insulator situation has for the last few years engaged the earnest thought of all engineers directly or indirectly responsible for the operation and maintenance of high-voltage transmission lines. It has been assumed that :—

1. The insulator must not flash-over at operating voltage even when dirty and wet.

2. The insulator should flash-over on excess voltage at normal frequency and not puncture.

3. Sufficient surface leakage distance should be provided to prevent excessive leakage current. (To prevent burning of wood poles and pins.)

4. It should be mechanically strong enough for the load imposed upon it.

Insulators by the car load have been made that meet fully those requirements, as far as normal frequency voltages are concerned—that is, those that do not fail under factory test do. These new insulators, designed according to the best then existing engineering knowledge, were placed on our transmission lines and the insulator manufacturers began the study of making more and cheaper insulators, while the engineers operating the lines began to get interested in other things, when the insulator situation again became of prime moment.

It was found that after about two or three years in service these insulators were failing at a rate of from 10 per cent. to 40 per cent. per year, apparently without logical regard to location or severity of service, climatic or electrical. Many very valuable and brilliant methods for detecting insulators about to fail were developed, and the best that was hoped for was a chance to take them off when convenient before they went out at an inopportune time.

About this time a rather startling fact was discovered by several investigators almost simultaneously. If a certain lot of insulators, having passed successfully factory routine tests, are placed in a warehouse for a couple of years, a large per cent. of them will fail at the end of that time on tests less severe than they passed to escape from the factory junk pile.

Not satisfied with the generally accepted theories in explanation of these failures the author began in 1914 an extended research into this field, which finally led to the use of the microscope in an endeavour to ascertain, if possible, the mechanism of the failure of porcelain insulators.

From a study of the insulator troubles of several systems for the past three years, and from a microscopical analysis (using polarised light and crossed nicols) of several hundred insulators whose records were known, the following points regarding the deterioration of the porcelain insulator seem to be pretty well established :—

1. Perfectly good insulators that will pass all sorts of tests right after manufacture deteriorate at an alarming rate even when not in use. I have personally known of insulators stored in a warehouse, all of which have passed test on an oscillator, and also 60-cycle flash-over. Two years later 14 per cent. of these insulators failed under 60-cycle flash-over. That is, they punctured at a voltage under the flash-over voltage.

2. It is very apparent that something takes place, inside the cap in a suspension unit, and between the shells in a pin-type unit, that causes this deterioration when not in service, though it is not impossible that the electric tests have some part in starting or causing some of this deterioration.

3. There seems also to be grounds for suspecting that in some manner certain insulators deteriorate at a rather rapid rate due to dielectric stresses combining with other stresses in such a manner as to materially hasten the failure of the insulator.

The results of the investigations seem to show that four factors are of predominant importance in this connection.

1. Mechanical stresses due to temperature changes necessarily resulting from the different coefficients of cubical expansion of the metal, cement and porcelain ; mechanical stresses due to the expansion of moisture in the cement on freezing and the changes in volume of cement with different moisture contents ; and mechanical stresses due to improper firing and cooling of the porcelain.

2. Dielectric flux concentrations due to improper design of insulator shapes and defects in the porcelain. This can be remedied, but its general effect is, as has been shown, to permit the stressing of the porcelain to very high values by means of transients, which, like the poor, are always with us.

3. Dielectric flux concentration due to the fact that the porcelain is inevitably made of two or more materials of widely different physical properties, one isotropic and the others anisotropic in character. The dielectric constant or specific inductive capacity of an anisotropic medium is not the same in all directions, but varies according to the angle between the principal optic axis and the direction of the electric force. With the random alignment of the anisotropic crystals in a porcelain body, relatively large, minutely local flux concentrations result. While partially fluid in the process of firing, most insulator shapes develop flow lines wherein the crystals, anisotropic in nature, align themselves in such a manner that the permittivity of the dielectric along these flow lines is considerably greater than in other portions, resulting in definite flux concentrations along these flow lines.

4. Mechanical stresses due to the differences in coefficients of expansion of the constituents of the porcelain acting to establish a separation surface between the crystals.

Considering the cement, the volume changes of Portland cement under change of moisture content are well known, and examination of the cement in 218 insulators whose history was well known has shown the following facts :—

All but 15 of the insulators that had failed electrically (207) had cement whose absorption, after two hours' baking at 120°C. and four hours boiling in water, was over 12 per cent., and in some failing quickly the absorption ran up to 46 per cent. Of those which had failed mechanically or were still good (11) only one had cement whose absorption ran over 6 per cent.

It can readily be seen that absorptive of such amounts of water the cement in such insulators must expand and contract viciously under temperature and humidity changes. Investigations are at present under way using various water-proofing compounds and different mixtures of cement to find the mixture that with a permissible strength sacrifice will give the lowest absorption.

The porcelain from which insulators are made consists in the main of partially dissolved crystals of silica (SiO_2) in a ground mass of feldspar glass and crystals of sillimanite of a size depending upon the heat treatment of the porcelain. It has been found by some investigators that it is entirely possible and easy to determine within ± 25°C. the temperature at which a porcelain has been fired by the examination of a thin section under the microscope.

Microscopic examination of a great many samples has shown that the flow lines mentioned are mechanically weak and have a great tendency to develop minute cracks, apparently during cooling. These cracks are often lined or filled with crystals of sillimanite (Al_2SiO_5), which are anisotropic and more or less in alignment. The combination of such cracks and the above-mentioned flux concentrations along flow lines is a source of further weakness in the porcelain insulator.

If the four factors last mentioned are the predominant ones in causing insulator depreciations we can, of course, lay out the requirements of an insulator that will avoid them.

1. A cement must be developed that will be elastic enough to take up the necessary changes due to expansion and contraction of the insulator parts under temperature changes. Condensite and other compounds have been tried in this, but, so far as the writer knows, no positive results have been obtained that are as yet of commercial value.

2. Improve the design of the insulator to avoid flux concentrations and the placing of dielectric of different permittivities in series and improve the workmanship to avoid defects.

3. Make the insulator from an amorphorous, non-crystalline substance, containing only one constituent, or only those of the same electrical and temperature characteristics.

Certain of the compounds that have been experimented on give promise of some success as a cement of the character described, and fused quartz except for inherent difficulties in working is ideal as an insulator material.

The temperature coefficient of expansion of fused quartz is about 0·00000059, or about one-fifth that of porcelain. Its dielectric strength is very high and its mechanical strength and elasticity are

* Abstract of a Paper read before the American Institute of Electrical Engineers.

Digitized by Google

all that could be asked. It withstands indefinitely the action of high-frequency voltages such as those from the Poulsen arc, and is to the action of the elements the most resistant material known.

Due to its low temperature coefficient of expansion an incandescent piece of fused quartz can be dropped into a pail of water without effect, except an apparent improvement in elasticity. This is a valuable property when it comes to running it into chilled moulds.

The drawback is that it has a tendency to evaporate before flowing enough to mould and on fusing to explode and form a milky substance full of tiny air holes and useless as an insulator, and is also chemically very active at extremely high temperatures. Means of overcoming this have been found, and until the microscope slides of the product were examined it was thought a perfect product had been secured, as the tiny carbon particles and bubbles are not visible to the unaided eye; merely giving the quartz a blue colour. Means have been found to overcome even these defects, and on a laboratory scale the manufacture of fused quartz as an insulator material is assured. The problem now engaging our attention is the production of this material in commercial sizes at a cost that will not be prohibitive.

CONCLUSION.

A study of the growing mass of data on insulator deterioration forces upon our attention the following insulator situation :—

1. The porcelain insulator as commercially available to-day is not a success; it is deteriorating too rapidly both in and out of use, and the gathered evidence points to certain inherent features of manufacture and composition that are responsible in large part for this unreasonable deterioration.

2. The design features may be overcome by a correct appreciation of the mechanism of breakdown and the application of correct principles of dielectric flux distribution.

3. It has been found possible to make and manufacture fused quartz on a laboratory scale, and indications are that it can be done on a commercial scale for a permissible price, and it is hoped that the development of this and other studies now being made by many engineers may lead to a lessening of the enormous cost of the present insulator depreciation encountered by the operating companies.

The investigations herein mentioned have been made in the high-voltage laboratory of the Oregon Agricultural College and recognition is hereby expressed of the aid of Mr. A. Strieff, assistant instructor, and Mr. J. A. Hooper, a member of this year's senior class, both of whom rendered invaluable assistance in the many tests necessary to such an investigation.

TAR OIL FUEL FOR DIESEL ENGINES.

From a Paper on this subject, read by Mr. Geoffrey Porter before the Diesel Engine Users' Association on May 24th, we extract the following interesting figures, showing the oil consumption and financial results obtained by using tar oils with a certain proportion of petroleum oil.

From a Diesel engine (fitted with pilot jet ignition gear), for which Mr. Porter is responsible, the following results were obtained from September, 1916, to the end of April, 1917 :—

Hours running	2,671
Average load	58·5% of full load
Weight of oil fuel per kw.-hour (tar oil and residual petroleum oil)	0·826 lb.
Petroleum oil as per cent. of tar oil	14·9% by weight
Estimated saving by comparison, equivalent cost of petroleum oil	0·494d. per kw.-hr. (in cash, £372. 7s. 9d.)

The figures given in the two following tables relate to a pair of exactly similar engines (under Mr. Porter's control), the one burning residual petroleum oil, the other tar oil with a pilot ignition jet.

The thermal results are a little curious, as higher efficiencies are obtained with the lower grade oil—*i.e.*, the oil of the lower calorific value. I assume that the result has its origin in the fact that the residual petroleum oil we are now obtaining has a lower heating value than the oil obtained before the war broke out. This has been suspected by many engineers during recent months owing to the fuel consumption of their engines being consistently higher than was formerly the case. Members will agree that under present circumstances we are only too glad to get oil at all, and are willing to sacrifice heat units to the power to "carry on."

These figures are not the results of trials, but are taken from the daily records, and are put forward as an example to indicate approximately the limits within which results may be expected to lie. They actually point to the fact that the tar oil plus pilot jet engine

Table I.—*Fuel Oil, Residual Petroleum.*

	Running plant load factor.	B.T.U.s per kw.-hour.	Overall thermal efficiency.	Cost of fuel, pence per kw.-hour.
1	32·1%	15,650	21·7	0·931d.
2	47·1%	15,480	21·8	0·981d.
3	61·2%	13,370	24·1	0·836d.

Table II.—*Fuel Oil, Tar Oil with Pilot Jet Ignition, 10·3% at Full Load.*

1	36·3%	15,005	22·6	0·458d.
2	47·2%	13,229	25·79	0·399d.
3	49·5%	15,205	24·23	0·410d.
4	62·4%	12,615	28·9	0·399d.

is better than the petroleum oil engine, not only in cost of working, but in efficiency also, the latter being a result one would not anticipate.

This Paper will not be complete without a few figures giving the reductions in fuel cost in power stations whose engineers have been good enough to send me the information :—

(1) Engines using pilot jet ignition gear :—
- (*a*) Reduction of fuel cost ..... £12. 10s. per week.
- (*b*) „ „ ..... 0·35d. per kw.-hour.
- (*c*) „ „ ..... 0·494d. per kw.-hour.

(2) Engines burning tar oil without pilot jet gear :—
- (*d*) Reduction of fuel cost ..... 0·26d. per kw.-hour.
- (*e*) „ „ ..... 0·400d. per kw.-hour.

Owing to varying rates paid in different localities for tar oil and residual petroleum oil, the above figures are not strictly comparative. All of them, however, show large reductions in fuel cost, and are, to those who have taken up this fuel question seriously, distinctly gratifying.

LEGAL INTELLIGENCE.

J. Mears v. Weston & Sons.

Recently Mr. Muir Mackenzie, Official Referee, heard this action, in which plaintiff (proprietor of the Richmond Cinematograph Theatre claimed from defendants damages for breach of contract.

Mr. C. J. CONWAY (for plaintiff) said that defendants offered (in a letter dated Oct. 1, 1914) to install an electric light and power system for plaintiff at his theatre. The contract included the supply of two motor generators, wiring, switches, main switchboards, plain pendants and water-tight fittings, half-watt lanterns and brackets and all lamps and dimmers. The whole was to be supplied for £473. On Oct. 9, 1914, plaintiff orally accepted the offer subject to the price being reduced by 5 per cent. It was a term of the contract that defendants should use throughout heavy gauge screwed conduits, enamelled inside and out, of ample size to enable the cable to be drawn in and out after erection, &c.; also that there should be no joints whatever in the wiring and that the whole of the work should be carried out in accordance with the wiring rules of the Institution of Electrical Engineers, the fire insurance company concerned, and the supply authorities, of the Secretary of State under the Cinematograph Act and of the Surrey County Council. The whole of the work was to be guaranteed by defendants for 12 months from the date of the certificate of completion. The breach of contract complained of was that defendants did not use heavy gauge screwed steel conduits of sufficient size to enable the cables to be drawn in and out after erection and that they did not lay the conduits so that the condensed moisture could be successfully drained off. It was also alleged that the wiring was not without joints and that the work generally was not carried out in accordance with the terms of the contract. It was alleged that the installation was not efficient, that it was not maintained for 12 months in accordance with defendants' guarantee and that plaintiff had suffered damage to the extent of £109. 19s. 6d. From time to time plaintiff paid to defendants sums of money on account for work performed under the contract, and for extras amounting in all to £785. 15s., the final payments being made on Sept. 6, 1915, and Jan. 23, 1916, under a mistaken impression that the amounts paid were due, whereas £23. 13s. was overpaid, as deduction had not been made of 5 per cent. discount on £473.

Defendants denied that the contract price was to be reduced by the allowance of discount and they also denied the allegations as to defective work. Plaintiff agreed to appoint an architect to supervise the work and grant certificates showing, amongst other things, the completion thereof, but that he did not do. They completed the work in accordance with the terms of the contract on Dec. 24, 1914, and subsequently carried out their 12 months' guarantee. By not appointing an architect plaintiff had himself committed a breach of contract and was, therefore, precluded from requiring that the date of completion should be fixed by "the date of the last certificate of completion," as specified in the contract. Defendants further denied that there had been any breach of warranty or that there had been any mistake as to the non-deduction of discount by plaintiff when the final payment was made.

Digitized by Google

Mr. T. L. LINTON, manager for plaintiff, said that after the opening of the theatre for a short time the electric lighting was satisfactory, but early in the year complaints were made that some lights were going wrong.

Mr. J. E. EDGCOMBE, Kingston Borough electrical engineer, said that he made a thorough examination of the installation at the theatre and found that while the materials used were quite good the installation itself was defective. The method of using the materials had not, in his opinion, been in accordance with the specification. Mr. Dewhurst was called in to remedy the defects which cost £109. 19s. 6d.

Mr. DEWHURST gave evidence as to the details of the work he had done.

Several witnesses were called for the defence to prove that the work had been properly done, that the complaints as to defects were without foundation and that if any alleged defects did exist they were due to the dampness of the building.

Counsel for the defence argued that the onus was upon plaintiff to to show want of skill and that had not been done.

In delivering his reserved judgment, Mr. Muir Mackenzie went over the facts of the case, and found that plaintiff had failed to establish his case. Accordingly he gave judgment for defendants.

Veithardt & Hall v. Rylands Bros.

This case came before the Court of Appeal last week upon the appeal of defendants from a judgment of Mr. Justice Younger. The question in the case was whether a contract for the supply of steel rods from Germany by plaintiffs to defendants by instalments had come to an end by reason of the war, as contended by the plaintiffs, or was merely suspended until the termination of hostilities. Mr. Justice Younger held that, although the contract contained provisions with regard to war, strikes, lock-outs, &c., it contained no limit, and was not intended to cover, circumstances which made the contract illegal, and that the provision to entrust the obligation to other works in Germany precluded any such idea as that war between Great Britain and Germany could have been contemplated. Accordingly he held that on the outbreak of war between Great Britain and Germany the further performance of the contract became illegal on the part of plaintiffs, and no claim for damages for failure to deliver the remaining instalments could be established. He made a declaration that plaintiffs were under no obligation to defendants under the contract, and that the controller of plaintiffs was at liberty to distribute the assets without any regard to the claim of defendants. He also ordered defendants to pay plaintiffs' costs, the Board of Trade's costs to come out of the assets of the controlled company. From this decision defendants now appealed.

At the conclusion of the arguments their Lordships dismissed the appeal with costs.

Osram Lamp Works (Ltd.) v. Pope's Electric Lamp Co.

The hearing of this appeal by the House of Lords has been adjourned until Monday. Already the case has occupied 11 days, and Mr. A. J. Walter, K.C., has to reply on behalf of the appellants.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

4,937 NATIONAL SAFETY APPLIANCE CO. Automatic block signal systems for railways (30/6/15.) 100,779.

4,938 COATES, A. M. Electric time switches. (4/4/16.) 106,108.

5,091 MARKS, E. C. R. (American Model & Instrument Co.) Electric make-and-break devices. (6/4/16.) 106,111.

5,884 STRUYVEN, J. P. M. A. Electrically-operated temperature alarms. (25/4/16.) 106,117.

6,467 HOWARD, J. W. Dynamo-electric machines. (5/5/16.) 106,118.

7,244 STOBIE, V., & DAVENPORT, S. Electric furnace electrodes. (22/5/16.) 106,152.

10,919 SIMMS, F. R. Magneto-electric machines. (2/8/16.) 106,195.

13,816 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Systems of electric distribution. (7/10/15.) 101,711.

Relates to systems of the kind in which a direct-current circuit, such as an electric railway circuit, is supplied with energy from an alternating-current circuit, through a vapour converter or other suitable current rectifying device, and consists in placing a circuit-breaker in the alternating-current circuit, the trip coil of which is energised from the direct-current circuit through a condenser, whereby the supply of energy to the direct-current circuit may be interrupted on occurrence of a short circuit or other abnormal condition therein, without injury to the system or the apparatus associated therewith.

1917 SPECIFICATIONS.

3,765 FRANCE, A. G. Sparking plugs for internal combustion engines. (15/3/17. 106,256.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

April 19, 1917.

5,494 TIARKS. Constant current motor and dynamo without commutator.
5,519 B. T.-H. CO. (G. E. Co.) Wireless signalling systems.
5,528 GUYAMA. Electric lamps. (19/4/16. U.S.)
5,529 & 5,533 HEURTLEY. Telegraphy.

April 21, 1917.

5,632 DEKKER. Electrolytic deposition of metals.

April 23, 1917.

5,614 WARDLE ENGINEERING CO. & WILKINSON. Lanterns, &c., for incandescent lamps.
5,663 BREEDEN & LUCAS. Dynamo-electric machines.
5,693 VALENTE DA CRUZ. Magnetometer for weak magnetic fields.

April 24, 1917.

5,738 B. T.-H. CO. (G. E. Co.). Wireless signalling systems.
5,762 WESTINGHOUSE MACHINE CO. Power-developing apparatus. (22/5/16, U.S.)
5,778 BATHKE. Heating elements for electric radiators.

April 25, 1917.

5,788 FOX. Reflectors for electric flash lamps, pocket lamps, &c.
5,801 THOMAS. Electric light fittings.
5,804 HARVEY. Apparatus for detecting and magnifying electric impulses.
5,811 KINGSLAND. Dynamos.
5,815 DAVIS. Switches for miner's electric lamps.
5,825 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Centrifugally operated short-circuiting devices. (3/5/16, U.S.).
5,840 BOSSON. Shock absorbers for batteries.
5,843 CLEATHERS & SPURR. Magneto-electric machines.

April 26, 1917.

5,873 DICKENSON. Propellers for driving dynamos, &c., on aircraft.
5,878 HOPE. Fuses or cut-outs for electric circuits.
5,894 FARNSWORTH. Cable clips.

April 27, 1917.

5,941 BUTLER. Electric switches.
5,984 B. T.-H. CO. (G. E. Co.) Electric lamps for projectors.
5,993 DODD. Electromagnetic detecting or indicating apparatus.

April 28, 1917.

6,014 SMITH. Life-guards for tramcars, &c.
6,019 BURTON & WHELAN. Section insulator for overhead electric equipment.
6,023 STOLS ELECTROPHONE CO. & HYMAN. Electrophones.
6,032 B. T.-H. CO. (G. E. Co.) Elastic fluid turbines.
6,036 LAIDLAW. Electric multiple switches.
6,046 MAJOR & PYBUS. Plates, slabs, &c., for electric insulation.
6,050 CADETT & PERCY. Electric arrangements for facilitating starting of engines.

April 30, 1917.

6,053 JOHN. Working signals, &c., by electric currents.
6,054 DUNGEY & KERSTING. Inter-communication telephone systems.
6,081 FALLOWS. Electric torches.
6,094 B.T.-H. CO. (G.E. Co.) Electric motor control.
6,098 MARKS. (S. A. des Etablissements L. Bleriot.) Ignition magnetos.
6,110 ATHERTON. Electric ignition apparatus for engines.

May 1, 1917.

6,132 JOHN. Electric cut-outs, leakage detectors, &c.
6,150 D. P. BATTERY CO. Secondary batteries.
6,159 B.T.-H. CO. (G.E. Co.) Calibrating U-tubes for flow meters, &c.
6,164 GREVILLE. Electrodes.
6,177 BASTIAN. Magnetically controlled apparatus and methods of operating same.

May 2, 1917.

6,185 HOPE. Combined switch, plug and socket devices.
6,196 CABLE ACCESSORIES CO., DAVIS & REEVES. Electric irons, &c.
6,225 B. T.-H. CO. (G.E. Co.) Elastic fluid turbines.
6,233 STANWORTH. Water power systems.
6,239 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Valve-seating means. 5/6/16, U.S.)
6,255 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Controllers for electric motor circuits.

May 3, 1917.

6,265 THOMAS. Power transmission.
6,280 B. T.-H. CO. (G.E. Co.) Electric heating devices.
6,285 MELLERSH-JACKSON. (Murray.) Electric welding apparatus.
6,287 WOODS. Improving starting torques and simplifying startor of s. p. induction motors.
6,305 PAINE & HYDE-THOMSON. Incandescent lamps.
6,308 BREEZE & WEST & CO. Electromagnetic lock-out switch or contactor.
6,309 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electric motor control systems.
6,315 RENSHAW. Ships' telegraphs.
6,320 BERRY. Electric heating apparatus.

May 4, 1917.

6,334 BRADSHAW. Cooling appliances for engines and dynamos.
6,335 LANCASTER. Detection for wireless telegraphy.
6,341 LANCASTER. Receivers for wireless telegraphy.
6,343 DONOVAN. Electric switches.
6,344 BRIGGS. Electric apparatus for detecting, measuring, &c., bore-holes.
6,364 WOODS. Automatically recording telephone calls.
6,374 A.G. BROWN BOVERI ET CIE. Starting apparatus for motor car engines. (29/5/16.) Germany.)
6,383 GREVILLE. Electro-medical apparatus.
6,399 BERRY. Insulation for switches.

May 5, 1917.

6,433 MARCONI'S WIRELESS TELEGRAPH CO. & SHOENBERG. Thermaconic devices.
6,437 SYMES. Automatic micro-telephones. (26/6/16, N. Z.)

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Officer Commanding: Lieut.-Col. C. D. Clay, V.D.

Orders for the week:—

Officer for the week.—Commander C. Campbell.

Next for duty.—Platoon Commander A. Gerard.

Monday, July 9th.—Technical instruction for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' drill, 6.30.

Tuesday, July 10th.—Lecture, 6.30. Physical drill and bayonet fighting, 7.30.

Wednesday, July 11th.—Drill, No. 1 Company, Right Half Company.

Thursday, July 12th.—Drill, No. 2 Company, 6.30, Right Half Company. Ambulance class. Signalling.

Friday, July 13th.—Technical instruction for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' drill, 6.30.

Saturday, July 14th.—C.O.'s parade, 2.45. Uniform, for drill in Hyde Park.

Armlets.—Members are warned that armlets must be worn at all plain clothes' parades.

Musketry.—For all Companies, see Notice at Headquarters.

NOTE.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street).

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Carbon Imports. On the 28th ult. a Royal Proclamation was issued prohibiting the importation into the United Kingdom of carbons for arc lamps, carbons for searchlights and electric dry cells and carbons therefor. The prohibition does not apply to any such goods which are imported under licence given by the Board of Trade.

* * * *

The Consular Service. The chairmen of the sections of the Manchester Chamber of Commerce concerned with foreign trade recently submitted a memorandum setting out the lines upon which the Chamber might fall in with the Foreign Office scheme for recording and disseminating (through the principal Chambers of Commerce) recent intelligence likely to be of interest to manufacturers and merchants.

The matter will be discussed at a conference between representatives of the Chamber and the Foreign Trade Department in a few days. The board approved of the scheme submitted by the chairmen, which involves the appointment of special assistance and appropriate office accommodation.

In a letter from the Board of Trade in reference to representations made by the Chamber as to the desirability of following the example of the United States Government in sending trade experts to Australia and other countries, it is pointed out that they have already adopted the system in regard to Spain and Portugal, and as there was no question as to the value of the method it was hoped that the system would be further developed.

* * * *

Meeting Foreign Competition. At the recent meeting of the Ironmonger's Federation Association at Birmingham, Mr. J. Osborne proposed a resolution urging British manufacturers to compete more in the future than they had done in the past with the foreign manufacturers.

Mr. Osborne said the object in view was to promote in every way the sale of English-made goods, but in doing that they must impress upon the English manufacturers the necessity of ensuring that their goods were equal, if not superior, to the foreign goods in quality and finish. He had found in the past that English manufacturers had brought out goods in imitation of foreign patterns which had been favourably received, but that they had failed in the effort to give that degree of finish and accuracy to their productions which was necessary to secure the market. It was not always the lowest-priced goods that commanded the market; as a rule, it was the best goods in any line. If the English manufacturers applied themselves to the task they could beat the world as regarded quality, but they would never do that unless they improved their methods of manufacture.

* * * *

Chinese Imports. The Acting British Consul at Canton (Mr. R. S. Pratt) has prepared a table showing the distribution amongst the Chinese ports of imports into that country during 1915 of metals and metal manufactures, machinery, &c. The values are in Haikwan taels (=2s. 7½d.), and the ports are classified as (*a*) Northern ports, (*b*) Yangtze ports, (*c*) Central ports, (*d*) Southern ports, and (*e*) Frontier ports.

Amongst the figures given are: Electrical materials and fittings (*a*) 772,000, (*b*) 183,000, (*c*) 848,000, (*d*) 276,000, (*e*) 17,000; telegraph and telephone materials (*a*) 138,000 taels, (*b*) 64,000, (*c*) 109,000, (*d*) 77,000, (*e*) 6,000. Total values of imports of machinery, &c., were (*a*) 5,021,000, (*b*) 1,547,000, (*c*) 4,585,000, (*d*) 885,000, (*e*) 76,000 (total 12,114,000); and of metals, &c. (*a*) 6,130,000, (*b*) 4,808,000, (*c*) 4,480,000, (*d*) 3,849,000, (*e*) 34,000 (total 19,301,000).

* * * *

Commercial Library. The Libraries Committee of Leeds Corporation, which had already approved the principle of the provision of a commercial library for the city, has now instructed the City Engineer to prepare a plan and to submit an estimate of the cost of erecting and equipping such accommodation.

* * * *

India's Copper. Before the war copper to the value of over £2,000,000 per annum was imported into India, and a considerable proportion of the total came from Germany.

Yet India itself has copper deposits of no little importance, and the British Empire Producer's Organisation understands that in former days this ore was mined and smelted in considerable quantities in Southern India, Rajputana, and at various places along the outer Himalayas—*e.g.*, Garwhal, Nepal, Sikkim and Bhutan. Chota Nagpur is reported to contain rich lodes of copper. Various companies have exploited the copper ores of India during the last 50 years, but until recently the results have been anything but successful—due, apparently, to unscientific methods. The Indian Munitions Board have now engaged experts in England to go out to India and develop the industry on scientific lines. There appears to be ample scope for development, and India, it may be hoped, will ere long be producing enough copper to replace, at all events, the former German imports.

* * * *

Workmen's Compensation. Some time ago we reviewed some of the cases arising out of the Workmen's Compensation Act, and we then felt ourselves impelled to criticise certain of the decisions of the Court of Appeal, because we considered some of them were erroneous in law, while others placed a very rigid construction upon certain sections of the Act, and also because the excessive litigation arising out of the Act was a cause of the labour unrest, and seemed to call for an amending Act. We are glad to notice that the important judgment given recently by the House of Lords, in the case of Dennis *v.* A. J. White & Co., goes some way to meet our criticism, and restores the law to the position it was generally conceived to be before the decisions of the Court of Appeal. Not only does the judgment cover a number of decisions which have been severely criticised, but it lays down important principles governing cases in which workmen claim compensation for accidents due to risks common to all mankind.

The facts of the case were as follows: Appellant (a boy aged 16) was employed as a plumber's mate by a firm of builders, and his duty was to go on errands to different parts of London. He was directed to use a bicycle belonging to the firm for such errands, and on Aug. 27, 1915, was ordered to fetch some plaster. As he was crossing Sloane-square he came into collision with a motor-car, and he was knocked down, his left leg being broken. Appellant had used the bicycle about once a day for 18 months. The County Court judge found for respondents, and the Court of Appeal (by a majority) affirmed this decision.

In allowing the appeal, the Lord Chancellor said that the decisions below were erroneous. The only question was whether the accident arose out of the employment. It was not disputed that appellant was riding the bicycle in the course of his employment and by the orders of his employer. The risk of collision in such circumstances was incidental to the use of a bicycle; it was a risk inherent in the nature of the employment and it was the cause of the accident. It followed that the accident arose out of the employment. It was quite immaterial that the risk was one which was shared by all who used bicycles for such a purpose. Such as it was, it was a risk to which appellant was exposed in carrying out the orders of his employer. If a servant in the course of his master's business had to pass along the public street, whether on foot or on a bicycle, or on an omnibus or car, and he met with an accident by reason of the risks incidental to the streets, the accident arose out of as well as in the course of his employment. The frequency or infrequency of the occasions on which the risk was incurred had nothing to do with the question whether an accident resulting from that risk arose out of the employment. The use of the streets by the workman merely to get to or from his work, of course, stood on a different footing altogether, but as soon as it was established that the work itself involved exposure to the perils of the streets the workman could recover for any injury so caused. As was said in Thom *v.* Sinclair, "the fact that the risk may be common to all mankind does not disentitle the workman to compensation if in the particular case it arises out of the employment." There were, of course, cases in which it was necessary to inquire whether the nature of the employment specially exposed a workman to a risk of a general nature. In the case of injury by lightning it was very material to inquire whether the work involved special exposure to the danger of being so struck, as in the case of employment on a steeple or elevated scaffolding. In the case of injury by a bomb thrown from hostile aircraft, the fact that the workman was engaged on work in a building brilliantly lighted so as to attract the notice of the enemy crews might be most material as showing that the injury by the bomb was one which arose out of the employment. In the case of sunstroke or frostbite, it was material to show that the work involved special exposure to the heat or the cold. If the injury was the result of an assault it was material to show that the employment was such as to involve liability to such mishaps as in the case of a gamekeeper or watchman. Where the risk was one shared by all men, whether in or out of employment, in order to show that the accident arose out of the employment it must be established that special exposure to it was involved. But when a workman was sent into the street on his master's business, whether occasionally or habitually, his employment necessarily involved exposure to the risks of the streets and injury from such a cause arose out of his employment. There was nothing in the Act about any necessity for showing that the employment involved an extra or special risk, and once it was clear, as it was in the present case, that the accident was the result of a risk necessarily incidental to the performance of the servant's work, all inquiry as to the frequency or magnitude of the risk was irrelevant. It was quite immaterial whether the nature of the employment involved continuous or only occasional exposure to the dangers of the streets. The decision of the Courts below was, therefore, reversed.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Croydon.—The L.G. Board recently sanctioned the borrowing of sums of £1,700 and £300 for laying of new electric main and for the purchase of transformers in connection with the supply of electricity to a factory.

The loans are for periods of 25 and 15 years respectively. The Board also sanctioned the raising of £4,761 (under a previous sanction), and of loans of £9,500 and £500 for laying a h.t. main and the erection of a sub-station for the supply of electricity to two local works.

Hackney (London).—The Borough Council propose to take up loans of £6,500 and £3,185 from the L.C.C. for extensions of the electricity station buildings and undertaking.

Kingston-on-Thames.—The Council has received formal sanction to the borrowing of £3,642 for the electricity undertaking, and the Board also states that when the present restrictions on borrowing are removed it will be prepared to sanction loans in respect of the balance of the excess expenditure of £5,792, and the expenditure of £507 incurred on house service meters and mains between the end of 1914 and Nov. 30, 1915.

Liverpool.—A special sub-committee, entitled the Extensions Sub-committee, has been formed to deal with the supply of electrical energy to the Mersey Docks and Harbour Board.

Mr. A. Bromley Holmes is chairman of the new sub-committee and it will consider all questions of electric supply charges and extensions before being submitted to the Tramways and Electric Power and Lighting Committee.

Worcester.—The question of putting in additional boilers at the electricity works was before the Council again on Tuesday.

The Electricity Committee reported that they had received a letter from a firm urging them to ensure a regular supply of current to meet their maximum demand.

The electrical engineer (Mr. C. M. Shaw) again reported on the necessity for installing at once the proposed boiler-house plant. Three boilers were constantly required to maintain the supply, and there was not the slightest doubt that every boiler would have to be constantly under steam next winter. It was, therefore, imperative that no further time be lost in ordering an additonal boiler and other plant. The sub-committee dealing with this matter also support Mr. Shaw because of increasing demand for current, the necessity of being prepared to meet a decision of the Board of Trade under the scheme for linking-up electricity undertakings, and because of the economics which would be effected by putting in the plant. Mr. Shaw has been asked to make a formal application to the Ministry of Munitions for a contribution towards the cost of the additional boiler, mechanical stoker and ash handling plant. The Council were also recommended to approve of the purchase and installation of the boiler and plant and to apply to the L.G. Board for sanction to a loan of so much of the cost therefore as may not be contributed by the Ministry of Munitions. The total cost of the plant will be £5,200.

The report was adopted by the Council.

GENERAL.

Belfast.—On Monday the Corporation decided to increase the charge for electric energy by a ½d. per unit to all consumers.

Bolton.—On Sunday a switchboard attendant named Hoarler was killed at the electricity works through coming into contact with a high-tension wire.

Brighton.—At the meeting of the Corporation last week the accounts of the electric supply department, which are abstracted in another column, were adopted.

It was decided to place the surplus of £5,140 on the year's working to reserve fund. The Chairman of the Lighting Committee (Mr. Heun) expressed his great pleasure at his first experience in moving the adoption of such a favourable balance sheet. On behalf of the Corporation he thanked the staff for the way in which they had carried out their work. The price of coal had greatly increased, but he saw no prospect of relief, while the quality of the coal had also deteriorated.

Mr. Campbell thought the position of the undertaking was marvellously good. The report contains the promise of even greater things for the future. The great increase in the demand for power undoubtedly meant cheaper current. Maintaining the increased use of power would reduce the cost to the general consumer. He could foresee the time when the cost for power would be cut down by a half, even to a halfpenny a unit. That would result in a transformed Brighton, purer air and a much pleasanter state of things in the town. No distribution of profits would ever equal such a boon to the town at large.

The Lighting Committee also presented a report from the Engineer (Mr. J. Christie) as to the installation of stokers, suitable for efficiently burning inferior qualities of coal, coke-breeze, &c. Mr. Christie stated that before the war the average price paid for fuel was 14s. 6d. per ton, but now they were paying anything up to 44s. per ton, and in the future might have to pay even more than that. That represents an increase amounting to approximately £18,000 per annum. Not only had the cost increased, but the class and quality had latterly fallen off in a most marked degree. Owing to their supply of sea-borne coal being very largely curtailed, they had to get the bulk of their supply by rail, and instead of getting single washed nut coal, for the burning of which the grates were specially designed, they had to take an inferior nutty slack, containing a very large percentage of small coal and ash. The fine dusty coal accumulated in pockets in the bunkers and when it came through in a rush it frequently drowned out the fire and a large percentage of it dropped through the open bars into the ashpit unburned. Owing to lack of labour it was impossible to separate that and they had no grates of a suitable type to burn it efficiently if they did. That was a serious source of waste and, owing to the poor quality of the fuel, it was necessary to keep in service nearly double the number of boilers that they would do if the old class of nut fuel were available. If modern travelling grate underfeed stokers with forced draught were fitted on the boilers, it would enable them to burn that class of fuel very efficiently, and it would also open up a wider field for obtaining supplies, as those grates would burn small anthracite and coke-breeze equally efficiently, and also the class of coal they might likely have to use in future from the Kent coalfields. The Gas Co. offer to supply them with a considerable quantity of suitable coke-breeze at quite a reasonable price. That would materially assist the Government just now in saving transport. The Controller of Mines endorsed the proposal and stated that he would request the Ministry of Munitions to grant a priority certificate to the makers to enable the work to be put in hand without delay. The cost of equipping one battery of three boilers would be £3,500, and he was confident that the installation, directly and indirectly, would enable them to save £4,000 to £5,000 a year in their fuel bill.

The committee concurred in the advice of Mr. Christie and recommended that an order be placed with the Underfeed Stoker Co. This was agreed to without discussion.

Grimsby.—The Corporation has decided to transfer the balance on the past year's working of the electric supply department to the revenue fund, in order to meet prospective capital charges during the first year or two after the war.

An additional war bonus of £50 per annum has been granted to the deputy borough electrical engineer (Mr. A. S. Channon) while he is in charge of the undertaking.

Ilford.—A provisional agreement has been made for renewing the lease of the Barking tramway track for 3 years from June 1, at an annual rental of £1,250, and current will be purchased from Barking Council at 1¼d. per unit.

Lees (Lancs).—Representatives of the Urban Council are to meet the Oldham Electricity Committee in order to discuss terms for the supply of electricity in Lees.

London County Council.—At the meeting on Tuesday, Mr. Hume, chairman of the special committee on electricity supply, stated, in reply to Mr. Gordon, that the Committee would be called together next week to consider the conclusions of the Board of Trade Electric Power Committee.

HYDRO-ELECTRIC NOTES.

Hydro-Electric Development in New Zealand.—The question of developing hydro-electric power in the North Island, New Zealand, is being investigated by Mr. Evan Parry, who has issued an interim report on the subject.

Mr. Parry considers the best source of power to be in the Arapuni Gorge, 8 miles from Hira Hira, where it would be possible to obtain 120,000 H.P. on a 50 per cent. load-factor basis. He believes this scheme would be successful if only 40,000 H.P. were developed in the first instance; the cost of the necessary plant, with transmission lines for serving surrounding districts, would be £1,200,000. The most suitable source of supply for Wellington is the Mangahao River, where 25,000 H.P. can be obtained on a 50 per cent. load-factor basis; and later on a further source of power might be obtained in the Taranaki district to supplement this.

Hydro-Electric Power in Norway.—At the recent meeting of Edward Lloyd (Ltd.), the chairman reported that the directors had disposed of the whole of their Vittingfos property to a Norwegian company which had been formed to develop the water power to its fullest extent for the purpose of supplying electric power to the surrounding towns and district.

Water-power Utilisation in Germany.—It is expected that the large hydro-electric power station on the Murg River, in the Schwarzwald, will commence to supply electrical energy before next winter.

Digitized by Google

LIGHTING AND INDUSTRIAL POWER.

Islington (London).—The Borough Council are recommended to appoint Mr. Hadyn T. Harrison to report upon the question of the improvement of street lighting and on the proposal to substitute half-watt lamps for the existing arcs.

Westminster.—The Council recently agreed to the substitution of incandescent lamps for the arc lamps for street lighting in St. George, Hanover-square, one of the conditions being that the minimum candle-power shall be 70, when measured with the globe off and without reflector, and as ascertained by the average of two readings taken from positions on the street at an angle of 90 deg. measured horizontally to each other and at an angle of 45 deg. measured vertically with the lamp.

ELECTRIC TRACTION.

Brighton.—The tramway strike has terminated. The women conductors agreed to go back on the old terms, but the Tramways Committee will consider all the points in dispute.

Glasgow.—In order to legalise the tramway prize drawing in aid of the war, a modified scheme was recently prepared, so as to bring it within the Art Unions Act of 1846, and the Board of Trade was been asked to approve of this modification. The Board has, however, refused to sanction the scheme.

Manchester.—The tramway trouble in the Manchester area continues.

On Tuesday the Tramways Committee received a deputation of employés with reference to the "stay in" strike, which has caused great inconvenience and annoyance to the public. After sitting over two hours the Committee adjourned, without having effected a settlement of the trouble.

There are now over 150 of the extra cars idle in Manchester.

Sheerness.—The Council have been notified that it is proposed to close down the local tramways and remove the rails, poles and overhead equipment, but before doing so the directors of the local company offered to sell the undertaking to the Council. The latter has, however, decided not to entertain the offer, and in due course the tramway track will be pulled up. The company is running a motor omnibus service.

Stoke-on-Trent.—The principle of the new agreement for extending the lease of the local tramways, &c., has been accepted by the Council, but the clauses are to be considered in detail at a future meeting.

The Electric Railway in Warfare.—According to the "Railway News," the problem of transporting the heavy supplies of ammunition, food, &c., over the shell-torn fields to the points of action has been greatly simplified by the use of portable track.

This track, according to American trade reports, is made in convenient lengths—1¼, 2½ and 5 metres—which may be readily connected to curved sections, turntables and numerous types of switches and cross-overs. The three lengths have three, five and eight ties, respectively. The gauge is 60 cm. The rails which are rolled to a special size, weigh 20 lb. per yard. The ties weigh 20 lb. each and withstand a bending stress of more than 4,500 lb. They are pressed hot from 3/16 in. sheet stock into a dished form, measuring 6 in. by 44 in., with a ¾ in. rim. The track is built to withstand severe service; it is laid by experienced track layers and carries carload after carload of heavy shells and other supplies. The trains are operated by double-ended Baldwin electric locomotives.

Women Tramcar Conductors.—Mr. Peter Fisher (manager of the Dundee Tramways) stated before the Magistrates last week practically all the male conductors at Glasgow have been replaced by women. All the male conductors who were now left were being trained as drivers.

IMPERIAL NOTES.

Australasia.—"The Times" Engineering Supplement reports that Victoria is eagerly awaiting the time when plans can be settled and plant ordered for increasing its supplies of electric power.

Existing power stations are fully loaded, recent extensions having gone ahead almost beyond the capacity of the sources of power supply. The Melbourne Electric Supply Co. is providing additional electricity to the St. Kilda-Brighton Tramway, but more still is wanted. When the new turbine installation at the Newport power house is started there will be an improvement in the situation, but even then there will be a wide scope for development in the provision of power for traction, lighting and industrial power.

A proposal has been made to erect a power house at Morwell, in order to utilise the deposits of brown coal, and it is also proposed, if the initial costs work out on a favourable basis, to establish hydro-electric works on the Kiewa River, with a view to transmitting the power to Melbourne.

India.—"Indian Engineering" states that both in Lucknow and Allahabad the United Provinces Electric Supply Co. (Ltd.) is now giving a supply of current to consumers.

In each case current is supplied from a steam dynamo, originally intended as auxiliary plant, and there is also a battery at each power-house. There appears to be no likelihood of work on the main plant being resumed until after the war, and to meet the demand for current the company is installing a second-hand steam plant. The poles required to complete the erection of the overhead mains have been secured.

FOREIGN NOTES.

Aluminium Manufacture in Italy.—A company entitled Società del Alluiminio Italiano has been formed in Turin with a capital of £800,000 in order to establish works for the manufacture of aluminium and other electro-chemical products, and also to erect hydro-electric power plants, &c., in Italy.

Aluminium in Switzerland.—In a Federal Decree of May 11 and in regulations made thereunder provision is made for the control of the sale of aluminium and of articles manufactured from aluminium, &c., and also for fixing maximum prices for same. The sales are vested in the "Office Suisse de Controle de l'Aluminium," in Berne, and maximum prices have been fixed.

Argentina.—Rosario Municipal Council at a recent meeting sanctioned a resolution which declares forfeited the authorisation given to the telephone company at present operating in that city, and ordaining that tenders shall be invited for the installation and exploitation of a general telephone system within the Municipal zone.

Chile.—Decrees granting concessions for the installations of electric lighting and power systems (overhead transmission) have been granted to Carlos Magno Coggiola for the commune of Quinta Normal; José Raurich G. for the town of Casablanca; and Juan Korskolm for the town of Corral.

Tin Smelting in Bolivia.—H.M. Consul at Antofagasta reports that experiments on a small scale in the electrolytic smelting of tin ore have been made in Bolivia. The tin extracted is of high quality, but, owing to the prohibitive cost of production, the experiments did not indicate the possibility of commercial production. Further experiments will probably be made.

Venezuela.—The Venezuelan Ministerio de Fomento have entered into contracts with A. J. C. Herrera, of El Callao (State of Bolivar), for constructing and working a telephone system about 94 miles long, connecting Guasipati, El Callao, Tumeremo and Cuyuni, in State of Bolivar; and with Caracciolo R. Paredes, of Nirgua (State of Yaracuy), for a telephone system (about 123 miles long) from Nirgua to Valencia (Carabobo) and Tinaquillo (Cojedes).

MISCELLANEOUS.

An Official Directory.—The Department of Commercial Intelligence of the Board of Trade announce that it is compiling an index or directory of British and Irish manufacturers, which it is proposed to forward to Consular officers, trade commissioners and other correspondents of the Board of Trade abroad for use in dealing with inquiries for the supply of British and Irish goods.

A large number of firms have supplied information as to their products, but before transmitting this information abroad it is desired to furnish all manufacturers in the United Kingdom interested in the export trade an opportunity of applying for the inclusion of their names in this index. The Department is now compiling the sections of the index dealing with the boot and shoe, leather and leather goods, wearing-apparel, rope, twine and net trades, haberdashery, fancy goods and floorcloths and coverings. Manufacturers who desire to apply for the inclusion of their names in this index should forward particulars to the Department of Commercial Intelligence, 73, Basinghall-street, London, E.C. 2.

Coal Prices.—The Controller of Coal Mines has issued a code of directions as to the sale of coal, with a view to dealing with fluctuations in colliery prices which have recently occurred in certain districts owing to abnormal market conditions, and preserving the regularity in the distribution of coal, which is so necessary at the present time. The directions mainly affect prices of coal for export and bunker purposes, for which a definite schedule of prices has been drawn up and accompanies the directions, but it also provides that the pit prices of coal for home consumption shall remain at the maxima prescribed by the Price of Coal (Limitation) Act.

Electricity in Agriculture.—As stated in our last issue, Chester Corporation have applied for a grant of £200 from the Development Fund for the purpose of collecting data and making investigations as to the practicability of a scheme prepared by the borough electrical engineer (Mr. S. E. Britton) for utilising the water power of the River Dee above Chester to generate electricity to be used for agricultural purposes and the development of rural industries.

The SHERIFF, in proposing the adoption of the Committee's recom-

Digitized by Google

mendation, said Mr. Britton based his observations on the results of the past year, which had proved satisfactory in generating electricity for the city, without doing any harm to the concern. He had been making preliminary investigations on the upper reaches of the river, the results of which he submitted to the Board of Agriculture and Fisheries, and as a result Mr. Britton brought a report to the Electricity Committee. The Board were impressed by the nature of the investigations, and were prepared to recommend to the Treasury that £200 should be granted. The committee thought that the authorities, with the data placed before them, should take up their investigations, and that the money should be advanced for them and not to the Corporation. They, however, said the application must go through the Corporation; the Town Clerk and Mr. Britton (accompanied by Sir John Snell) had an interview with representatives of the Board, who were impressed by the observations. If the committee's propositions was carried, it would not commit the Council either financially or in any other way. The work would consist of taking surveys, and when those were complete they would go to the Board of Agriculture and Fisheries. No interest would be affected by those preliminary investigations.

Mr. P. S. BROOK seconded, and said the idea emanated from the brain of their electrical engineer, who when he found the results from the Hydro-Electricity Works were so successful in saving coal, thought that on that ground it would be of national importance, and suggested it to the Board of Agriculture. That was one of the reasons the Board had been so favourably impressed. The Council were in no way involved in any expenditure.

After some discussion the minutes were approved.

Excess Profits Duty.—On Tuesday the House of Commons went into Committee on the Finance Bill.

On Clause 17, which provides for the continuance of the Excess Profits Duty and an increase of the rate from 60 per cent. to 70 per cent., Mr. Currie pressed for information as to the trades and industries from which £140,000,000 the proceeds of the tax last year were obtained. It was impossible that trade discussions could be conducted satisfactorily in the absence of such information or profiteering dealt with.

Mr. Sherwell expressed doubt as to whether the figure of 80 per cent. might not be attended by consequences of greater permanent mischief to trade and industry than the revenue derived from it would justify. He was afraid that when peace came and unprecedented opportunities for commercial and industrial expansion offered traders would not, owing to the high level of the tax, be able to take full advantage of those opportunities.

Other members having advocated the extension of the duty to farmers and professional men.

The Chancellor of the Exchequer said that the Excess Profits Duty had had great results, but he did not know how the Government would have financed the war without it. He did not overlook the gravity of such taxation, but in any case the war could not fail to have a bad result on the country. When the war ended stronger national credit which resulted from raising so much of our expenditure from revenue would assist traders and the nation would gain rather than lose. The revolution in methods of manufacture as the result of munition making would have a lasting effect on the general industrial conditions of the country. He had tried to make the tax work less harshly and had put down amendments which he hoped would have that effect. He asked that further discussion of the point should be deferred until the Report stage.

The Clause was then agreed to

French War Taxation.—Among the taxes proposed in the Bill which was recently brought forward by M. Thierry, Minister of Finance, were taxes on railway transport, electricity and gas supply.

Inquest.—Last week an inquest was held at Birmingham on Ernest Ralph Evans, electrician, who was recently killed on the premises of Tubes (Ltd.), of Aston.

Deceased was testing a "starter," and received an electric shock which resulted in his death. An examination showed that the accident was due to a screw becoming loose and falling into such a position as to divert the current to the cover of the "starter," to the danger of anyone touching it without special protection for the hands. The current was at about 440 volts. Evans looked for the missing screw, and failing to find it he inserted a brass screw in its place.

A verdict of accidental death was returned.

Metals and Research.—It is announced by the "Birmingham Daily Post" that the Government proposes to create a new department for the study of electro-chemical and electro-metallurgical questions. It is recognised that the requirements and activities of the war have emphasised the importance of the matter, and such investigations as may be undertaken are considered certain to have a beneficial effect, when the war is over, on the great industries included in their scope.

Street Lighting Contract.—On Tuesday Mr. Justice Bailhache heard an action by the Wycombe Borough Electric Light & Power Co. for the recovery of £1,290, alleged to be due under a lighting contract with the mayor of the borough of Chipping Wycombe. The case arose out of the Lighting Restriction Order, the effect of which was to reduce largely the number of lamps allowed in the town. The Corporation of Chipping Wycombe contended that they should be relieved of their obligation to pay considerable sums to the company for the full and complete lighting of the town. After hearing legal arguments his Lordship held that the diminution in the lighting was not due to any cause over which plaintiffs had control, and that the case was indistinguishable from the Leiston Gas Co. v. Leiston Urban District Council.

The Channel Tunnel.—Mr. Arthur Fell, M.P., chairman of the House of Commons Channel Tunnel Committee, has forwarded a request to the Prime Minister and to Mr. Bonar Law, as leader of the House, asking for facilities for debating a motion on this subject. The request is signed by 110 M.P.s.

Trading with the Enemy.—The Controller of the Foreign Trade Department has issued a new list consolidating previous lists, and containing the names of over 2,000 persons and firms with whom persons in the United Kingdom are forbidden to trade under the Trading with the Enemy (Statutory List) Proclamation of 1916.

Wiremen's Wages.—Mr. W. H. Stoker, K.C., has awarded an advance in the wages of electrical wiremen in the Bradford and Shipley districts.

The men demanded an adavnce from 9½d. to 1s. per hour, with no war bonus, and the award raises the standard rate to 11½d. per hour, to cover and include all advances given previously. Payment for overtime is to be at the rate of time and a quarter for the first two hours, and time and a half afterwards until midnight, with double time subsequently until starting time next morning. Double time is to be paid for Sundays and Christmas Day, and time and a quarter for Bank Holidays. The working hours are reduced for the ordinary week from 52½ to 49½, and there are other concessions relating to night work, "dirty money," travelling, &c. A council composed of employers and workmen in equal numbers is to be appointed for the purpose of settling disputes.

EDUCATIONAL.

Liverpool University.—The faculty of engineering provides complete courses of instruction in civil, electrical, mechanical and marine engineering, naval architecture, design and drawing, physics, mathematics, chemistry, &c. The special matriculation examination, or entrance examination, must be passed in order to secure admission Prospectuses of the faculty may be obtained from the Registrar.

University of Manchester.—Sir William Mather has given a donation of £5,000 for the endowment of a Russian department.

TENDERS INVITED AND ACCEPTED.

Pipework.

MANCHESTER Electricity Committee invite tenders for supply and erection at Stuart-street generating station of high and low pressure steam and feed pipework, &c. Specifications from Mr. F. E. Hughes and tenders to Chairman of Electricity Committee, Town Hall, Manchester, by July 11.

Motor Ambulances.

WEST HAM Corporation require tenders for the supply of two motor ambulance vehicles. Tenders, which should contain details of chassis, &c., particulars of speed, consumption of petrol or electricity, &c., are to be sent to the Town Clerk by 4 p.m. July 17.

BRADFORD.—An order has been placed with Messrs. Hewitt & Kellett (at £548) for a Lancashire boiler and with Newton, Bean & Mitchell for a horizontal engine (at £320) for the electric lighting plant at Grassington Sanatorium.

GLASGOW.—The Tramways department have accepted the tender of the British Westinghouse Co. for armature coils and that of Cookson & Co. for trolly cord.

SALFORD.—The Council has accepted the tender of the Macintosh Cable Co. for cable, at £5,395. 19s. 1d.

WEST HARTLEPOOL.—An order has been placed with Messrs. Cammell, Laird & Co. for the supply of tramcar tyres at 42s. 6d. per cwt.

BUSINESS ITEMS.

The partnership hitherto subsisting between Alfred Charles Wright and Gabriel Douhairet, manufacturers' agents of motor, electrical and ignition accessories, 64, Poland-street, London, W. 1 (trading under the style of firm of Leo Ripault & Co.), has been dissolved as from May 10. Debts by Mr. Douhairet.

Meters for Sale.—Oldham Corporation advertises for sale some two-rate meters, time switches and demand indicators. Particulars from Mr. W. Chamberlain, joint engineer and manager, electricity works, Oldham.

Digitized by Google

APPOINTMENTS VACANT AND FILLED.

Switchboard attendants are wanted for a generating station in the Manchester district. *See an advertisement.*

A magneto investigation assistant is required immediately for a Government factory. *See advertisement.*

An assistant engineering master will be wanted in September at the Coventry Municipal Technical Institute. Forms of application from the Secretary, Education Committee, Council House, Coventry. Applications by July 16.

A lecturer in physics is required for Battersea Polytechnic (London, S.W.11). Salary £175. Applications by July 17. Particulars from the Secretary.

The Government of the Union of South Africa require an industrial adviser to the Industries Section of the Department of Mines and Industries. Salary, £2,000. Applications to the High Commissioner, 32, Victoria-street, Westminster, London, S.W. 1, by July 31.

The London County Council has made the following appointments in the electrical department of the tramways :—

Mr. E. W. Dickinson, superintendent of Greenwich generating station to be power station engineer, at a yearly salary of £500, rising by four annual increments of £25 and two of £50 to £700 a year ; Mr. E. L. Pope and Mr. T. L. Horn, resident electrical superintendents of the southern and northern sections, to be distribution engineers of their respective sections, at a yearly salary of £500, rising by annual increments of £25 to £600 a year.

Mr. E. C. Sanford, of Burham, has been appointed manager of the Minehead Electric Supply Co.

BANKRUPTCIES, LIQUIDATIONS, &c.

The Universal Telephone & Electrical Co. (Ltd.) is being wound up voluntarily, and Mr. J. E. Percival, 6, Old Jewry, London, E.C., has been appointed liquidator.

A meeting of creditors of Morris & Lister (London) (Ltd.) will be held at the offices of Messrs. Sugden & Hextall, 36, King-street, Cheapside, London, E.C. Mr. H. S. Sugden is liquidator of the company.

Claims against Charles Benjamin Ogilvie, electrical engineer, 43, Dudley-road, Whalley Range, Manchester, must be sent to Mr. J. G. Gibson, O.R., Byron-street, Manchester, by July 18.

CATALOGUES, &c.

Prescot Wiring System..—A pamphlet of 12 pages, giving particulars of the Prescot wiring system, has been prepared by the British Insulated & Helsby Cables (Ltd.), of Prescot, Lancs., and London. Prices and dimensions of wires, joint boxes and other accessories are included.

Boiler House Elevators.—An illustrated booklet issued by Messrs. Ed. Bennis & Co. (Ltd.) describes the firm's boiler house elevators. Of late years the replacement of human labour by machinery in handling material in bulk has made great strides, and conveying plant is an essential item in the modern boiler house. Particulars of a number of actual elevators installed are given, and some striking figures are presented to show the economies derived.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Bingley.—The accounts of the District Council's electricity department for the year ended March 31 show that the capital borrowed amounts to £7,625, and £6,826 is outstanding.

Revenue from sales of current and meter rents, as per consumers' ledger, was £1,048 (compared with £859 in previous year) and from sales of current, &c., as per day book (including £124 for charges for fittings, &c.), £1,660 (£1,904), stock in hand is taken as £2,991 (£2,979), working and general expenses, including £351 (£370) excess capital expenditure, were £3,109 (£2,974), stock in hand being included on the expenditure side as £215 (against £148), the loss on revenue account being £333 (£144). Interest and capital repayment required £787 (£672), which, added to the loss on revenue account, made the year's deficit £1,120 (£816).

Brighton.—The accounts of the electricity department for the year ended March 31, which were submitted to the Council on June 21, show gross capital expenditure £844,490 (increase £1,623), and £435,236 has been provided for redemption.

Revenue was £106,880 (compared with £93,397 in previous year), and total costs were £59,815 (£53,052), leaving gross profit £47,065 (£40,345). Interest required £17,662 (£17,760), and sinking fund £22,593 (£24,908), and the net profit was £5,140 (compared with a deficit of £3,990. Total costs, exclusive of loan charges, were 1·51d. (1·36d.), and average price obtained per unit was 2·53d. (2·29d.). There are 6,739 (6,602) consumers.

In his report, Mr. John Christie (borough electrical engineer) calls attention to the fact that the lighting and power sales, which were about equal in pre-war times are now in the proportion of 30 and 70 respectively. Coal cost 40s. 9½d. per ton, compared with 17s. 3d. in 1913-14. Motors connected are equal to 4,015 H.P. of which 1,256 H.P. are hired from the department.

The tramway accounts show gross capital expenditure £280,616, of which £83,751 has been paid off. Revenue was £64,819 (against £57,974 in previous year), and working expenses were £37,960 (£37,163), leaving gross profit £23,321 (£16,935). Sinking fund required £6,432 (£6,429), interest £7,345 (£7,348), income tax £1,644 (£966), and revenue contribution to capital outlay and writing off preliminary expenses of rail-less system required £513, leaving balance in hand £7,521. Average total revenue per car-mile was 13·75d. (13·202d.), and working expenses, including power, were 8·05d. (8·47d.). Passengers carried were 13,678,251 (12,295,198), car-miles run 1,131,201 (1,053,285), and units used 1,837,629 (1,678,627).

The engineer and manager, Mr. Wm. Marsh, says in his report the number of girl conductors increased from 48 to 76, and they have proved their fitness for their work. No increase was made in fares. The surplus on the parcels service was £56 (£28). Part-time motormen have been employed for the week-ends.

Colchester.—The electricity department's accounts for the year ended March 31 show total capital expenditure £98,464 (increase £328), of which £41,185 has been repaid.

Revenue was £21,083 (compared with £18,933 in previous year), and total costs were £14,073 (£12,846), leaving gross profit £7,010 (£6,087). Interest required £1,981 (£1,926), and sinking fund and instalment of principal £4,113 (£3,994), the net result being a surplus of £541, compared with a deficit of £881). Average prices obtained for current were : Private supply 3·02d. (2·95d.), public lamps 2·18d. (2·25d.), tramways 1·59d. (1½d.). Total costs were 1·802d. (1·775d.) per unit, and interest and redemption 0·781d. (0·818d.). Units sold were 1,873,904 (1,737,315). Maximum load was 958 kw. (992 kw.), and load-factor 22·3 (20·83) per cent.

Dundee.—Last week Treasurer Soutar submitted the accounts of the electricity department.

The past year's accounts closed with a deficit of £2,647, which, with £3,245 in hand at the beginning of the year, made a total deficit of £5,892. The revenue was £1,940 less than in 1915-16 and the expenditure was £4,361 more, due to increased cost of materials, higher wages, &c. It was proposed to raise the price of current for lighting by ¾d. and for power ⅜d. per unit.

Mr. Lairn, who seconded the motion for the increase, said that it looked rather heavy, but it really amounted to only 10 per cent., compared with 27 per cent. in the gas department of the corporation since the beginning of the war.

Luton.—The gross expenditure of the electric lighting department at March 31 was £170,105 (increase £154,54), of which £107,167 is outstanding.

Revenue was £52,149 (compared with £44,366 in previous year), and working expenses were £35,034 (£27,639), leaving gross profit £17,115 (£16,727). Interest required £4,929 (£3,850), and instalments of principal £7,827 (£5,872). The net profit was £5,025 (£6,228). Units generated were 16,139,059 (14,146,120), and sold 14,227,136 (12,254,529). Total maximum supply demanded was 4,937 kw. (4,208 kw.). Motors connected equal 7,156 (6,632) H.P.

Stafford.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £39,838 (increase £4,503), of which £19,909 is outstanding.

Revenue was £10,217, total costs (including £800 placed to depreciation) were £7,261, and gross profit was £2,955. Repayment of loans

Digitized by Google

required £1,592, interest £703, andi ncome tax £607, leaving net surplus £235, or which £52 is the net profit for the year. Revenue was equal to 1·577d. per unit sold, working expenses were 0·994d. and capital charges, income tax and depreciation amounted to 0·571d. Maximum supply demanded was 680 kw. (the same as last year). The horse-power of motors connected is 1 764 kw. Units generated were 1,910,301 (compared with 1,657,906).

Stoke-on-Trent.—The accounts of the electricity department for the year ended March 31 were presented to the Council last week.

The chairman of the Committee (Ald. Leese) stated that during the year they had generated 10,966,619 units, compared with 11,291,932 in the previous year. The cost per unit for fuel was 0·313d., compared with 0·365d. in 1915-16. Their sales during the year amounted to 7,574,764 units, against 7,673,381 units, a reduction of 98,617 units. Although there had been a reduction of units used for lighting of 749,436 units, there had been an increase in the units supplied for power of 630,618 units. Their total revenue had been £59,577, and their expenditure £37,333, leaving a gross profit of £22,243, which, with capital charges of £42, made a total profit of £22,285. After paying sinking fund and redemption charges (£23,068) the net loss was £782, and, adding £417 for the purchase of new meters, there was a total deficit of £1,199, making their debit balance £6,836. Two years ago they had paid an average of 11s. a ton for coal; in 1915-16 it was 15s. 3d., and in the year he was dealing with it was 17s. 6d., which represented a total of £1,783 more than the previous year. Owing to the action of the Coal Controller in diverting a large proportion of their supply, he anticipated that the increase which was last year £500 would amount in the coming year to £1,500. The Committee were reluctantly compelled to announce a further increase to consumers, making 33⅓ per cent. since the commencement of the war. The accounts were adopted.

COMPANIES' MEETINGS AND REPORTS.

Globe Telegraph & Trust Co. (Ltd.)

The 44th ordinary general meeting was held on Tuesday, Sir JOHN WOLFE BARRY, K.C.B., the chairman of the company, presiding.

The SECRETARY (Mr. Sidney Collett) having read the notice convening the meeting and the minutes of the last ordinary general meeting and the auditors' report,

The CHAIRMAN said our total receipts for the 12 months ended May 31 last, after deducting the working expenses, amounted to £226,623, being an increase over those of the preceding year, and makes with the balance carried forward from last year a total of £263,472. We have paid to our preference shareholders the usual three quarterly interim dividends of 3s. per share, less income tax, and to our ordinary shareholders three interim dividends of 2s. per share, free of tax. These have absorbed the sum of £115,468. And your directors recommend the payment of a final dividend of 3s. per share, less income tax, on the preference shares, making 6 per cent. for the year, and of 8s. per share, free of income tax, on the ordinary shares, making with previous distributions a total dividend for the year on those shares of 7 per cent., free of income tax. These final dividends will absorb a further sum of £92,827, and leave £55,176 to be carried forward. Having explained the position of the company's various investments and their yields, he said that, taking the lowest market prices for their securities, they showed that day a surplus over the original capital of nearly half a million sterling. He concluded by moving the adoption of the report and accounts, and that the final dividends as recorded be declared.

Sir JAMES PENDER, Bart., seconded the motion, which was unanimously agreed to.

The CHAIRMAN said, in reply to a question with regard to wireless telegraphy: I do not think I have anything to add to what I have said on many occasions—that is, that no one can exactly put bounds to the discoveries and improvements of science. All we can say is that, as far as our experience goes, the view which I have laid before other telegraph companies has been that the wireless system has done no harm whatever to the cable system up to the present time; but, on the contrary, I think that to some extent it acts as a handmaid for the cable system. Certainly we have not experienced any injury from it, and I hope that we shall not. I do not see any reason to anticipate that what has been the experience of the past will not be the experience of years to come, but there I must leave it. I think that the view of most Governments and most great telegraph companies is that the business of the cable companies justifies a large expenditure upon cables as being the most trustworthy and the most favoured mode of transmission by telegraphy throughout the globe. That is a pretty good justification for the view I have held from the first that the wireless system will not—as it has not done in the past—injure the cable enterprise. There I think I must leave it. I still hold the same opinion, and I think that individual shareholders, if they study the point, will see that they are more or less in accord with the views I have ventured to express

The Right. Hon. Viscount Midleton, K.P., the retiring director, was unanimously re-elected, and Messrs. Deloitte, Plender, Griffiths & Co. were also re-elected auditors.

A vote of thanks to the board, the staff and those who are away on active service was passed unanimously, and the proceedings then terminated

Electric & General Investment Co. (Ltd.)

The 28th ordinary general meeting was held on Tuesday, Mr. J. B. BRAITHWAITE in the chair.

The ACTING SECRETARY (Mr. R. L. Sare) read the notice convening the meeting and the auditor's certificate.

The CHAIRMAN said: Gentlemen, the balance sheet this year is somewhat similar to the one last year. As you know, since the outbreak of the war the ordinary financial business out of which this company usually makes its living has been almost non-existent. We have, therefore, simply to conserve our resources and sit quiet awaiting the return of peace. The changes in the balance sheet are not very noticeable. The investments have increased from £323,524 to £336,605. This is due to our having subscribed £25,000 to the War Loan, and we sold certain securities which reduced the amount. The reserve is maintained at about the same figure as last year—£80,116 against £81,435, a slight reduction after crediting profits and deducting losses on securities sold, so that the net balance of investments, less reserve fund, comes out at £256,488 instead of £242,088, an increase of £14,000, against which we have, of course, the £25,000 War Loan. The sundry debtors are about the same as last year, and cash about £700 more. The chief changes will be seen on the debit side of the balance sheet and they are all of a satisfactory kind. The debenture stock has been reduced by £1,132. 10s. during the year, and stands at £16,681 instead of £17,813, and the loans from bankers and others £81,000 against £90,000, so on these two items alone the company's liabilities have been reduced by £10,132. Sundry creditors on open accounts are £11,202 against £11,710, a reduction of £508. On the other hand, the balance at profit and loss account stand at £12,999 against £10,194, an increase of £2,805. You will see, therefore, that the position of the company has improved by £10,132 in reduction of liabilities and by £508 in reduction of sundry creditors, while there is an increase of £2,800 in profit and loss balance. You will agree with the Board's policy of not making any distribution at the moment by way of dividend. It is better, I think, to strengthen our position and our reserves. The preference shareholders will notice that the amount which we carry forward, about £13,000, represents rather more than two years' dividend on their shares. In the profit and loss account the chief reduction is in interest and dividends on investments. This is very largely due, of course, to the increased income tax; otherwise, there is not much to say with regard to it. We are looking after the company's interests as well as we can, although there is not very much to do in the present stagnation of financial business. All we can hope to do is steadily to strengthen the company's financial position and prepare ourselves for the happier time coming when we hope financial business will be again brisk and enable us to resume the old-time prosperity of this company. I now have pleasure in moving the adoption of the report and accounts.

Mr. EMILE GARCKE seconded the motion, which was unanimously adopted.

Mr. J. B. Braithwaite, the retiring director, was re-elected, and Mr. H. Leigh Williams, F.C.A., was also elected auditor.

The proceedings then terminated.

ALUMINIUM CORPN. (LTD.)—The net profit for 1916, after providing for debenture interest and other charges, amounts to £46,898, which with balance brought forward makes a total of £51,457. After paying a dividend of 7 per cent. on the preference stock there remains £36,779. The directors last Christmas, in view of the trading results then ascertained, distributed a dividend at rate of 7 per cent. per annum on the preference stock, but as it has been impossible to ascertain in time for the coming meeting the amount that will be payable for war taxation, they regret they cannot recommend payment of a further dividend, and therefore propose carrying forward the balance of £36,779.

Mr. K. M. Clark, who presided over the meeting last week, said that their net profit showed the large increase of £32,640, but that was subject to war taxation. The figure proved how important an industry the manufacture of aluminium had now become. The additions to capital account amounted to £70,489, for erecting a new rolling mill for the production of sheet aluminium, a railway siding into the works, new stores, the preliminary expenditure in connection with the two new dams, the erection of a special plant, and a sum of over £20,000 expended in the purchase of new water rights, &c. The investments in subsidiary companies had been increased by £11,000 in preference shares of the Bauxite Refining Co. The directors, having regard to the results obtained, and being naturally anxious that the shareholders should receive the benefit at the earliest possible date, distributed an interim dividend of 7 per cent. per annum at Christmas last, and they had hoped that it would be possible to clear off another year's preference dividend at the meeting; but the taxation upon industries of that description was of a heavy character, and the settlement of the various items in the accounts was a matter of great difficulty. It was, therefore, impossible, having regard to the innumerable questions that had to be decided, to form any estimate as to what amount would be available out of the balance for distribution. He hoped that the authorities would bear in mind that their industry was one of the key industries of the country, and that our opponents in other countries had been reaping a large benefit from the enormous prices they had obtained for their metal. Their profits had been practically untouched by special war taxes, and in consequence they had been able to build up large reserves, which would naturally place them in a strong position to deal with the international competition that must arise when war ceased. The increase in their output had been a matter of much concern to the directors, and they had during the year carried out, under unavoidable difficulties, a large amount of work. The negotiations for the purchase

Digitized by Google

of the additional water rights had been prosecuted vigorously, and a great many difficult purchases carried through. The plant for the erection of the dams had been purchased, and the means of transit to the site of the dams (1,200 ft. above sea level) provided. The new turbo-generator had been delivered and would undergo its trial run in their works within a few days. That meant an increase of 20 per cent. to the capacity of their plant, and should put them in a position during the coming winter, for the first time in their history, to make full use of their pipe line; but they should not be able to make full use of the entire electrical capacity until they had completed the erection of the new dams. The original scheme in connection with those works was the utilisation of the waters of the Cowlyd Lake, but owing to various circumstances that was abandoned and the dam built upon the Eigiau Lake. Their Bill confirming the agreement with the Cowlyd Water Board and authorising the construction of the dam across the Cowlyd Valley had duly received the Royal Assent, and they would be enabled to complete the water scheme as originally designed. During the year they erected a heavy rolling mill plant, with three trains of rolls, and they had been in satisfactory use for some time past. Last year's output was the largest in the company's existence; in fact, it showed an increase of more than 30 per cent. in production. That increase was mainly due to the Dulyn tunnel, which had far more than justified its formation. There was no doubt that the war had shown new uses for aluminium, and in his opinion the production of light alloys would be an important feature of the aluminium industry in the years to come. He looked, therefore, for a largely increased demand after the war for aerial construction and motor cars. Great developments had taken place in the quantity of the metal produced all over the world, but personally he was quite satisfied that, with the exception of temporary set-backs, which must necessarily be looked for, the demand will keep pace with the supply.

BROWETT, LINDLEY & CO. (LTD.)—The net profit for 1916, after providing for interest charges and writing off £6,134 for depreciation, was £9,450, out of which the full year's dividend of 6 per cent. has been paid on the preference shares, together with an extra distribution of 3 per cent. on account of arrears, and a dividend of 4 per cent. on the ordinary shares, leaving £3,540, subject to excess profits duty.

CONSOLIDATED ELECTRICAL CO. (LTD.)—The chairman (Mr. H. Allen) presided over the annual meeting last week, and stated that they were paying the same dividend as in the previous year, but they were carrying forward only £3,066, against £3,159. Their investments had suffered no material depreciation during the year.

IMPERIAL TRAMWAYS CO. (LTD.)—The net revenue account for the past year shows an available balance of £23,039, and after payment of interest on debenture stock and interim dividend on the preference shares in respect of the half-year to June 30, it is proposed to pay dividends of 6 per cent. per annum on the preference capital and of 2 per cent. on the ordinary capital (less tax), and to carry forward £123.

INTERNATIONAL NICKEL CO. (LTD).—The net profit for the year ended March 31 last was $13,557,970. In August last the company acquired a site at Port Colborne (Ont.) for the erection of a nickel refinery. This property is located at the Lake Erie entrance of the Welland Canal, and is considered to be the best point in Canada for the assembling of the necessary materials. In October construction work was commenced on a refinery, the cost of which will be $5,000,000. A dividend of 6 per cent. has been declared on the common stock.

PETTERS (LTD.)—At the recent annual meeting the chairman (Mr. E. W. Petter) said that it would be some weeks before they could settle the balance sheet, but the directors were satisfied that the dividends recommended had been earned after providing for depreciation. They had been fully occupied during the year in the manufacture of Petter oil engines, and they had laid down the beginnings of a steel foundry. Owing to extensions they were negotiating with a view to obtaining sanction for an increase of capital. In addition to the payment of the 6 per cent. preference dividend they were paying 10 per cent. on the ordinary shares.

RANGOON ELECTRIC TRAMWAYS & SUPPLY CO. (LTD.)—Sir F. W. R. Fryer, who presided over the meeting last week, said that after providing for interest on the debenture issues and the dividend on the preference shares, there remained £9,982, from which the directors recommended payment of 4 per cent. on the ordinary share capital (tax free), carrying forward £2,902. Owing to the war the takings of the tramway and omnibus services showed a decrease compared with 1915, and the board decided to reduce the fares to half an anna for distances from half to three-quarters of a mile. The rearrangement of prices and distances, although it had only lately come into force, had proved to be so far successful. A reduction of fares was rendered advisable in face of new forms of locomotion which had increased during the year. The private lighting and power department continued satisfactory. The gross receipts for current supplied showed an increase of 8·89 per cent. (against 13·77 per cent. for 1915) and the expenditure was 40·38 per cent. (against 42·28 per cent.). The negotiations with reference to public lighting had advanced a further stage, and were now, with the exception of a few minor details, practically settled. The house wiring and supply department again showed an increased profit of Rs.32,549, against Rs.25,219 for last year. The working expenses were almost the same, and the turnover of stock was somewhat increased.

SHEERNESS & DISTRICT ELECTRIC POWER & TRACTION CO. (LTD.)—During 1916 the revenue from all sources was £19,015, and the working expenses were £16,525, leaving £2,490. After providing £377 for interest on loan and £1,447 for debenture interest, the profit was £665 which decreased the balance at debit of revenue account to £979. Revenue from the sale of current, meter rental, &c., amounted to £11,026, and working expenses to £8,931, compared with £8,977 and £6,993 respectively in preceding year. The total number of units sold were 1,552,095, against 1,336,869 in the previous year, an increase of 215,226; the number of consumers was 291, against 278 in 1915. The gross receipts from the working of the light railways and omnibuses were £7,878, and working expenses £5,476, the results, after setting aside £525 for renewal of omnibuses, being a surplus of £1,877, compared with £862.

SINGAPORE ELECTRIC TRAMWAYS (LTD.)—Sir Frank A. Swettenham, G.C.M.G., who presided at the recent meeting, said that the past year's profit was £9,913, subject to the royalty payable to the municipal commissioners. With balance from previous year, and deducting dividend paid in July last, the balance was £10,946, out of which £3,000 had been placed to depreciation reserve and they were carrying forward the balance of £7,946. The traffic receipts for the year were better by £7,592, while the passengers showed an apparent falling off of 2,736,882, due to the revision of stages, &c. The revenue from the sale of electrical energy was £13,530 against £13,789 in 1915, a slight decrease in revenue, although they had actually supplied more energy. Generation and traffic expenses had gone up and so had the London office and other expenses. The maintenance and repairs were less than for 1915, due to the difficulty of obtaining materials. They were obliged to restrict the special track repair work which they had been doing for some years past. The reduction of maintenance and repairs work was not satisfactory, as it was only by maintaining the track in good condition that the electrical and general expenditure in connection with maintenance and rolling stock could be kept down to its proper level. Having failed entirely to obtain in Great Britain a few rails for repairs where the wear was abnormal, they were only able to secure an odd lot—and not all of one section—by paying a price which represented, delivered in Singapore, about £20 per ton, against the pre-war price of about £9 per ton c.i.f. The expenses of the whole undertaking represent 59 per cent. of the total receipts, while the Singapore expenses were 57·8 per cent. of Singapore revenue, compared with 62·2 per cent. and 59·5 per cent. for 1915. The directors intend to declare shortly an interim dividend of 5 per cent.

SOUTHERN BRAZIL ELECTRIC CO. (LTD.) — At the recent meeting the chairman (Mr. E. H. Tootal) stated that the electrification of the steam railway, which should have been completed some time ago, had again been delayed owing to want of the material required for construction, and for the same reason it had not yet been possible to comply with all the applications for additional power connections. It was intended to carry out two important extensions of the railway so soon as practicable, both of which were expected to result in a material increase of revenue when completed, and to consolidate the company's control of the district. Quite recently they acquired from the municipality of Itapira a 30 years' concession for the electric light and power service of that town, taking over from them as a going concern the existing system, which was no longer sufficient to meet local requirements. Itapira is a prosperous town about 20 miles north of Amparo in the centre of a very rich coffee district, where many estates would require to be connected for supply of current, and it was proposed to extend the transmission lines from Amparo to Itapira, thus linking up both towns with Campinas. When the service had been fully established in the town and the surrounding country it should yield a good return. Their new installations had been attended with most satisfactory results, as an instance of which he mentioned the small town of Rio das Pedras, where, since the shutting down of the old steam plant and the connecting up with the Pirasicaba power station the net revenue had increased about 300 per cent. With the resources of the State developing so rapidly, there was bound to be an increased demand for electricity. They were carrying forward the profit for the year (£1,196).

J. STONE & CO. (LTD.)—After allowing for depreciation, &c., the profit for 1916 was £114,853, and with £207,147 from 1915, the total was £322,000. Owing to further extensions of premises, the high cost of raw materials, &c., the directors propose to place £100,000 to reserve and to pay a dividend of 10 per cent. per annum, together with a bonus of 6 per cent. per annum on the ordinary shares, £142,968 being carried forward.

UNITED ELECTRIC TRAMWAYS OF MONTEVIDEO (LTD.)—At the meeting last week the chairman (Sir Geo. A. Touche, M.P.) said that their gross traffic receipts (£330,601) had advanced by £17,172 over the previous year. While gross receipts tended to improve, they might comfort themselves with the belief that the net receipts would look after themselves when conditions were again normal. Last year more car-miles were run and more passengers were carried, the number of the latter being equal to 114 times the population of Montevideo. The operating expenses were 68·69 per cent., compared with 63·64 per cent. in 1915-16 and 60·86 in 1914-15. The net traffic receipts (£108,898) showed a decrease of £11,322, which was the more serious as it followed a decrease of £21,257. Nearly three-quarters of the increase in operating expenses arose from the high price of coal. In the previous year the price ranged between 38s. and 52s. 6d. per ton, but it had steadily increased up to 101s. in October, 1916, and it was now about 150s., with no improvement in sight. Freights, which used to be 12s. to 14s. per ton, were now 100s. to 120s. Another item of additional expense was the operation of the Eight Hours' Law in Montevideo, for not only had it been necessary to increase wages so as to bring earnings up to something like the old figure in respect of a shorter day, but a larger staff was required. Last year he explained the adoption by the municipality of a vast paving programme, and its entry into a contract for an extensive scheme of asphalt paving,

Digitized by Google

about whose suitability for a city with Montevideo's gradients grave doubts had been expressed by experts. Work under the contract had commenced, and had affected, was affecting, and would continue to affect, the company's interests very seriously. The whole cost of paving the streets was defrayed by the owners of property on either side in equal parts. Where tramway lines existed, the company had to pay for the equivalent of the space occupied by the lines and 50 cm. on either side of the rails. The fact that the ultimate cost fell upon the property owners and the tramway companies (not the municipality) undoubtedly had been an important factor in influencing the authorities to enter upon so large a contract in a period of unparalleled stringency. If the project were persisted in, it would cast an oppressive burden on the tramway companies at a time when conditions were at their worst. The authorities had been urged to refrain from carrying out the project; but still the work proceeded, and further representations had been made with a view to restricting the amount of work done and the burden on the tramway companies to an extent in keeping with reasonable treatment of a commercial enterprise. Proceedings had been commenced in Monte Video with a view to obtaining a definite legal decision as to the company's legal position. The directors recommended payment of the preference divdend, carrying forward £12,814. In the first six months of the current year the gross receipts (£186,622) showed a decrease of £797, and operating expenses were £126,800, an advance of £9,310. The next six months were the lean months, when there were no exceptionally heavy traffics to help towards meeting the fixed charges, now abnormally high.

WESTERN UNION TELEGRAPH CO.—The gross operating revenues for 1916 was $61,919,140. Operating expenses (including repairs, taxes, &c.) were $48,727,921, leaving $13,191,219. Adding income from loans and investments and deducting interest on bonds and single special payment to employees, the balance is $12,395,405, making, with surplus from 1915, $31,552,635. Deducting amount transferred to reserve for maintenance of cables, the surplus is $24,568,068. The treasurer's balances have decreased $1,216,938, caused generally by the increased dividend paid and investments in securities and purchases of outstanding shares of leased companies. The volume of business during the year has been the largest in the history of the company. Compared with 1915 the gross operating revenues increased 21 per cent., operating expenses 18·9 per cent., income from loans and investments 30·6 per cent., net income for the year before paying dividends 21·9 per cent., dividends paid and declared 20 per cent., and the surplus, after transferring $1,000,000 to reserve for maintenance of ocean cable plant and allowing for dividends at rate of 5 per cent. per annum and 1 per cent. extra, 30·1 per cent. The increase in operating expenses is due not only to the well-known cause of material prices and a general increase in taxes, but to large increases in salaries and wages.

WAYGOOD-OTIS (LTD.)—At the meeting last week the chairman (Mr. H. C. Walker) stated that by rigid economy the result for the past year was encouraging, and would enable them to pay a further instalment on account of arrears of the preference dividend. They had executed a considerable amount of special work that was new to them and required careful supervision. They hoped to continue paying a dividend on the regular days unless something unforeseen should occur.

WEST COAST OF AMERICA TELEGRAPH CO. (LTD.)—The accounts for 1916 show an available sum, including £2,977 brought forward, of £31,308. After providing for interest charges, the same as for the previous year, transferring £14,000 to general reserve fund and providing £1,000 for investment fluctuations, £9,286 has been carried forward.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

BLACKWALL ENGINEERING & WELDING WORKS (LTD.) (147,833.)—Private company; reg. June 28. Capital £3,000 in £1 shares, electricians, mechanical and electrical engineers, welders, makers of motor vehicles and parts thereof, &c.

BRITISH GLASS WOOL CO. (LTD.) (147,843.)—Private company; reg. June 29, capital £1,500 in £1 shares, manufacturers of glass wool and glass fibre, importers and manufacturers of electrical appliances applicable thereto, and any other electrical and mechanical appliances, &c. First directors are A. R. Holmes (permanent) and Alice M. Stevens.

DOMINION EXPORT CO. (LTD.) (147,785.)—Private company. Reg. June 21. capital £1,500 in £1 shares. Exporters, importers, shipowners, shipbuilders, charterers, dealers in electrical and other apparatus, hardware, &c. Reg. office: Surrey Canal, Trundley-road, Deptford, S.E.

HOOTON & ELLESMERE PORT DISTRICT ELECTRIC SUPPLY CO. (LTD.) (147,809.)—Private company; reg. June 25, capital £3,000, in 1,500 "A" shares and 1,500 "B" shares of £1 each. Objects as title. First directors are S. S. Dawson, T. R. Cholmondeley, J. Macgregor and C. Stewart. Reg. office, 136, Albany-buildings, Old Hall-street, Liverpool.

JAMES & SHAKSPEARE (LTD.) (147,797.)—Private company, reg. June 22, capital £17,000 in £1 shares, to take over business of metal brokers and merchants formerly carried on at 1, Metal Exchange Buildings, E.C., and elsewhere, as "James & Shakspeare." First directors are: A. F. B. James, H. H. James and R. H. H. James. Reg. office: 1, Metal Exchange Buildings, E.C.

PRECISION GAUGES (LTD.) (147,753.)—Private company, reg. June 16, capital £2,000 in £1 shares, manufacturers of and dealers in gauges, testing and measuring tools, &c. Reg. office: 4, Wrentham-street, Birmingham.

REGINALD CHRISTIE & DICKINSON (LTD.) (147,848.)—Private company; reg. June 29, capital £1,000 in £1 shares, to take over the business of a marine engineer, engineers' agent and general machinist, formerly carried on as Reginald Christie & Co., also to carry on the business of consulting and electrical engineers, aeroplane manufacturers, &c. First directors are R. Christie and J. T. Dickinson.

MORTGAGES AND CHARGES.

BRILLIANT ARC LAMP & ENGINEERING CO. (LTD.)—Memorandum of satisfaction in full on May 12, 1917, of charge dated Dec. 7, 1916, securing all moneys due or to become due thereunder.

ENFIELD ELECTRIC CABLE MFG. CO. (LTD.)—Debenture dated June 8, 1917, to secure £35,000 charged on the company's undertaking and property, present and future, including uncalled capital, with a specific charge on land at Brimsdown, Enfield, and the factory and other buildings thereon, &c. Holders: London County & Westminster Bank.

FARADAY & SON (LTD.)—Particulars of £5,000 debentures created Jan. 6, 1917, have been filed, whole amount being now issued. Property charged: Company's undertaking and property, present and future.

PHONOPORE CONSTRUCTION CO. (LTD.)—Particulars of £2,000 debentures created May 15, 1917, the whole amount being now issued, property charged. The company's undertaking and property, present and future, including uncalled capital. No trustees.

RECEIVERSHIP.

LONDON UNITED TRAMWAYS (LTD.)—Notice of appointment of F. S. Price, 3, Frederick's-place, E.C., as receiver of company's undertaking (by Order of Court dated June 5, 1917) has been filed.

FOREIGN COMPANY.

U.S. LIGHT & HEAT CORPN. (1,583F.)—Particulars filed June 20, 1917, reg. in U.S.A. June 30, 1915, capital stock $7,000,000 ($3,000,000 preferred and $4,000,000 common stock). Principal office: City of Niagara Falls, U.S.A.; British address: 17, Conduit-street, W. 1. Directors: J. A. Smith, A. H. Ackermann, R. C. Caples, H. W. Farnum, E. H. Gold, E. K. Gordon, C. L. Lane, J. A. Roberts, B. J. O'Reilly and G. C. Shephard, all of U.S.A.

CITY NOTES.

AUTOMATIC TELEPHONE MFG. CO. (LTD.)—Warrants for dividend to June 30 on 6 per cent. cumulative preference shares have been posted.

BELL TELEPHONE CO. OF CANADA.—This company will commemorate Dominion Day by inaugurating a complete free pension system, covering the whole of its employés, numbering 9,000. The scheme includes old-age pensions, sickness and disability benefits to employés, and allowances to dependents of deceased employés.

BRITISH INSULATED & HELSBY CABLES (LTD.)—Warrants for interest to June 30 on the 4½ per cent. and 5 per cent. debenture stock have been posted.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units sold to consumers during the four weeks ended April 27, 1917, amounted to 2,174,348 compared with 1,917,213 units in the corresponding four weeks of 1916.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—The directors announce that it is impossible to complete the accounts to March 31 last, but they are satisfied that the result of the year's trading warrants payment of a dividend on the ordinary shares at rate of 10 per cent. per annum for the half-year ended March 31.

EASTERN EXTENSION, AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The interest on this company's 4 per cent. mortgage debenture stock for the year ending 31st inst. will be paid on the 1st August. The stock register will be closed from the 27th to the 31st inst. inclusive.

EDGAR ALLEN & CO. (LTD.)—The directors have declared a dividend of 10 per cent. and a bonus of 1s. 6d., making 17½ per cent., compared with 15 per cent. for the previous year, and £25,000 has been placed to reserve.

O. C. HAWKES (LTD.)—An interim dividend at rate of 5 per cent. per annum has been declared for the past six months.

INDIA RUBBER, GUTTA PERCHA & TELEGRAPH WORKS CO. (LTD.)—An interim dividend of 5s. per share (tax free) has been declared on the ordinary shares.

MONTREAL LIGHT, HEAT & POWER CO. (LTD.)—A dividend of 2 per cent. has been declared for the quarter ending July 31.

NATIONAL ELECTRIC SUPPLY CO. (LTD.)—A half-yearly interim dividend at the rate of 5 per cent. per annum, less tax, has been declared.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The transfer books will be closed from the 2nd to 12th inst. inclusive, preparatory to payment of an interim dividend of 5 per cent. (12s. per share), tax free, to shareholders on the register on the 2nd inst.

Digitized by Google

OUR MARK.

ONE, TWO AND THREE-PHASE.

The need of the hour is Efficiency.
For Efficiency and Economy use Langdon-Davies Motors.

LANGDON-DAVIES ELECTRIC MOTOR Co.

Head Office:

110, CANNON STREET, LONDON, E.C. 4.

Telephone: CITY 2744 (2 lines). Telegrams: "DAMOPHON, CANNON, LONDON."

Works: Eastdown Works, Dermody Road, Lewisham, London, S.E.

Telephone: LEE GREEN 1473.

AND AT

LEEDS.	NOTTINGHAM.	NEWCASTLE-ON-TYNE.
SHEFFIELD.	GLASGOW.	CARDIFF.
DUBLIN.	INDIA.	PARIS.
PETROGRAD.	MOSCOW.	GREECE.

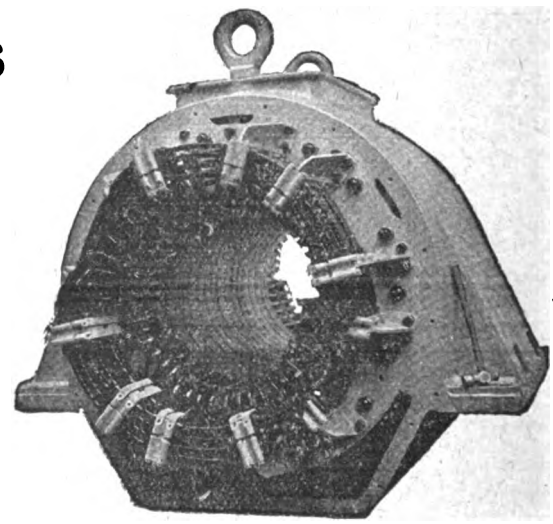
CONTRACTORS TO—

ADMIRALTY, WAR OFFICE, CROWN AGENTS FOR COLONIES, INDIA OFFICE, GENERAL POST OFFICE, LONDON COUNTY COUNCIL, &c.

Digitized by Google

Turbo-Alternators

Complete Electric Power and Sub-Station Plants, Steam Turbines, Mining Installations, Large Pumping Plants, Railway & Tramway Equipments, Manufactured & Supplied by



DICK, KERR

& CO., LIMITED.

HEAD OFFICE: ABCHURCH YARD, CANNON STREET, LONDON, E.C. 4.

Branch Offices: Manchester, Newcastle, Tokyo, Sydney, Buenos Aires, Johannesburg, Rio de Janeiro and Milan.

Digitized by Google

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—Why Glover's Almanac, of course; a diatrine tonic for every day in the week, including Sundays!

* * * *

Eatless Bread. There never was a better description since Grogan invented "extractives."

* * * *

"Tyneside" Clothier is evidently determined that Newcastle shall not be behind hand in electrical matters. He is consolidating the Electrical Section of the local Chamber of Commerce with a weather eye on trade after the war. The Hun electric power plant and cables in his area will, I expect, decide him to adopt as his watchword "Never AEGain."

* * * *

As a rule the British Commercial Gas Association is fairly accurate in its advertisements, though the management do not distress themselves on this point where electrical matters are concerned. A Stonehaven correspondent sends me an advertisement cutting from the "Strand Magazine" in which the following passage occurs:—

"In the summer, when the *barometer* denotes 80° in the shade—then indeed both mistress and maid bless the gas cooker."

Possibly this mention of the barometer is one of the subtle references of the B. C. G. A. to the vagaries of gas pressure, a subject which gas people are, as a rule, very reticent in discussing.

* * * *

Worcester's problem at the moment is to raise the Powick dam and increase the capacity of the electric power plant without obstructing the passage of fish; if it does the latter the Severn Fishery Board will have something to say about it. The electricity committee will in due course know whether to dam the river still further or the Fishery Board! Perhaps a compromise will be effected by electro-culture of the fish!

* * * *

The Same, Yet Not The Same.

Then the lighting station shift man, had the battery to charge
Ere he left for home and beauty—otherwise the chief would barge.
Now, you'll see him fix his bayonet; but his game is still the same—
He is off to charge a battery, though he comes back halt and lame.

Then the armature winders, who spent all their former days
'Midst the lap, the wave, the half-coil—they have gone their several ways,
O'er the wave that's ever lapping, all the mighty ocean's shores,
To the field of far spread glory—they're still busy *forming* fours.

And the baker leaves his oven, leaves his flour and his yeast,
For he knows his country needs him; he is shipped off to the East,
But you'll find him there in Egypt, or on Tigris' arid banks
'Neath the tropic sun—still baking—with his comrades in the ranks.

So all of us, both old and young, experienced or precocious,
May find our work is suitable, for circumventing Boches.

W. R. M. in *Glover's Almanac.*

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, July 3, 1880.]

MELBOURNE.—The use of the telephone has been adopted in the Argus office, and gives great satisfaction.

THE ELECTRIC LIGHT.—The Siemens system of lighting has been adopted at the Holyhead Harbour, also at the Victoria Docks Extension.

ELECTRIC CLOCKS.—A clock-maker of Copenhagen, named Louis Soenderberg, who for some time past has had charge of that city's electric time-keepers, has just invented an ingenious appliance which obviates the necessity of winding up the regulator from which the clocks in question "take their time." By a mechanical contrivance which periodically cuts off the stream of electric fluid emanating from the battery, and brings an electro-magnet to bear upon the relaxed mainspring in such sort as to renew its tension instantaneously, perpetual motion is practically imparted to the works of the regulator—that is to say as long as the batteries connected with it are kept properly supplied with acids. The discoverer of this important improvement has satisfied himself, by six months' successful experiments in his own workshops, that his system works faultlessly, and has applied for permission to adapt it to the electric clocks set up by the municipality in different parts of the Danish capital. Electricity, under Mr. Soenderberg's compulsion, is destined not only to make the Copenhagen clocks go, but to wind them up, with never-ending recurrence, until the "crack of doom."

PORTABLE ELECTRIC TOOLS.

The Light Electric Motor Co., Baltic-street, Dundee, which makes a speciality of portable electric drills, grinding machines, &c., has issued a number of leaflets giving particulars of their manufactures.

The unique features of these machines are largely centred in the motor, which is manufactured on a patented principle. It is universally recognised that in portable electric tools the motors have to work in the great majority of cases under very trying conditions. They are often operated under conditions of excessive temporary overload and not infrequently the overload is of a practically permanent nature. The inventor of the motor in question dispensed with the arrangements adopted in the ordinary type of design with the result that it is possible to obtain a machine with an armature diameter of 80 per cent. of the over-all diameter of the machine case. The advantages of the greatly increased torque, which is thereby obtained, are obvious and enable the ungeared models to be used on jobs which many ungeared tools could not be. The heat radiating surface of the armature core in direct contact with the air is from three to five times that of an ordinary machine of similar power, and even in the largest (*i.e.*, 1¼ in.) type no part of the armature core is more than ¼ in. from a radiating surface directly exposed to the air. The entire magnetic circuit is laminated, and all armature coils are former wound, binding wires being entirely dispensed with. Double silk copper wire is used throughout in all machines, and both armature and field coils are treated by a special process which makes them impervious to damp and capable of resisting high temperatures without risk of damage. The commutator is built upon a detachable sleeve and is of large diameter (not less than 2⅛ in. in the smallest machine), drawn bronze alloy bar and mica insulation being utilised. It is internally ventilated by a duct of large diameter, which will not become clogged up by oil or dust. Carbon brushes are fitted, working in radial brush-boxes fitted with spring tensions and ball bearings and thrusts are fitted.

The range of types manufactured include:—Breast drills $\frac{1}{16}$ in. to $\frac{3}{8}$ in., suitable for both alternating current and direct current circuits. pivot drills ¼ in. to ⅝ in. for direct-current circuit; 1¼ in. heavy duty side spindle drills; external and internal grinders for use in lathe with or without independent screw feed; portable hand grinders fitted with stirrup and stump handles and taking wheels up to 9 in. × 1 in. for dressing castings, rivet-head grinding, &c.; percussion tools of all types; riveting, clipping and caulking hammers, boiler and ship scalers, stone dressing and carving tools. It is claimed for these machines that they are lighter, considering their robust construction, power for power, than any other machine of similar efficiency; they will not burn out even should they be jammed dead; they are the most perfectly ventilated tools of their type; they will stand up to more severe continuous overloads than any other machine. All machines carry a 6 months' guarantee against faulty material and workmanship.

IGRANIC
STARTERS and REGULATORS
IGRANIC ELECTRIC Co LTD
for every requirement.
147, Queen Victoria St., LONDON.
No. 25.—Heavy Duty Starter. Copper and Auxiliary Carbon Contacts. Liberally Rated Resistance.

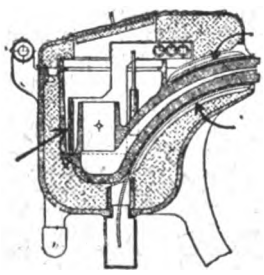
No. 200.—Combined Starter and Interlocked Shunt Field Regulator with Automatic Release.

Digitized by Google

ELECTRIC LINOTYPE POT.

The Cutler-Hammer Mfg. Co., Milwaukee (Wis.), has experienced a brisk demand for its electric linotype pot. According to the "Electrical Review & Western Electrician" both electric supply companies and printing houses have investigated the merits of the electric pot and are satisfied that it has many advantages over the gas-heated pot. Electricity is primarily clean, safe, quick, economical and easily controlled, and there is an absence of open flames and the resultant products of combustion. It furnishes a desirable load for the central station and the automatic temperature regulation gives the printer better slugs and at the same time electric heat makes his rooms odourless, cooler and more sanitary. While the machine is in operation the current input is 600 watts and since these machines operate from 8 to 12 hours per day, a steady non-fluctuating load is the result and in many newspaper plants the load is between midnight and morning. When the metal is cold, the input for about 50 minutes is about 1,600 watts. It can readily be seen that a considerable yearly revenue is given the central station where even but a few of these electric pots are in service; as few as 20 pots furnish a yearly load of over 50,000 kilowatt-hours.

The Cutler-Hammer electric linotype pot in its principle of applying heat to the linotype crucible is a departure from old methods. The heater is known as the immersion type, being immersed directly in the metal instead of being applied to the outside of the crucible. The immersed heater permits of no radiation except through the metal, thus making economical and comfortable operation. As the metal is uniformly heated from within the crucible, a high temperature can be applied at the start, and the metal can very quickly be reduced to a fluid state. The pot delivers the molten metal to the casting point at the exact temperature registered in the crucible, which, it is claimed, insures a perfect moulding of each character, and slugs that are solid



SECTION OF POT, SHOWING ARRANGEMENT OF HEATING ELEMENT.

and close-grained. The heating units are in sections, enclosed in cases of a special grade of steel. Two sides and all the edges of the cases are autogenously welded, making the structure liquid-tight. Two sets of heating units are immersed in the metal in the crucible. The entire surface of the pot, throat and mouthpiece over which the molten metal flows, is heated by units on the upper and under side.

The immersion principle of the Cutler-Hammer pot allows the full space between the crucible and jacket, formerly occupied by the gas burner, to be utilised for heat insulation. This confines the greater percentage of heat generated to the crucible and reduces the consumption of electric current.

Automatic temperature control is secured by the joint action of a dynamic thermometer and a magnetic switch panel. The bulb, or the temperature-responsive portion of the thermometer, is immersed in the crucible at a point most sensitive to temperature variations. To the bulb is attached a capillary tube leading to an operating coil in the control panel. These parts are of a special steel welded together into a system without joints. The free end of the operating coil governs the movement of a lever which controls a magnetic switch and the flow of electricity. The bulb, the capillary tube and operating coil are filled with mercury and sealed. The liquid expansion of the mercury causes the operating coil to move a lever to a contact, upon touching which the magnetic switch cuts off the current. As the temperature decreases the mercury contracts and the coil operating swings the lever back, closing the heating circuit. Thus, the heating current is automatically cut in and out and the temperature of the metal held within 12° above or below the mean operating point. It is stated that the "New York World," after a series of tests, equippped its entire battery of 56 linotyes with the Cutler-Hammer pot. On the United States battleship "Wyoming" a Mergenthaler linotype equipped with a Cutler-Hammer pot is installed and used in printing the "Wyoming's" magazine.

The illustration shows a section through the pot and gives the arrangement of the heating element. The pots are of standard design and construction, which makes them applicable to all outstanding linotype machines.

THE FUTURE OF INDUSTRY.

An important interim report has been prepared by the Sub-committee of the Reconstruction Committee on the relations between employers and employed, and copies have been sent to the leading employers' associations and trade unions.

In a covering letter from Sir D. J. Shackleton it is stated that the report, drawn up by a sub-committee mainly composed of prominent representatives of employers' associations and trade unions, puts forward certain important proposals for the better regulation of industry. The War Cabinet are deeply concerned that timely and effective measures should be taken to deal with these questions, for they feel that the future of industry, and indeed of the country itself, are closely bound up with their successful solution. Moreover, they feel strongly that action cannot be deferred until after the war, as it is essential that the problems concerning the organisation of industry which peace will bring should be fully and frankly discussed between employers and employed before they actually arise. Before deciding to adopt the proposals in the report the Government desire to have the general views of employers and trade organisations upon them. It should be understood that the proposals are applicable only to well-organised industries, and are intended to deal with only one aspect of the problem of industrial reconstruction; other aspects requiring other measures remain to be dealt with, but if the fundamental questions affecting the relations between employers and employed are satisfactorily settled on a permanent basis, the solution of all subsequent difficulties becomes incalculably easier. Communications on the subject should be addressed to Mr. Arthur Greenwood, Ministry of Labour, Montagu House, London, S.W. 1.

The sub-committee was composed of the Right Hon. J. H. Whitley, M.P. (chairman), Mr. F. S. Button, Mr. G. J. Carter, Prof. S. J. Chapman, Sir Gilbert Claughton, Bart., Mr. J. R. Clynes, M.P., Mr. J. A. Hobson, Miss Susan Lawrence, Mr. J. J. Mallon, Sir Thomas R. Ratcliffe Ellis, Mr. Robert Smillie, Mr. Allan M. Smith and Miss Mona Wilson.

The report states that the circumstances of the present time are admitted on all sides to offer a great opportunity for securing a permanent improvement in the relations between employers and employed, while failure to utilise the opportunity may involve the nation in grave industrial difficulties at the end of the war. It is generally allowed that the war almost enforced some reconstruction of industry, and in considering the subjects referred to us we have kept in view the need for securing in the development of reconstruction the largest possible measure of co-operation between employers and employed. In the interests of the community it is vital that after the war the co-operation of all classes, established during the war, should continue, and more especially with regard to the relations between employers and employed. For securing improvements in the latter it is essential that any proposals put forward should offer to workpeople the means of attaining improved conditions of employment and a higher standard of comfort generally, and involve the enlistment of their active and continuous co-operation in the promotion of industry. To this end the establishment for each industry of an organisation, representative of employers and workpeople, to have as its object the regular consideration of matters affecting the progress and well-being of the trade from the point of view of all those engaged in it.

With a view to providing means for carrying out the policy outlined above we recommend that H.M. Government should propose without delay to the various associations of employers and employed the formation of Joint Standing Industrial Councils in the several industries, where they do not already exist, composed of representatives of employers and employed. The appointment of a chairman or chairmen should be left to the council, who may decide that these should be: (1) A chairman for each side of the council; (2) a chairman and vice-chairman selected from the members of the council (one from each side of the council); (3) a chairman chosen by the council from independent persons outside the industry; or, (4) a chairman nominated by such person or authority as the council may determine, or, failing agreement, by the Government.

It is suggested that the council should meet at regular and frequent intervals, and should consider appropriate matters affecting the several industries, and particularly the establishment of a closer co-operation between employers and employed. Questions connected with demobilisation will call for early attention. One of the chief factors in the problem, as it at first presents itself, consists of the guarantees given by the Government, with Parliamentary sanction, and the various undertakings entered into by employers, to restore the trade union rules and customs suspended during the war. The committee take the view that while this does not mean that all the lessons learnt during the war should be ignored, it does mean that the definite co-operation and acquiescence by both employers and employed must be a condition of any setting aside of these guarantees or undertakings.

In the well-organised industries, one of the first questions to be considered should be the establishment of local and works organisations to supplement and make more effective the work of the central bodies. The National Industrial Council should not be regarded as complete in itself; what is needed is a triple organisation—in the workshops, the districts and nationally. Moreover, it is essential that the organisation at each of these three stages should proceed on a common principle, and that the greatest measure of common action between them should be secured. With this end in view, we are of opinion that the following proposals should be laid before the National Industrial Councils:—

(a) That district councils, representative of the trade unions and of the employers' association in the industry, should be created or de-

Digitized by Google

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite—Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1912 to 1917.

ATTWATER & SONS,

Telegrams: Attwaters, Preston. Telephone No. 1048 (2 lines).

Hopwood St. Mills, PRESTON.

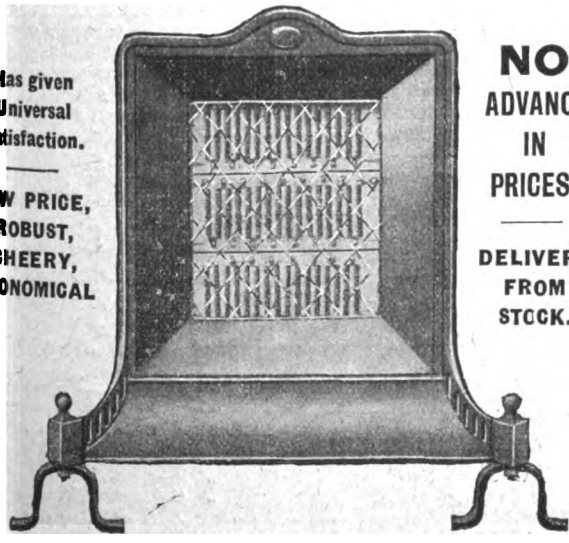
Established 1868. Codes: 5th Edition A B C & Western Union.

— THE —

ARORA

ELECTRIC

FIRE



Has given Universal satisfaction.

LOW PRICE, ROBUST, CHEERY, ECONOMICAL

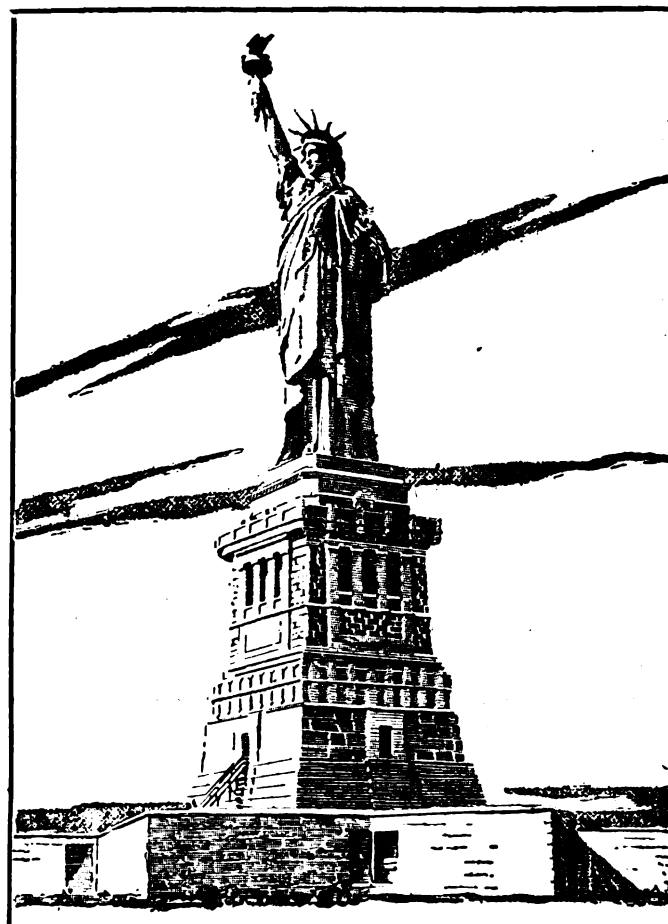
NO ADVANCE IN PRICES.

DELIVERY FROM STOCK.

Write for LIST G (Fires and Cookers),

to Sole Manufacturers—

THE ARORA CO., LOUGHBOROUGH.



LIBERTY AND FREEDOM.

It has been well said that the price of Liberty is eternal vigilance.

The price of Freedom from troubles in the erection and use of Electrical Conductors is the current price of Simplex Conduits Fittings and Accessories.

That Freedom also is purchased by the same eternal vigilance in all the processes of manufacture.

The price includes not only value in material things, but the added value that is contained in 20 years of experience in the selection of the fittest, and the elimination of the "good enough."

SIMPLEX CONDUITS LIMITED

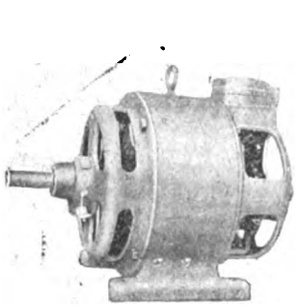
GARRISON LANE, BIRMINGHAM.

LONDON—
113-117, Charing Cross Rd, W.C.
MANCHESTER—
16, Corporation Street.
GLASGOW—
72a, Waterloo Street.
NEWCASTLE—
61, High Bridge.
BRISTOL—
10 & 11, Denmark Street.
LIVERPOOL—
96, Whitechapel.
LEEDS—
6, White Horse Street.
SWANSEA—
14, Heathfield Street.
CARDIFF—
4, Westgate Street.
ABERDEEN—
1, Crimon Place.
SHEFFIELD—281-3, Attercliffe Common.

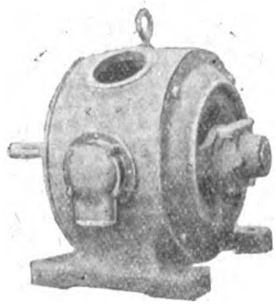
Digitized by Google

SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current.



For Three-phase Current.

for
ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

FOR
High and Low Tension
SWITCHGEAR
THE
NEW SWITCHGEAR CONSTRUCTION CO., Ltd.
SUTTON, SURREY, ENGLAND.
ABC Code 5th Edition. Telephone: Sutton 773.

If you wish to dispose to best advantage of your ACCUMULATION of
OLD and NEW SCRAP
EBONITE & VULCANITE SOLID SHAVINGS
RUBBER GLOVES, CABLES, TYRES, VALVES, &c.
GUTTA PERCHA CABLES BUCKETS
When writing for Price List return this advt. for Special Quotations to
J. SCHNURMANN, Downham Mills, TOTTENHAM
(Proprietors: J. J. SHERMAN and S. P. CASSY)
LONDON, N. 17.
Branch Works: 49/51, Broughton Lane, Manchester.

veloped out of the existing machinery for negotiation in the various trades.

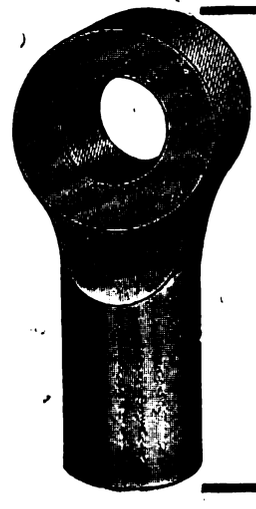
(*b*) That works committees, representative of the management and of the workers employed, should be instituted in particular works to act in close co-operation with the district and national machinery.

As it is of the highest importance that the scheme making provision for these committees should be such as to secure the support of the trade unions and employers' associations concerned, its design should be a matter for agreement between these organisations. The respective functions of works committees, district councils and national councils will require to be determined separately in accordance with the varying conditions of different industries. Among the questions with which it is suggested that the national councils should deal or allocate to district councils or works committees the following may be selected for special mention :—

(*i.*) The better utilisation of the practical knowledge and experience of the workpeople. (*ii.*) Means for securing to the workpeople a greater share in and responsibility for the determination and observance of the conditions under which their work is carried on. (*iii.*) The settlement of the general principles governing the conditions of employment, including the methods of fixing, paying and readjusting wages, having regard to the need for securing to the workpeople a share in the increased prosperity of the industry. (*iv.*) The establishment of regular methods of negotiation for issues arising between employers and workpeople, with a view both to the prevention of differences and to their better adjustment when they appear. (*v.*) Means of ensuring to the workpeople the greatest possible security of earnings and employment, without undue restriction upon change of occupation or employer. (*vi.*) Methods of fixing and adjusting earnings, piecework prices, &c., and of dealing with the many difficulties which arise with regard to the method and amount of payment, apart from the fixing of general standard rates. (*vii.*) Technical education and training. (*viii.*) Industrial research and the full utilisation of its results. (*ix.*) The provision of facilities for the full consideration and utilisation of inventions and improvements designed by workpeople, and for the adequate safeguarding of the rights of the designers of such improvements. (*x.*) Improvements of processes, machinery and organisation, and appropriate questions relating to management and the examination of industrial experiments, with special reference to co-operation in carrying new ideas into effect and full consideration of the workpeople's point of view in relation to them (*xi.*) Proposed legislation affecting the industry.

The methods by which the functions of the proposed councils should be correlated to those of joint bodies in the different districts, and in the various works within the districts, must necessarily vary according to the trade. It may, therefore, be the best policy to leave it to the trades themselves to formulate schemes suitable to their special circumstances, it being understood that it is essential to secure in each industry the fullest measure of co-operation between employers and employed, both generally, through the National Councils, and, specifically, through district committees and workshop committees. In forwarding the proposals to the parties concerned, we think the Government should offer to be represented in an advisory capacity at the preliminary meetings of a council, if the parties so desire. We are also of opinion that the Government should undertake to supply to the various councils such information on industrial subjects as may be available and likely to prove of value. It appears to us that it may be desirable at some later stage for the State to give sanction of law to agreements made by the councils, but the initiative in this direction should come from the councils themselves.

Stating that the plans sketched are applicable in the form in which they are given only to industries in which there are responsible associations of employers and workpeople which can claim to be fairly representative, the sub-committee give it as their considered opinion that an essential condition of securing a permanent improvement in the relations between employers and employed is that there should be adequate organisation on the part of both employers and workpeople. No suggestions or opinions are offered with regard to such matters as profit-sharing, co-partnership or particular systems of wages, the sub-committee considering it impracticable to make any useful general recommendations on such matters, having regard to the varying conditions in different



E. SHOWELL & SONS, LTD.
STIRCHLEY, BIRMINGHAM.
Cast
Cable Sockets.
Suite E74. Made in all Sizes.
Type A.—Straight.
„ B.—Offset.
„ C.—Right angle.
Illustrated Dimensioned Showcard for Drawing Office use supplied free on application.
Sole Agent for the Electrical Trade:—
LIONEL ROBINSON, 3, Staple Inn, London, W.C.
TELEPHONE: Holborn 6383.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

"The Cables have been laid, tested, formally accepted, and are now in daily service.

"The Government Authorities are satisfied and pleased with the quality of Prescot Cables and Fittings."

Thus one of our foreign representatives.

We somehow thought this new customer would be pleased.

We have supplied many cables to many parts of the World for many years, with a like result.

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED SECOND HAND

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Vicmaster, Sowest London.

For Effective Impregnation
use "LACWATT"
Black or Golden Brown.
JENSON & NICHOLSON, Ltd., Insulating Varnish Department, Goswell Works, Stratford, E.15.

Digitized by Google

LOAD AND EXPERIMENTAL
RESISTANCES
MADE TO ANY SPECIFICATION.
Particulars of Standard Types will be found in our List, to be had on application.
RAPID DELIVERIES GUARANTEED.
ISENTHAL & CO., Ltd.,
(DEPARTMENT 4)
Denzil Works, Willesden, London, N.W. 10.
Contractors to the Admiralty, War Office, India Office Colonial Office, Postmaster General, etc.

trades. They state, however, "We are convinced, moreover, that a permanent improvement in the relations between employers and employed must be founded upon something other than a cash basis. What is wanted is that the workpeople should have a greater opportunity of participating in the discussion about and adjustment of those parts of industry by which they are most affected. The schemes recommended in this report are intended not merely for the treatment of industrial problems when they have become acute, but also, and more especially, to prevent their becoming acute. We believe that regular meetings to discuss industrial questions, apart from and prior to any differences with regard to them that may have begun to cause friction will materially reduce the number of occasions on which, in the view of either employers or employed, it is necessary to contemplate recourse to a stoppage of work."

Questions addressed by the Reconstruction Committee to the Sub-committee, and given with the answers in an appendix to the report, show that as there already exist in most organised trades joint bodies for particular purposes, it is not proposed that the industrial councils should necessarily disturb these existing bodies. It is contemplated that agreements reached by industrial councils should (whilst not possessing the binding force of law) carry with them the same obligation of observance as exists in the case of other agreements between employers' associations and trade unions.

OERLIKON ELECTRICAL ENGINEERING WORKS.

A 64-page brochure recently issued by the Oerlikon Works illustrates chronologically some of the principal Oerlikon engineering products, and incidentally also gives a few exterior and interior views of the modern Oerlikon Works.

Developments in the organisation of the workshops have been made, which enable the company to promise reasonable delivery schedules. The importation of raw materials into Switzerland from America and Great Britain, also to a less extent from Scandinavia, is receiving attention, and facilities are offered by the Société Suisse de Surveillance Économique and by the attestations from the Ministries of Munitions of the Governments of Nations allied to Great Britain. The Oerlikon Co. is a specifically Swiss undertaking, and its factories are run and managed by Swiss, while over 98 per cent. of all the labour is Swiss.

Bolivian Tungsten and Antimony.—The tungsten output of Bolivia for 1915 was 792·5 metric tons, an increase of 516·5 tons over that of 1914. "Engineering" states that the United States took 436 tons and Great Britain 357 tons of the 1915 output. The Bolivian antimony production in 1915 amounted to 17,923 tons, against 186 tons in 1914. Great Britain took the larger part of the 1915 output, 16,184 tons, 1,589 tons going to the United States.

BELLING
FIRES
GRILLERS
BOILERS
OVENS
ALSO ALL KINDS OF SPECIAL ELECTRICAL APPARATUS FOR MUNITION WORKS & MANUFACTURING PURPOSES
BELLING & CO.,
ELECTRIC HEATING & COOKING SPECIALISTS,
Derby Road Works, Montague Road,
UPPER EDMONTON, LONDON, N.

ELECTRICAL CHINA.
PROTECTION OF ENGLISH TRADE.
ENGLAND
ALL GOODS MADE BY MEMBERS OF THE CHINA FURNITURE AND ELECTRICAL FITTINGS MANUFACTURERS' ASSOCIATION ARE MARKED WITH ABOVE TRADE MARK, WHICH IS A GUARANTEE OF ENGLISH MANUFACTURE.
T. H. SIMMONDS, Secretary,
BRYN, GOLDTHORN HILL, Wolverhampton.

H. Weidmann, Ltd., Rapperswil, Switzerland.
WE ARE SPECIALISTS IN THE MANUFACTURE OF—

PRESSPAN (2)
(Pressboard)
Best Quality.——Proved by repeated tests.
Sheets in thickness from 0·1 upwards.
Endless Rolls and Strips from 0·1 to 1 mm. thickness.
Presspan Coils and Tubes for Transformers.
Presspan Armatures, Discs and Shaped Articles.
VARNISHED PRESSPAN. BLACK PRESSPAN.
OILED PRESSPAN. MICA-COVERED PRESSPAN, &c.
Grand Prix: Marseilles 1908. Gold Medal: Berne 1914. Silver Medal: Paris 1900.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,043. [Vol. LXXIX. No. 15.] FRIDAY, JULY 13, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 573
Arrangements for the Week 575
New Concentric Standard Dynamometer Wattmeter for Heavy Currents: And Concentric Non-Inductive Standards of Low Resistance. By A. E. Moore. Illustrated.—*Concluded* 576
The Condensation Pump: An Improved Form of High Vacuum Pump. By Irving Langmuir. Illustrated 579
Phase Lag in Current Transformers. By A. J. Makower, M.A., and A. Wuet. Illustrated 581
Engineering Precautions in Radio Installations. By Robert H. Marriott 583
Water Power and Power Transmission in the United States. By Dr. Louis Bell 585
THE DISTRIBUTION OF COAL 586
Effect of Current-Limiting Reactors on Turbo-Generator Systems Under Conditions of Short Circuit. By P. B. Juhnke. Illus. 589
Shall Great Britain and America Adopt the Metric System? *Discussion* 590
CORRESPONDENCE 591
Coal Supply and Distribution. Illustrated 592
LEGAL INTELLIGENCE 594
Patent Record 594
Volunteer Notices 594
COMMERCIAL AND INDUSTRIAL SECTION 597
Electricity Supply 598
Tenders Invited and Accepted 600
Financial Matters 601

NOTES.

Fuel Economy by Altering Steam Conditions.

IN our correspondence columns this week we publish an interesting letter from Mr. F. SAMUELSON describing the results obtained with steam plant at the Rugby works of the British Thomson-Houston Co. Mr. SAMUELSON points out that considerable economy may be attained by using higher steam pressures and higher temperatures, the possible saving being in the neighbourhood of at least 15 to 18 per cent. Moreover the proportional improvement is greater the higher the temperature. Alterations in this direction are, of course, limited by the strength of materials at high temperatures, and thus about 800°F. may be looked upon as the limit. Mr. SAMUELSON points out that a pressure of 500 lb. per sq. in. is desirable, but after consultation with Messrs. Babcock & Wilcox the pressure of 350 lb. was adopted as a compromise and the steam was superheated to a total temperature of 700°F. The plant which has been constructed and run to prove this contention is of 1,500 kw. capacity. As will be seen by the curves which we reproduce, the results obtained with a 1,500-kw. turbo-alternator under these conditions were remarkably good, the steam consumption at full load being about 11·2 lb. per kilowatt-hour. From the test figures it was found that the heat supplied to the boiler amounted to 20,000 B.Th.U. per kilowatt-hour generated exclusive of power taken for auxiliaries, the boiler efficiency being 80 to 83 per cent. This must be considered as an exceedingly satisfactory result for a plant of this size. Owing to the improved efficiency under the conditions obtaining at the works, the saving in coal has exceeded the 15 to 18 per cent. which was suggested. Only minor troubles have been experienced. Mr. SAMUELSON refers to certain power plant schemes with high load factor in which it was found that the steam consumption, including all losses, but exclusive of power taken for auxiliaries, would be only 15,000 B.Th.U. per kilowatt-hour. These results serve to emphasise the view held by many engineers that we have by no means yet reached finality in steam practice, and that a very considerable economy is still possible if suitable methods are adopted and old plant is discarded.

Effect of Current-Limiting Reactors.

ELSEWHERE in this issue is given an abstract of a Paper of considerable interest that was read earlier in the year before the American Institute of Electrical Engineers. The author, Mr. P. B. JUHNKE, deals with the effect of current-limiting reactors on turbo-generator systems under conditions of short circuit, and takes as an example the system of the Commonwealth Edison Co., which has a rated generator capacity of about 250,000 kw., the total reactance of each of the generators being 8 per cent. or thereabouts. A fault on one of the outgoing cables near the generating station resulted in a second fault on the same line within the station, and this second fault (which on investigation was found to be between the oil-switch and current transformer) prevented the oil-switch from automatically disconnecting the faulty line. Apart from the unusual nature of the fault itself two significant facts are brought to light. The first of these is that in virtue of a fault on what might easily be an important line 40 per cent. of an enormous power supply system can be temporarily put out of action. The second of these is one on which the engineers in charge of the system are to be congratulated and deals with the speedy resumption of service. It appears that the service interrupted from sub-stations connected to the section in trouble amounted to about 50,000 kw. for five minutes; on one of the two sections protected by sectionalising reactors to 20,000 kw. for three minutes, and on the other to about 10,000 kw. for two minutes. Till comparatively recently such a fault on a much smaller system would have given rise to a long interruption of supply, and would in all probability have resulted in the breakdown of a good deal of the generating plant. In the case which Mr. JUHNKE describes, none of the generating plant was disabled, and even on the section directly affected everything was ready for immediate resumption of service as soon as the fault was cleared. The figures for the probable value of the short-circuit are based on experimental data obtained some time ago on the machines in another station. From these it appears that the stresses due to the short circuit were only about one-third what they would have been without protective reactances. The estimate of a stress of half-a-ton per foot of conductor in the unprotected station seems to be a reasonable one, and the existence of such high short-circuit stresses has been established beyond question in many cases. We have said that on account of a trivial defect either in the lay-out or design of the plant, 40 per cent. or more of the plant may be put out of action for a time. Nothing can be more exasperating to power supply authorities than these weak links in the chains of perfection which they are forging, and from every point of view it would be well to spare no effort in endeavouring to remove them.

Digitized by Google

Excess Profits Duty.

A WHITE Paper has now been issued which will do much to clear up the position of firms in regard to the valuation of stocks, the allowance for wear and tear, depreciation, &c., permitted in evaluating the excess profits duty. From the abstract which we give in another column it will be seen that broadminded views are being taken by the Government on various points. The value of stocks is a case in point. If these are merely taken at their cost price or at their market price, which ever is the lower, there may be considerable hardship on many firms on the termination of the war, owing to the fact that they will have purchased stocks at high prices and will not be able to utilise them before the market prices have fallen considerably. This hardship is realised and consequently an allowance is to be made from the profits for any difference between valuation and the sum realised on the market. We take it that if the valuation is lower than the purchase price a reserve is permissible which will be allowed. The principle is adopted that a profit can only be obtained by sales and not by mere market fluctuations in the value of stocks. This principle is sound. In regard to wear and tear special allowances are to be permitted for depreciation in addition to the usual allowance for ordinary wear and tear. Special relief will be granted in respect of postponement or suspension of renewals or of repairs as a consequence of the war, for exceptional depreciation or obsolescence of assets, and for the necessity of providing plant which will not be required after the war. These allowances extend to any material assets, and not merely to machinery or plant, and the measure of the allowance to be made will be the difference between the cost and the post-war value. The measure of the allowance will be the difference between the value of the assets (depreciated or written down for wear and tear), to date from the time when liability to excess profits duty began, and their post-war value. We notice a reference to the "temporary character" of the excess profits duty and hence to the necessity for special allowances for depreciation. We hope this does not mean that the Government merely regard the question of depreciation as a matter for temporary consideration; we hope, indeed, that in future this item will figure properly in arriving at the profit of industrial concerns for purposes of income tax.

The Patentee and His Patents.

UNDER existing conditions the lot of the inventor is not a happy one. In order to protect himself he must pay the annual dues to keep his patents alive; and in many cases he does so with the knowledge that there is no immediate likelihood of being able to develop the patent. But, apart from what may be called out-of-pocket expenses, these unfortunate inventors have so far lost, for all practical purposes, about three years of the protection which the patent affords. If the war lasts another year or two, the patentee will lose approximately 33 per cent. of the time covered by the patent. Notwithstanding the many urgent calls on the time of Parliament, we think that time could be found for bringing in a short Bill for prolonging the life of patents adversely affected for a period equal to, or preferably one year greater than, the duration of the war. We understand that the Comptroller of the Patent Office has this matter under consideration, but we think it is time that some definite steps were taken. We also feel that something ought to be done to safeguard the interests of those who take out a provisional patent at the present time, the more so since a large proportion of the useful inventions, having nothing whatever to do with the war, cannot be developed owing to the impossibility of obtaining materials and labour. Proofs are not wanting which show that British patents, taken out as recently as 1915, are being exploited in neutral countries by German engineers, to the detriment of the engineering firms at home.

Institution of Electrical Engineers (Students' Section).—The Committee of the Students' Section of the Institution invites offers of Papers from students to be read during the coming session, between September, 1917, and May, 1918. Offers should be sent with as much information as possible to the Hon. Secretary, Mr. A. W. Grace, "Evandale," Granville-road, Sidcup.

American Gear Manufacturers' Association.—The newly-formed American Gear Manufacturers' Association held its first convention in Pittsburg on May 14th–15th. It is hoped that at the present time the Association will be helpful in promoting the efforts being made by the U.S.A. Government in the direction of standardisation of manufacture. Addresses were given on "Industrial Organisation" and "The Spiral or Curved Tooth Bevel Gear," and a visit was paid to the Pittsburg works of the Westinghouse Electric & Mfg. Co., where bakelite micarta for gears is manufactured.

Magnetic Aluminium Alloys.—Experiments carried out at the Engineering Experiment Station of the University of Illinois in 1915, showed the advantages of certain iron-silicon alloys, for electromagnetic uses. Other researches on iron-aluminium alloys melted in vacuo, have shown that aluminium, like silicon, greatly improves the magnetic properties of the metal, and also that aluminium imparts to the metal a greater toughness than silicon. These results are summarised in Bulletin No. 95, copies of which can be obtained from Mr. C. R. Richards, Director of the Illinois Engineering Experiment Station, Urbana, Illinois, U.S.A.

Magnetic Separators.—A recent issue of "Metallurgical and Chemical Engineering" contains some notes on the use of magnetic separators in treating minerals in a fine state of division. Thus, in treating monazite sand, magnetite is removed by the weakest magnet, ilmenite by the intermediate, and monazite by the strongest magnet. The use of a series of magnets of different strengths enables discrimination to be made between substances of varying magnetic susceptibility. Magnetic separators of the multipolar type have proved of great utility in purifying some classes of zinc ores, while the magnetic tungsten materials, wolframite, huebnerite and ferberite appear to lend themselves particularly well to such treatment.

The Corrosion of Cast Iron.—A Paper by E. A. and L. T. Richardson in the "Proceedings" of the American Electrochemical Society (May 25, 1917), discusses the value of cast iron as a rustproof material. For many purposes cast iron is in this respect preferable to steel. Instances are on record of cast-iron objects having remained in good condition though subjected to corrosive influences for many years, and underground it is usually superior to other kinds of iron. Its behaviour in this respect is contrary to the theory of electrolytic corrosion, according to which cast iron, being less homogeneous than steel or pure iron, should rust faster. It is possible that, although the initial rusting is largely determined by electrolytic action, other factors, such as the adherence of the coating of rust and the protection given thereby, have an important bearing on the subsequent resistance of the material to corrosive influences.

Exhibition of Women's Work at Leeds.—The series of exhibitions of women's work that is being arranged by the Labour Supply Department of the Ministry of Munitions is to be continued on July 9th by an exhibition at Leeds, which will be open for a fortnight. The exhibition will include samples of work, and a variety of photographs illustrating women so engaged, the photographs being arranged in 14 groups. Among the classes of work illustrated are engines for motor cars, "banks"; accessories, such as sparking plugs for such engines; guns and gun components; gauges and dies, optical munitions, wood and metal work for aircraft. In the photographs women are seen daubing, discharging and crunching coke, carrying rails to the saw, and charging the furnaces in rail mills; marking and nicking billets with the oxy-acetylene blow-pipe; treating hot naphthalene in chemical works—in fact, doing a great variety of operations undertaken almost entirely by men previous to the war.

Digitized by Google

Radiation from Straight and Helical Filaments.—An investigation on the above subject by Mr. W. W. Coblentz at the Bureau of Standards, and summarised in the "Electrical World," show that the brightness of the interior of the helix filament in a gas-filled lamp is as much as 1·87 times that of the exterior surface. Worthing and Langmuir have shown that the difference in temperature of these two areas could not exceed 5°C., whereas a difference of 200°C. would be needed to explain the greater brightness of the interior. Spectrophotometric researches show that the light from the interior is appreciably bluer and also shows marked polarisation. According to Coblentz, the greater brightness is due to successive reflection from adjacent tungsten surfaces. The selective reflection explains the bluer tint of the light and also the fact of its being partially polarised.

Local Co-operation in Developing Power Supply.—In these days, when action by the State seems to be regarded as a necessary preliminary to the development of power supply—and, indeed, for all developments on a large scale—it is interesting to observe in the United States how local enterprise often operates in such matters. An instance quoted in the "Electrical Review and Western Electrician" is afforded by the action taken in a prosperous Eastern city in the United States, which determined to develop important natural resources in the form of water-power in the vicinity. The community were at first rather slow to appreciate the value of the new service until the matter was taken up by the editor of a local journal, who dwelt on the advantages to the city of the new development. One could wish that the daily press always took an equally enlightened view of enterprises of this description.

Filters for Ultra-Violet Light.—A Paper by Mr. H. W. L. Absalom in the "Philosophical Magazine" summarises some researches with a view to obtaining colouring matter which, while opaque in the yellow region of the spectrum, should transmit as far as possible into the ultra violet. The materials tested included a variety of crystals and gems with a blue colouration, and also solutions of suitable analine dyes and other colours. Natural blue rock salt and natural blue rock salt coloured by cathode rays give promising results, while the aniline dyes and various coloured salts were much inferior to those obtained from colloidal metals. For example, a solution of magnesium in ammonia is extremely transparent in the ultra-violet region, and the relatively high transparency of certain varieties of zircon and topaz suggests that in this case also the colouring material is of the nature of colloidal metal.

Influence of Surface Tension on the Properties of Metals. In a recent Paper before the Iron and Steel Institute, Mr. F. C. Thompson contends that surface tension plays an important part in determining the properties of many metals; for example, the annealing of cold-worked materials, the influence of slag on the structure of a boiler plate, the tempering of steel, and the effect of special elements, such as manganese. He quotes an instance of annealed iron containing 0·05 per cent. carbon, the cement of which might be credited with a tensile strength of almost 550 tons per square inch, whereas the corresponding value for crystalline iron is in the neighbourhood of 20 tons per square inch. Such a difference, he suggests, can only be properly explained by the surface-tension theory, which must also be applied to explain why the layer of cement should adhere so closely to the main mass of material, and the nature of growth and form of the crystals.

The Theory of Decay in Radio-Active Luminous Compounds.—At a recent meeting of the Royal Society, Mr. J. W. T. Walsh read a Paper on this subject. The theory of destruction of "active centres" put forward by Rutherford to account for the decay of luminosity of radio-active luminous compounds leads to a simple exponential relation in the special case of a compound of constant activity. It has been found for radium zinc sulphide compounds that this relation expresses the observed results to a sufficient accuracy over short periods of less than 200 days, but that it fails to do so over longer periods, such as 500 days, the rate of decay of luminosity becoming gradually slower and slower, so that the brightness tends to a limiting value which is not zero. The Paper is an attempt to find a luminosity time relation which will allow of the prediction of the ultimate behaviour of compounds of varying composition, and it assumes the operation of some factor acting in a direction opposite to that of the destruction of the active centres.

Arcs Under Pressure.—Recent improvements in searchlights have taken the form of various methods of cooling the electrode with a view to obtaining greater local concentration of the light, either by a spray of alcohol or, as in the Sperry searchlight, by a blast of air. Another line of development being investigated in Germany has been the use of arcs under high atmospheric pressure. Lummer was reported to have obtained promising results shortly after the outbreak of war, and it was thought possible that a considerable improvement in the efficiency of arc lamps and projectors might be secured in this way. According to some experiments described by Mathiesen in the "Elektrotechnische Zeitschrift," this anticipation is not being realised. Pressures varying from a vacuum up to 5 atmospheres compression were utilised, both with inclined and vertical carbons. In the former case a marked gain in efficiency was secured, but the arc was found to become very unstable for pressures exceeding one atmosphere. On the other hand, with vertical carbons more stable conditions are realised, but the gain in efficiency seems to be very moderate.

"The Central."—The June issue of the "Central" contains some interesting articles. The first is by Mr. F. F. Renwick, and describes his method of localising foreign bodies in a wounded patient by means of X-rays. From the description, which is not very clear, it appears that the method eliminates geometrical constructions and careful measurements. The procedure is to take one exposure, then move the X-ray tube through a convenient distance parallel to the plate and make a second exposure on the same plate, which remains fixed. All objects equally distant from the plate will show two images equally displaced. The meaning of the displacement is determined by having an object on the patient's body at a known distance. Another article of topical interest is one on "The Human Element in Industry," in which the value of welfare work is emphasised. We note that the author favours compulsory evening classes as part of such a scheme, but we feel this view requires some qualification. In the third article a chatty account is given of the work of a Field Company in Picardy, and this is followed by a description of the Arthur's Pass Tunnel in New Zealand. The issue concludes with notes of the doings of old students.

OBITUARY.

DEATH ON ACTIVE SERVICE.—The following death on active service is reported:—

Capt. G. S. Thorne (R.F.C.), who has been missing since March 18 brought his aeroplane safely to earth on that day, but died of wounds shortly afterwards. He was 35 years of age and was formerly engineer of the Chinese Government Power & Light Station at Canton. His brother, Lt.-Col. H. V. H. Thorne, was killed in action on May 9.

PERSONAL.

F. R. C. Rouse, who has been associated with the various "Venner" companies and also Messrs. Chamberlain & Hookham for some years, is now a Lieutenant and I.O.M. in the engineering branch of the Army Ordnance Dept. He would be glad if old students of the electrical department of Finsbury Technical College would in future communicate particulars of their doings to Mr. J. F. Shipley, 35A, Upton-road, Birkenhead, instead of to him.

WAR HONOUR.—We are informed that Mr. Laurence A. Gripper, who in peace times is an official at the Blackburn Electricity works and is now a motor-ambulance driver in the Friends' Ambulance Unit of the British Red Cross attached to a division of the French Army in France, has just had the Croix de Guerre conferred upon him. He is one of five members of the unit to be thus distinguished for conspicuous bravery.

WAR CASUALTIES.—The following casualties are reported:—

Pte. L. North (R.F.), and Gunner T. W. B. Purchase (R.F.A.), formerly in the general office and the cashier and buyer's department of the India Rubber Co., respectively, have been wounded.

Digitized by Google

NEW CONCENTRIC STANDARD DYNAMOMETER WATTMETER FOR HEAVY CURRENTS: AND CONCENTRIC NON-INDUCTIVE STANDARDS OF LOW RESISTANCE.*

BY A. E. MOORE.

(*Concluded from p.* 541.)

CALIBRATION AND USE OF THE REFLECTING CONCENTRIC INSTRUMENT AS A STANDARD WATTMETER.

The scale at present used with the instrument is a straight one, 43 in. long, divided into tenths of an inch and placed approximately 2 meters away from the instrument. A calibration curve may be used with the wattmeter when desired, but for standard purposes the deflection is, as far as possible, always arranged to be either a fixed value or to deviate from the fixed value by only a small amount. This is brought about by varying the resistance of the pressure-coil circuit until a suitable constant is obtained.

Calibration.—The wattmeter is calibrated by the measurement of a single current in the following manner: The instrument is arranged with a standard resistance of 0·001 ohm, as a shunted-type dynamometer ammeter, the connections being as indicated in Fig. 8. The pressure-coil is connected in series with a non-inductive resistance so that the total resistance of the pressure-coil circuit is 500 ohms. A continuous current is maintained in the main circuit and is adjusted until the required deflection is obtained on the wattmeter scale. The current is measured by means of a potentiometer connected to the 0·001-ohm resistance strip. Then

if I = the current in amperes in the main circuit,
R = the resistance of the strip in ohms,
r = the resistance of the pressure-coil circuit,
v = the potential difference across the resistance R,
d = the deflection of the wattmeter,
k = the watts per division of the scale for a pressure-coil resistance of 1 ohm,

$$k = Iv/rd = I^2R/rd, \text{ or } krd = I^2R.$$

That is to say,

Watts indicated by instrument $= krd$,

since I^2R is the power absorbed by the resistance R. In fact the method of calibration consists in making the wattmeter measure the power absorbed in the resistance R, and the true value of this power is readily calculable if the resistance of R and the value of the current are known.

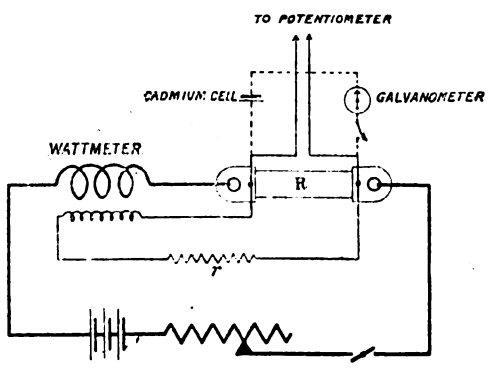


FIG. 8.—CONNECTIONS FOR CALIBRATION OF DYNAMOMETER AS WATTMETER OR AMMETER.

This method of calibrating ensures a minimum of errors. Only one current has to be measured and in making the measurement, therefore, no assumption is made with reference to the constancy of a second current or pressure. If the resistance r is chosen so that the desired deflection is produced with a potential difference at the terminals of the resistance R about equal to that of a standard cadmium cell (*i.e.*, a current of 1,000 amperes if $R = 0{\cdot}001$ ohm), certain possible errors in the potentiometer are eliminated. The potentiometer, as such, is in fact unnecessary when the above conditions obtain, and the author is arranging the testing circuit as indicated by the dotted lines in Fig. 8. In this case the main current is adjusted until the potential difference on the resistance R exactly balances the electromotive force of the standard cell. The resistance r is then varied until the required deflection is obtained.

The accuracy of the calibration will obviously depend upon the accuracy with which the resistances R and r are known.

* Abstract of a Paper in the "Journal" of the Institution of Electrical Engineers.

WATTMETERS FOR HIGH AND LOW POWER FACTOR MEASUREMENTS.

In good dynamometer wattmeters designed to give a full-scale deflection with full-load volts, full-load amperes and unity power factor, it is generally hardly necessary to make corrections for the phase lag in the pressure coils even when the instrument is used on low power factors.

It must not be assumed, however, that all the instruments so calibrated are free from measurable errors at low power factors. There are, in some types, serious errors due, not to the phase lag in the pressure coil, but to other disturbances.

The requirements in a wattmeter for making accurate measurements at low power factors are much more exacting than those which obtain in the high power factor instrument. In making measurements of the iron and copper losses in large reactance coils, transformers and induction motors, the power factor often falls as low as 0·05. To obtain accurate results it is essential that a reasonably large deflection be obtained on the wattmeter used, and an instrument is required which will give a full-scale deflection with full-load volt-amperes and a power factor of about 0·1 or even less. To obtain this on low-voltage circuits, and at the same time to maintain a reasonably strong control on the movement, the resistance of the pressure-coil circuit has to be diminished to a value which, in some cases, makes the pressure-coil inductance correction somewhat large at low power factors. It is very important indeed that there should be no phase error in these instruments other than that due to the inductance of the pressure-coil.

To correct for the phase lag in the pressure-coil the percentage correction is approximately $\pm 100 \times \frac{2\pi fL}{R} \tan \varphi$, and for a particular instrument, $100 \times 2\pi L$ is a constant, so that a curve may be plotted showing the relation between the power factor ($\cos \varphi$) and $100 \cdot 2\pi L \tan \varphi$.

The experiments made on the author's concentric instrument show that it is well suited to the low power factor measurements referred to above. The torsion-head instrument previously mentioned was used for a short time in the Transformer Department of the British Westinghouse Co., for the measurement of copper losses in cases where the current was over 1,400 amperes and the power factor about 0·05, and was found to be quite satisfactory. A unique feature of this torsion-head instrument is that the whole of the fittings outside the main current element are made of metal. This is a distinct constructional advantage obtaining with the concentric system, on account of there being no magnetic field produced outside the cage by the main current.

DOUBLE ELEMENT WATTMETERS FOR TWO-PHASE AND THREE-PHASE POWER MEASUREMENTS.

The author has recently made tests on the concentric instrument with the view to the construction of a two-element (polyphase) standard. Dr. Sumpner has pointed out that it is not possible to construct an ordinary deflectional two-element wattmeter without working to a predetermined scale. But in the zero types of instruments, torsion-head and balance, and also in a deflectional type used at a constant deflection, this defect does not obtain. The defects in two-element dynamometer wattmeters, other than the one referred to, are due to (*a*) magnetic, (*b*) electrostatic, disturbances between the two elements of the meters. Both these defects are eliminated naturally in the concentric system, because (1) the main currents produce no magnetic field outside the main-coil elements, and (2) each element of the movable system is enclosed within a metal cage at the same potential as itself. Although the cages may be at a comparatively high difference of potential from each other, the moving system is effectively screened from electrostatic disturbances.

The following considerations will serve to show the advantages of a standard two-element meter for checking the accuracy of three-phase integrating meters tested on a three-phase load:—

Some time ago the author made tests on polyphase integrating meters of various types and the tests showed that when the meters were tested on a three-phase load the results were different from those obtained when the meters were tested on a single phase load.* One of the chief reasons for this is that there is interference between the different single-phase elements, of which there may be two or

* "Journal," I.E.E., 1911, vol. 47, p. 44.

Digitized by Google

three in a particular meter. When the three-phase testing circuit is properly arranged it is less tedious to test a three-phase meter with a three-phase load than to test each element separately on a single-phase load, especially if a three-phase standard is available. At the same time, if there were no interference whatever between the single-phase elements of the meter, a properly carried out single-phase test would give exactly the same results as obtain on the three-phase test. If this were not true, then it would not be possible to construct a two-element, three-phase standard and calibrate it with continuous current. The author believes that it is possible to construct such a standard with the concentric system.

Scheme of Connections for Testing Two-element Polyphase Meters by the Two-circuit or False Load Method.

If the wattmeters are connected in the same manner on a two-circuit three-phase load (Fig. 9), one of the common point con-

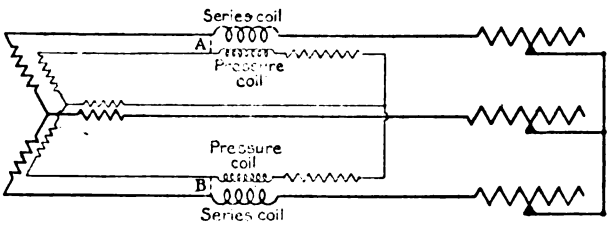


Fig. 9.—Two-supply, Three-phase Testing Circuit. Common point connections A and B cannot both be made at once.

nections, A or B, must be disconnected or the result will be that the high-pressure volt supply will be connected directly in parallel with the low-pressure current supply, and a partial short-circuit will result. On the other hand, if the connection A be eliminated, then the current and pressure coils of wattmeter A will have practically the full difference of potential of the volt supply between them, with consequent liability to error and damage. The method of getting over this difficulty adopted by the author is to make the connections as in Fig. 10. Only one pair of wattmeters is shown, but any number of pairs may be compared by connecting their current coils in series and their pressure coils in parallel in the respective circuits. If the

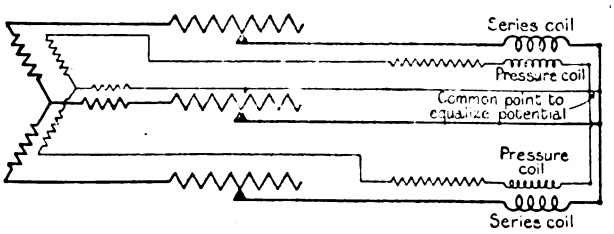


Fig. 10.—Modification of the Connections to Eliminate Electrostatic Disturbances in the Wattmeters.

wattmeter under test is a polyphase instrument of the dynamometer type, any errors there may be in the instrument due to electrostatic disturbance between the elements will not show up in the test. The instrument should therefore be subjected to an additional test, made by connecting each pressure-coil to its respective main-coil and then applying the full stated pressure between the two elements. Any resultant deflection of the pointer is probably due to electrostatic disturbance between the two elements.

Use of Concentric Reflecting Wattmeter as a Standard Alternating-current Ammeter.

When the wattmeter is connected up for calibration as shown in Fig. 8, it becomes a shunted type dynamometer ammeter and can be used as such. In order that the continuous-current calibration may be suitable for alternating-current tests, the shunt must have the same time-constant as the movable-coil circuit, or both time-constants must be reduced to such a small value that the frequency error is negligibly small. When the instrument is arranged as an ammeter, however, much wider limits of phase displacement are allowable than is the case when it is arranged as a wattmeter because the instrument is measuring on practically unity power factor. If a 0·001-ohm shunt of the Paterson and Rayner type be used with the reflecting instrument as at present arranged, and the resistance of the movable coil circuit be made 100 ohms, the inductance error at 100 periods is less than 1 part in 10,000. With this arrangement the instrument will give a deflection of approximately 250 scale divisions (25 in.) for 300 amperes, and the range may be increased up to the full-load carrying capacity of the shunt or the dynamometer by increasing the resistance of the movable-coil circuit. With a 0·01-ohm shunt the minimum current for a full-scale deflection is about 100 amperes. Above the minimum current the deflection may always be maintained at a constant value by varying the resistance of the movable-coil circuit. The current in amperes is given by

$$\sqrt{\left(\frac{kdr}{R}\right)}.$$

Concentric Non-inductive Standard Resistances.

The author suggests the following as a method of constructing non-inductive standards of low resistances. The method is the natural development of working with the concentric wattmeter.

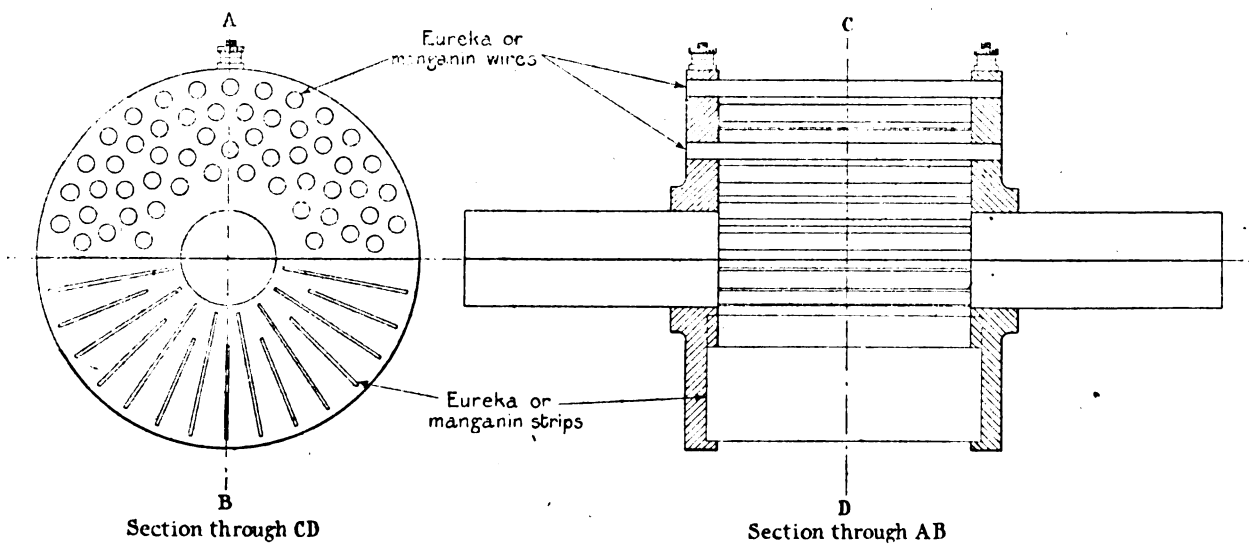


Fig 11.—Circular Shunt for Continuous Current, Showing Alternative Construction for Wires or Strips of Resistance Alloy.

If a cylinder of resistance alloy be substituted for the wires forming the outer conductor of the wattmeter cage, a non-inductive, low-resistance tube is obtained. If the thickness of the resistance alloy were indefinitely small the inductance of the tube would be zero whatever the length of the tube. For finite thicknesses of the material the inductance is calculable and may be made very small, and, in an actual example quoted, the time constant was $3{\cdot}7\times10^{-7}$.

An evenly distributed entry of the current into the resistance material is essential in standard resistances and particularly so in non-inductive types, and the arrangement of the concentric connections referred to appears to be the most effective way of ensuring this.

Ammeter Shunts.—The circular arrangement of the resistances would appear to be suitable for the construction of ordinary heavy-

Digitized by Google

current shunts for continuous currents where a high degree of accuracy is desirable. It is a difficult matter with shunts of the ordinary rectangular type to obtain uniform distribution of the current over the whole of the resistance strips or wires, especially with any variation in the arrangement of the connection to the main cables. This defect, however, the author shows, can be remedied by suitable design.

THE METHOD OF MEASURING SMALL DIFFERENCES OF PHASE.

Suppose it is desired to measure the phase difference between the primary and secondary currents of an instrument series transformer. If the primary current be passed through the fixed coil and the secondary current through the movable coil of a dynamometer free from phase errors, the dynamometer reading is

$$kI_fI_m \cos \varphi,$$

where I_f and I_m are the currents through the fixed and movable coils respectively of the dynamometer, k is a constant determined with, say, continuous current, and φ is the angle of phase difference between the two currents. It has been shown by Dr. Sumpner, however, that if φ is a small angle it cannot be measured actually in this way. If φ be as large as 3° the difference between cos 0° and cos 3° is only 14 parts in 10,000, and this difference would be hardly detected even on the best forms of dynamometers. Further, if the waves of the two currents differ in form, the product of their R.M.S. values would be different from that given by the dynamometer, even when the two currents are in phase, *i.e.*, when the dynamometer reading is a maximum for given values of the two currents.

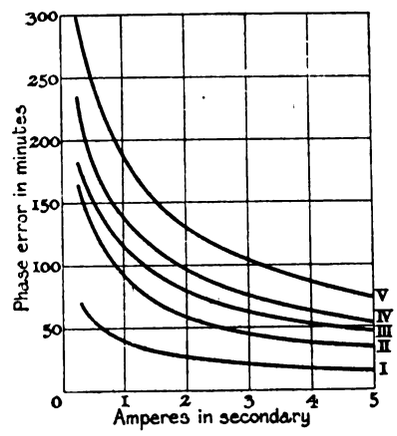


FIG. 12.—PHASE DIFFERENCE BETWEEN PRIMARY AND SECONDARY CURRENTS IN FIVE INSTRUMENT CURRENT-TRANSFORMERS BY DIFFERENT MAKERS.

Transformers were for 200 : 5 amperes, and were tested with a full secondary load of 15 volt-amperes at 50 periods per second.

In Fig. 12 are given curves showing the phase errors (angle between primary and secondary currents) in a number of different makes of instrument current-transformers which were tested recently by the author. It will be seen that some of the transformers are worse than others, but the phase difference between the primary and secondary currents does not exceed the 3° mentioned above except at low loads. The method indicated above is therefore unsuited to the measurement of the phase differences in these cases.

A modification of the method is to compare the phases of the two currents with that of a third current of the same frequency, the third current differing in phase considerably from the phases of the two currents to be compared. This may be done by using two suitable dynamometers (or wattmeters), passing the third current through, say, the two movable coils connected in series with each other, the primary current through the fixed coil of one, and the secondary current through the fixed coil of the other dynamometer. The two dynamometers then read as follows :—

$$\text{I.} \quad k_1I_pI_m \cos \varphi_1,$$

and

$$\text{II.} \quad k_2I_sI_m \cos \varphi_2,$$

where φ_1 and φ_2 are the phase differences between the current through the movable coils and the primary and secondary currents (I_p and I_s) respectively of the transformer. I_m being the same current in both dynamometers, $(\varphi_1 - \varphi_2)$ is the phase difference between I_p and I_s, *i.e.*, between the primary and secondary currents of the transformer, it can be shown that

$$\sin \theta = d_2/k_2I_sI_m.$$

For small angles $\sin \theta$ is the radian measure of θ, and hence the reading of d_2 is directly proportional to θ.

The adjustment of the phase of I_m may be effected by means of a suitable phase-shifting device. The current through the movable coils of the dynamometers may be obtained from the small machine provided with the movable stator, and the current through the primary winding of the transformer under test from the larger machine. The movable stator is then adjusted until one of the dynamometers indicates zero. Then, if d_1 is made zero,

$$d_2 = k_2I_sI_m \sin \theta,$$

and if d_2 is made zero—

$$d_1 = k_1I_pI_m \sin \theta,$$

and θ is calculable if the other factors are known.

The method is employed for the tests previously referred to in this Paper, in order to determine whether the active part of the flux in the current coil of a dynamometer wattmeter (that part of the flux which acts directly on the pressure-coil) is in phase with the main current. It is essential, however, that an instrument in which this is known to be the case is available for comparison.

In measuring the phase difference between the primary and secondary currents of a transformer, the author has found good agreements between the result calculated from the wattmeter readings and those calculated from the measured displacement of the movable stator. But good agreement is not obtained with the two methods when measuring the phase error in a wattmeter in which there are eddy currents. Also, in the case of such a wattmeter the value of the phase error θ is found to be different when determined with the main-coil current leading relatively to the pressure-coil current, from what it is when the main-coil current is lagging relatively to the pressure-coil current.

In cases where the phase errors are calculated from the wattmeter readings, and not from the measurement of the angle through which the movable stator is turned, the following method of finally adjusting the phase may be used. It is known that when an alternator is loaded the terminal potential difference lags behind the electromotive force. So that if a finely adjustable rheostat be connected to the terminals of the variable-phase machine, the phase of its terminal potential difference may be varied over a moderate range, and thus the final adjustment made at the test bench. The author has found this method particularly useful, as the phase shifter is not operated by remote control, and the services of an assistant are not always available. The method should also prove useful where the phase shifter does not admit of infinitely fine adjustment.

Water-Power in the United States.—In a Paper in the "Proceedings" of the American Institute of Electrical Engineers, Mr. C. W. Comstock gives some particulars of the present state and possible future development of water-power in the United States. According to a report of the Commissioner of Corporations in 1912 the total amount of electrical power generated from water supply (including plants under construction up to June, 1911) was then about 6,000,000 H.P. An addition of about 2,500,000 H.P. might be made to include undeveloped power owned or controlled by concerns reporting developed power. The geographical distribution of water-power is interesting. One-half of the population of the United States is east of the western boundary of the Ohio, and 60 per cent. of the developed water-power lies east of that meridian. On the other hand, there are curious anomalies. Thus, New England, which has only 8 per cent. of the hydro-electric power, has more than 40 per cent. of the manufacturing power. In many cases such discrepancies are due to local circumstances. Thus, on the Pacific the absence of coal (before the discovery of the oil supplies) led to water-power being highly developed. Large as it may appear, the existing developed hydro-electric power in the States is but a fraction of the total water-power capable of development, estimated by the United States Geological Survey at about 200,000,000 H.P. Future outlets for development require study. In the past the tendency has been to follow the demand for power, rather than to anticipate it. Electro-metallurgical work is a profitable outlet. The author also considers that the commonly expressed view that in the United States the fixation of nitrogen from the air is commercially impracticable owing to the high cost of power is by no means proved to be correct.

Digitized by Google

THE CONDENSATION PUMP: AN IMPROVED FORM OF HIGH VACUUM PUMP.*

BY IRVING LANGMUIR.

Summary.—Two new types of condensation pump are described, one built wholly of glass and the other wholly of metal. In these pumps a blast of mercury vapour carries the gas into a condenser. The method by which the gas is brought into the mercury vapour blast in the condensation pump is based on a new principle, the gas to be exhausted being caught by the blast of vapour and forced by gas friction to travel along a cooled surface. The action of this pump depends primarily upon the fact that *all* the atoms of mercury striking a mercury covered surface are condensed (no matter what the temperature). It is for this reason that the term "condensation pump" is proposed.

In a recent article in the "Physical Review † the writer described a new form of mercury vapour vacuum pump, which was characterised by its extreme speed and the high degree of vacuum attainable.

This pump operated extremely satisfactorily, but was rather difficult to make. Trouble was frequently experienced by some liquid mercury collecting at the bottom of the annular space, and this interfered with the free passage of gas into the pump.

The Improved Type of Glass Pump.—To completely avoid these difficulties the design shown in Fig. 1 was adopted. In this pump, mercury vapour from the flask *A* is carried through the thermally insulated tube *B* to the nozzle *L*. The vessel to be exhausted is connected to *R*. The gas from this vessel passes through the trap *G* and the tube *F* into the annular space *E*. At *P* this gas comes into contact with the mercury vapour blast issuing from the nozzle *L*,

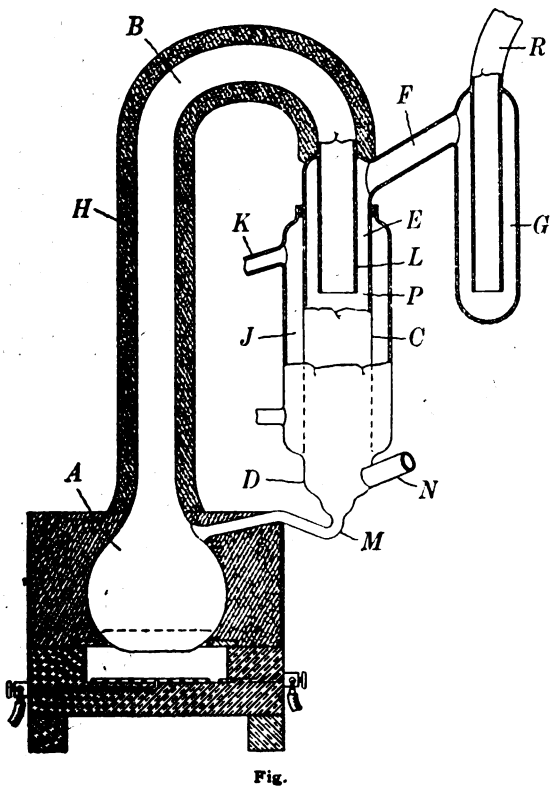


Fig. 1.

and is thus forced *outward* and *downward* against the walls of the tube *C*, and is finally driven down into the space *D* from which it escapes into the rough pump connection *N*. The mercury which condenses on the sides of the water-cooled tube *C* passes back through the tube *M* into the boiler *A*.

By this construction none of the mercury which condenses passes into the annular space *E*, and thus the troublesome blast of mercury into the tube *F* is wholly avoided. The glass blowing work on this type of pump is also much less difficult than on the earlier type.

In order that the pump may function properly it is essential that the end of the nozzle *L* (Fig. 1) shall be located below the level at which the water stands in the condenser *J*. The other dimensions of the pump are of relative unimportance. The distance between *L* and *D* must be sufficiently great so that no perceptible quantity of gas can diffuse back against the blast of mercury vapour, and so that a large enough condensing area is furnished.

The pump may be made in any suitable size. Some have been constructed in which the tube *B* and the nozzle *L* were 1¼ in. in diameter, while in other pumps this tube was only ¼ in. in diameter, and the length of the whole pump was only about 4 in. The larger the pump the greater is the speed of exhaustion that may be obtained.

* Abstract of an article in the "General Electric Review" (U.S.A.).

† Langmuir, "Phys. Rev.," VIII., 48 (1916).

Operating Characteristics.—In the operation of the pump the mercury boiler *A* is heated by either gas or electric heating, so that the mercury evaporates at a moderate rate. A thermometer placed in contact with the tube *B*, under the heat insulation, usually reads between 100°C. and 120°C., when the pump is operating satisfactorily. Under these conditions the mercury in the boiler *A* evaporates quietly from its surface. No bubbles are formed, so there is never any tendency to bumping.

Unlike Gaede's diffusion pump, there is nothing critical about the adjustment of the temperature. With an electrically heated pump, in which the nozzle *L* was ⅞ in. in diameter, the pump began to operate satisfactorily when the heating unit delivered 220 watts. The speed of exhaustion remains practically unchanged when the heating current is increased even to a point where about 550 watts is applied.

The back pressure against the which pump will operate depends, however, upon the amount and velocity of the mercury vapour escaping from the nozzle. Thus, in the case above cited, with 220 watts, the pump would not operate with a back pressure exceeding about 50 bars,* whereas with 550 watts back pressures as high as 800 bars did not affect the operation of the pump.

General Theoretical Considerations.—Vacuum pumps are characterised principally by three factors.

1. *Back pressure* against which the pump may be operated. This is the pressure on the exhaust side of the pump, as for example, at *N* in Fig. 1.

2. *Speed of the Pump.*—Gaede has defined *S* the speed of a vacuum pump by the equation—

$$S = \frac{v}{t} \log \frac{p_2}{p},$$

where *t* is the time required for the pump to reduce the pressure from p_2 to p in a vessel having the capacity *v*. The speed is thus measured in cubic centimetres per second. In the case of a piston pump this is approximately equivalent to the piston displacement per second.

3. *Degree of Vacuum Attainable.*—This is the lower limit to the pressure which may be obtained in a closed vessel connected to the pump. For convenience we shall refer to the back pressure acting on the pump as the *exhaust pressure*, while the pressure at which the gas enters the pump we shall call the *intake pressure*.

Most mechanical pumps of the piston type are built to exhaust at atmospheric pressure. But mechanical rotary pumps are frequently designed to be used in series with "rough pumps," in which case they operate with an exhaust pressure of a few hundredths of a megabar (1/5 cm. of mercury). Newer forms of pumps such as Gaede's molecular pump and diffusion pump require still lower exhaust pressures (approximately 10—100 bars, roughly 0·01 mm. to 0·1 mm. of mercury). Such pumps are always used in series with good mechanical pumps.

The type of mercury vapour pump shown in Fig. 1 operates with exhaust pressures ranging from 50 to 800 bars, depending upon the amount of heat supplied to the boiler *A*.

With the exception of Gaede's molecular pump, which gives a maximum speed of about 1,300 cubic cm. per second, mechanical high vacuum pumps have not had speeds exceeding 100 or 200 cubic cm. per second. Gaede's rotary mercury pump, for instance, gives a speed of about 120 cubic cm. per second. In nearly all cases the speed of a pump is practically independent of the exhaust pressure against which it operates, unless this is raised above a certain rather critical value at which the pump ceases operating satisfactorily.

With most types of vacuum pump the degree of vacuum attainable depends to a large extent on the exhaust pressure used. This is usually due to leakage back through the pump. In the Gaede molecular pump, operating at low pressures, there is a strict proportionality (about 50,000 : 1) between the exhaust pressure and the lowest attainable intake pressure.

THEORY OF THE OPERATION OF THE CONDENSATION PUMP.

For a number of years the writer has been convinced that the collisions between gas molecules and a solid or liquid body against which they may strike, are in general almost wholly inelastic. Each

* The bar is the C.G.S. unit of pressure: 1 dyne per sq. cm. One bar is equal to a pressure of 0·00075 mm. of mercury or about one-millionth of an atmosphere.

Digitized by Google

molecule which strikes a surface thus *condenses* on the surface instead of rebounding, although it may subsequently re-evaporate. This condensation takes place just as well at high temperatures as at low, but at high temperatures the re-evaporation may occur so soon that it is difficult to detect the condensation. In this case the condensed molecules constitute an adsorbed film. The condensed particles, before they re-evaporate, are held to the surface by the same kind of forces as those which hold solid bodies together. This leads to a theory of adsorption which is in excellent agreement with experimental facts. It was by a direct application of these ideas that the writer was led to construct a high-speed mercury vapour pump.

The author then describes the operation of Gaede's diffusion pump. The principle underlying the action of this pump prevents rapid action, and realisation of this fact led the author to construct the type of pump shown in Fig. 1. The very first pump constructed operated perfectly satisfactorily, and gave a speed of about 1,800 cubic cm. per second. The action of the pump is based on radically different principles from that of the ejector. The most essential element in the operation seems to be the condensation of the mercury vapour at *K*, and the maintenance of a temperature in this region so low that the condensed mercury does not re-evaporate. It is, therefore, suggested that pumps based on this principle should be called *condensation pumps*.

The distinction between the condensation pump and the ejector is clear when we realise that in the ejector there is no necessity for cooling the walls of the tube, whereas the condensation pump entirely fails to operate unless this is done.

If this later form of pump is examined during operation, it is seen that when there is a high vacuum on the intake side of the pump, practically no condensation of mercury takes place on the walls of the condenser *C* above the level of the point *P*. In other words, *all* the atoms of mercury vapour leaving the end of the tube *L* have downward velocity components and therefore cannot pass up above the point *P* unless they first strike some body not having the corresponding downward velocity. If, however, the walls of the condenser are allowed to become heated then the mercury atoms from *L* collide with mercury atoms evaporating from the walls (which do not have downward velocity), and as a result of these collisions a large faction of this mercury vapour is deflected upward into the space *E*. This prevents gas from *F* from reaching the point *P*, where it might be acted on by the direct blast from *L*.

When a small flow of gas is allowed to enter through *R*, so that the intake pressure is maintained at about 100 bars, it is interesting to observe that the line of demarcation below which the condensation occurs loses its sharpness, and that a considerable quantity of mercury vapour condenses above the point *P*. This is due to the collisions between the mercury atoms from *L* and the gas molecules, which are driven in close to the walls of the condenser *C*.

Another interesting fact may be observed by watching the operation of the condensation pump. The greater part of the mercury vapour which escapes from *L* condenses on the walls of *C* within a couple of centimetres below the end of the nozzle *L*. This indicates that the mercury atoms radiate out from the end of *L* in all directions, and show no particular tendency to continue to move in the direction in which the nozzle is pointed. This is essentially different from what happens in injectors or ejectors. It is well known that when steam escapes from a straight tube into the open air, the jet of steam continues to move in a nearly straight line for a considerable distance from the nozzle before it mixes to a large extent with the air. This effect evidently entirely disappears at very low pressures. This fact is in accordance with the kinetic theory of gases. At very low pressures the density of the mercury vapour is extremely small, whereas the viscosity of the gas is practically as great as at atmospheric pressure. The frictional effects of the walls therefore entirely predominate over the inertia effect which at higher pressures leads to the jet formation.

Some special pumps have been built to operate by a combination of the injector and condensation pump principles, so that very much higher exhaust pressures may be used. In this way it has been possible to operate a single mercury vapour pump producing as high a vacuum as the ordinary type of condensation pump, but exhausting at a pressure of about 20 mm. of mercury. Further development work will be necessary, however, before these pumps become as satisfactory as a condensation pump backed up by a mechanical pump.

Condensation Pumps Built of Metal.—The condensation pump lends itself admirably to construction in metal. One type of pump which has proved relatively simple in construction and efficient in operation is shown diagrammatically in Fig. 2. A metal cylinder, *A*, is provided with two openings *B* and *C*, of which *B* is connected to the backing pump, and *C* is connected to the vessel to be exhausted. Inside of the cylinder is a funnel shaped tube *F*, which rests on the bottom of the cylinder *A*. Suspended from the top of the cylinder is a cup, *E*, inverted over the upper end of *F*. A water-jacket, *J* surrounds the walls of the cylinder *A* from the level of *B* to a point somewhat above the lower edge of the cup *E*.

Mercury is placed in the cylinder as indicated at *D*. By applying heat to the bottom of the cylinder the mercury is caused to evaporate. The vapour passes up through *F* and is deflected by *E*, and is thus directed downward and outward against the water-coooled walls of *A*. The gas entering at *C* passes down between *A* and *E*, and at *P* meets the mercury vapour blast, and is thus forced down along the walls of *A*, and out of the tube *B*. The mercury which condenses on the walls of *A* falls down along the lower part of the funnel *F*, and returns again to *D* through small openings provided where the funnel rests upon the bottom of the cylinder. (A more detailed drawing of the pump as actually constructed is shown in the original article.)

Pumps of this type have been made in several different sizes. A pump in which the funnel *F* is 3 cm. in diameter and the cylinder *A* is 7 cm. in diameter gives a speed of exhaustion for air of about 3,000 cubic cm. per second, and will operate against an exhaust pressure of 200-600 bars, depending on the amount of heat supplied to the mercury. The energy consumption ranges from 100 to 500 watts. Very small pumps have also been constructed in which the tube *F* is only 0·6 cm., and the cylinder *A* is only 2 cm. in diameter. This type of pump gives a speed of about 200 cubic cm. per second.

Degree of Vacuum Obtainable.—The condensation pump resembles Gaede's diffusion pump in that there is no definite lower limit (other than zero) below which the pressure cannot be reduced. This is readily seen from its method of operation. A lower limit could only be caused by a diffusion of gas from the exhaust side (*N* in Fig. 1) back against the blast of mercury vapour passing down from *L*. The mean free path of the atoms in this blast is of the order of magnitude of a millimetre or less, and the blast is moving downward with a velocity at least as great as the average molecular velocity (100 metres per second for mercury).*

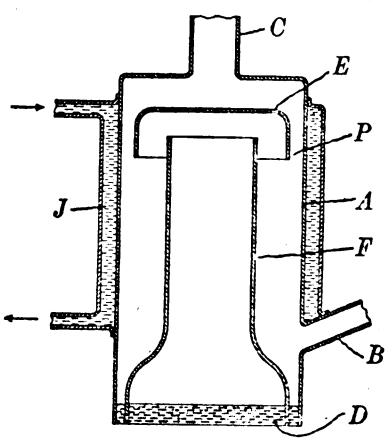


FIG. 2.

The chance of a molecule of gas moving a distance of about 4·6 times the mean free path without collision is only 1 in 100. To move twice this distance the chance is only 1 in 100^2, &c. If the mean free path were 1 mm. the chance of a molecule moving a distance of 4·6 cm. against the blast without collision would be 1 in 10^{20}. In other words, an entirely neglibible chance. However, if with any particular design of pump it should be found that gas does leak back against the blast of vapour, it is a simple matter to increase the pressure in the blast or increase the distance against which the gas must pass back through the blast. Thus, the construction adopted in Fig. 1 may be adopted where only a small part of the mercury is condensed close to the nozzle from which the vapour escapes, while the greater portion travels a considerable distance before condensing.

As a matter of fact even in the type of pump with a single condensing chamber such as shown in Figs. 1 and 2, there is evidence that the back diffusion is absolutely negligible under all normal operating conditions.

Of course, it must be realised that the condensation pump like any mercury pump, does not remove mercury vapour from the system to be exhausted. The vapour pressure of mercury vapour at room temperature is in the neighbourhood of 2 bars. By inserting a trap such as that indicated at *G* (in Fig. 1) between the pump and the exhausted vessel, this vapour pressure may be lowered.

For a very large number of experiments the presence of mercury vapour is not injurious. By use of solid CO_2 or liquid air the mercury vapour may be entirely eliminated.

As has been pointed out previously, the vacuum actually attainable by the condensation pump is usually determined by the rate at which gases are given off by the walls of the vessel being exhausted.

By means of a new type of vacuum gauge devised by Dr. A. W. Hull, of the research laboratory, pressures as low as 10^{-5} bar obtained by the condensation pump have already been measured. There is little doubt but that pressures very much lower than this can be and have been obtained by cooling the bulb to be exhausted in liquid air, so as to decrease the rate at which gases escape from the walls.

* This is apparent when we consider that no appreciable number of atoms pass up into the space *E*.

Digitized by Google

PHASE LAG IN CURRENT TRANSFORMERS.

BY A. J. MAKOWER, M.A., AND A. WUST.

The importance of determining the exact ratio of transformation of current-transformers and the phase-lag introduced by their insertion between the main circuit and the windings of meters has led a number of experimenters to develop a variety of methods of measurement of these quantities. Only recently P. de la Gorce has published details of tests, which appear in an abstract in THE ELECTRICIAN * containing a bibliography of the subject.

The object of this article is to describe methods that are simple to carry out and capable of giving the required results rapidly under commercial conditions.

If two wattmeters W_1 and W_2 (Fig. 1), the latter with a transformer, are connected with their shunt coils in parallel across the terminals of an alternator A_1 whose voltage is E, and with their secondaries so as to carry the currents I_1 and I_2 supplied by the coupled alternators A_1 and A_2, the readings of the instruments are given by the equations

$$W_1 = EI_1 \cos \varphi \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$W_2 = EI_2 \cos (\varphi + \delta) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where I_1 and I_2 are the primary and secondary currents of the transformer T under test and δ is the angle of lag introduced by it. The angle φ between the voltage E and the current I_1 can be varied at will by altering the coupling angle between the alternators by means of the adjustable coupling B. If the

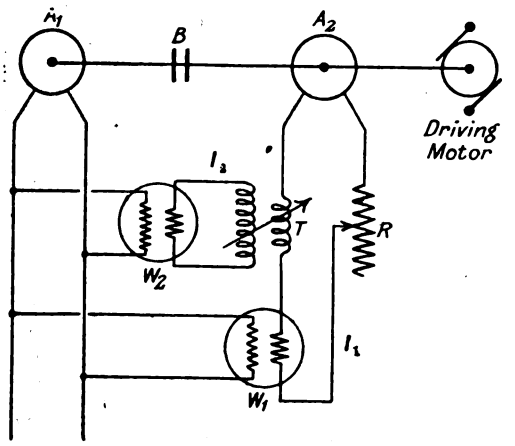


FIG. 1.

ratio of transformation of the transformer is given by $\lambda = I_2/I_1$, and the ratio of the wattmeter readings by $a = W_2/W_1$, it follows that

$$a = \lambda(\cos \delta - \sin \delta \tan \varphi) \quad . \quad . \quad . \quad . \quad . \quad (3)$$

If any two points a_1 and a_2 are taken at angles φ_1 and φ_2 from the curve given by $a = f(\varphi)$, it can be shown that

$$\tan \delta = \frac{a_1 - a_2}{a_2 \tan \varphi_1 - a_1 \tan \varphi_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The value of δ can be calculated from equation (4), taking several pairs of values, and the value of λ is then obtainable by substituting in equation (3) the mean value obtained for δ.

This method was applied to a pair of similar current-transformers of a commercial type, whose rating was 75/3·5 amp. at 25/125 cycles. The transformers T_1 and T_2 were connected back to back in the position occupied by the transformer T in Fig. 1. By this arrangement wattmeters W_1 and W_2 of the same range could be used.

If the nominal ratio of transformation of each of the transformers be called t, the nominal ratio of the combination will be $t/t = 1$. The actual ratios of transformation are λt and $\frac{1}{t}\lambda$, giving an actual combined ratio of transformation of λ^2, which we will call Λ. If the angle of lag introduced by each transformer is δ, the angle of lag introduced by the combination may be written as $\Delta = 2\delta$.

* THE ELECTRICIAN, Jan. 12, 1917.

The observed curve $a = f(\varphi)$ is plotted in Fig. 2.

From this curve Δ and Λ can be calculated as explained above, using equations (3) and (4), but it is preferable to obtain these quantities graphically by plotting the curve $a = f(\tan \varphi)$. This is shown in Fig. 3, from which we see that $AB = \Lambda \cos \Delta$

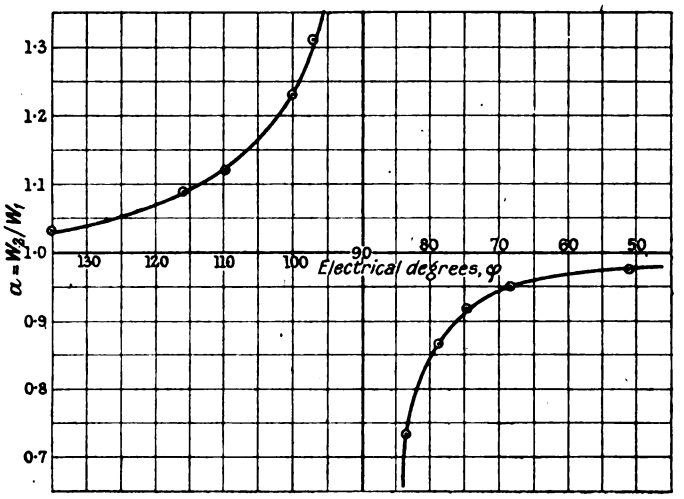


FIG. 2.

and $-\tan C\hat{B}D = \Lambda \sin \Delta$. Inserting the particular values we have

$$\Lambda \cos \Delta = 1{\cdot}01,$$

$$\Lambda \sin \Delta = -0{\cdot}0383,$$

whence $\Delta = -2°10'$ and $\Lambda = 0{\cdot}983$,

giving $\delta = -1°5'$ and $\lambda = 0{\cdot}993$.

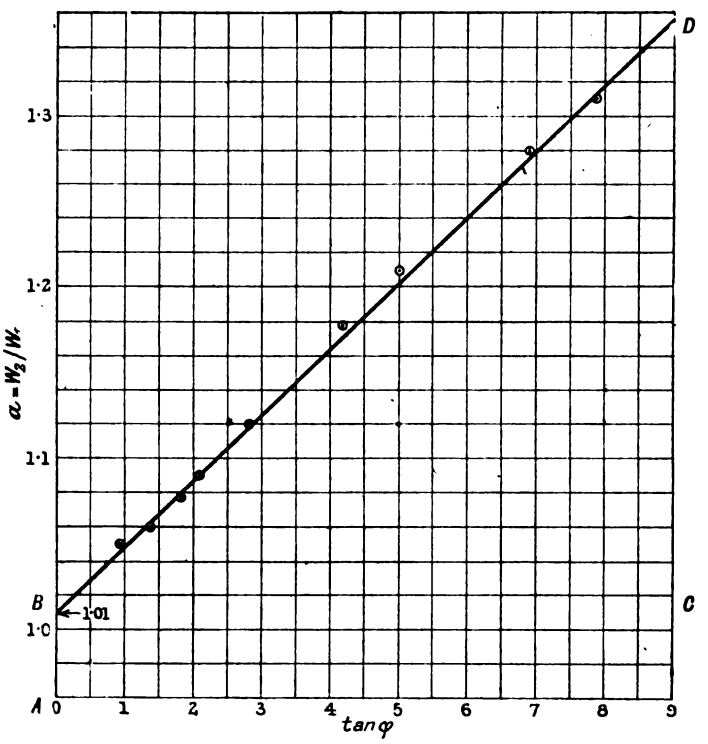


FIG. 3.

While the forms of the curves obtained above are of general interest, their determination involves considerable time and careful calibration of the two wattmeters in order to get correct values of the quantity a.

The tests are able to be greatly simplified if the value of δ alone is sought and the wattmeters are used only as zero reading instruments. It will be noted that if the curves

Digitized by Google

$W_1=f(\varphi)$ and $W_2=f(\varphi)$ are plotted, the distance between the points where these curves cut the axis of φ is the angle δ. Thus if some means is given to determine this difference angle, the angle δ is directly obtainable. The previous arrangements were somewhat modified to carry this out. The transformers

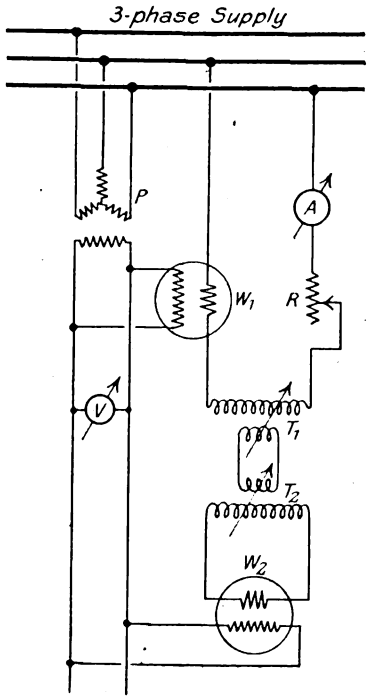


FIG. 4.

T_1 and T_2 and the wattmeters W_1 and W_2 were connected as already described across one phase of a three-phase supply and the shunt coils of the wattmeters were connected to the secondary of a phase-shifting transformer P, the primary of which was fed from the three phase supply (Fig. 4).

At any adjustment of the load of the transformers T_1 and T_2 the positions of the secondary of the phase shifting transformer were noted, for which the readings of the wattmeters W_1 and

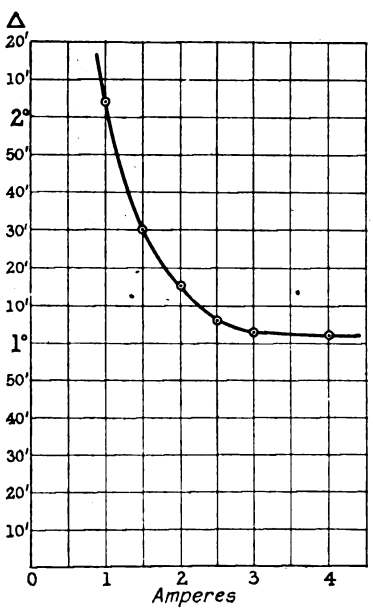


FIG. 5.—VARIATION OF PHASE LAG.

W_2 were respectively zero. The angle between these two positions is the required angle Δ, allowing for the conversion of mechanical into electrical degrees, and the determination of Δ is thus reduced to the measurement of a mechanical angle of rotation of the phase-shifting transformer. This angle was observed by means of a mirror mounted on the shaft and a reflected beam of light. The readings were taken on a scale graduated in millimetres and giving 22 mm. per electrical degree. The following experiments were undertaken in order to test this method. The variation of phase lag with the load current A was found to be as shown in Table I. and Fig. 5, the total secondary resistance being 0·96 ohm : the effect of varying

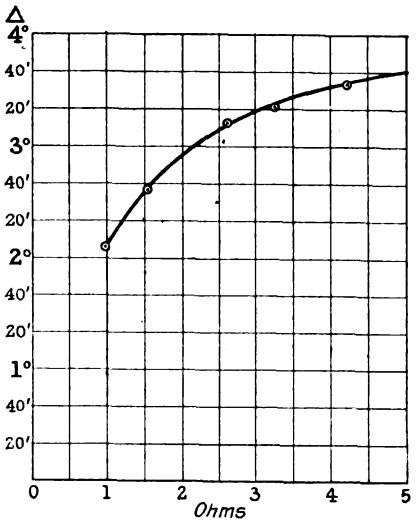


FIG. 6.—SECONDARY RESISTANCE.

the resistance of the secondary circuit of the combination of the pair of transformers while maintaining the current A constant at 1 ampere is shown in Table II. and Fig. 6 ; lastly, the effect of varying the reactance of the secondary circuit was found to be as shown in Table III. and Fig. 7, with a constant

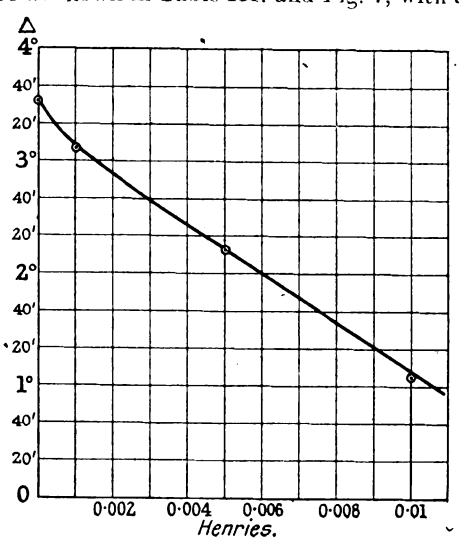


FIG. 7.—ADDITIONAL INDUCTANCES.

secondary resistance of 4·21 ohms, the current A being maintained at 1 ampere.

Table I.

A (amperes)	1·0	1·5	2·0	2·5	3·0	4·0
Δ	2° 4′	1° 30′	1° 15′	1° 6′	1° 3′	1° 2′

Table II.

Total secondary resistance (ohms)...	0·96	1·53	2·60	3·23	4·20
Δ	2° 6′	2° 36′	3° 12′	3° 21′	3° 33

Table III.

Added secondary inductance (henries)	0.	0·001	0·005	0·010
Δ	3° 33′	3° 7′	2° 13′	1° 6′

The above results have been given to show that the method that has been described is well suited for commercial use on account of its directness and the speed with which the results are obtainable.

Digitized by Google

ENGINEERING PRECAUTIONS IN RADIO INSTALLATIONS.*

BY ROBERT H. MARRIOTT.

Summary.—Various types of possible danger from radio installations are considered; shocks to the operator, short-circuit from lightning or from contact with high tension power lines, breakdown from the high-tension circuits of the radio transmitter itself, and harmful inductive effects from radio transmitters. In each case instances are given, together with the proper means of avoiding the undesired effect. In the original Paper some detailed experiments are described.

In this Paper the subject will be considered under four general headings: (1) Wherein dangerous shocks may be received from radio apparatus. (2) Wherein radio apparatus provides a path for currents other than radiocurrents; (*a*) lightning, (*b*) antennæ coming into contact with lighting or power lines. (3) Wherein radio apparatus provides the current or potential by direct discharge. (4) Wherein radio apparatus provides the current or potential by induction.

1. Injurious shocks may be received from the transmitter circuits. There are, or were, a few cases of dangerous practice along these lines. One was to shunt the operating key so that the transformer secondary was at a fairly high potential when the key was open. Another dangerous method, and probably by far the most dangerous to the life of the operator, was to use alternating-current primary generators which gave an open circuit voltage as high as 500 or 600 volts, and connecting that high voltage circuit through the operating key. Possibly it is reasonably safe to use a generator open circuit voltage as high as 250, but, all things considered, it may be best to bring this voltage down nearer 110, even if efficiency of transformation has to be sacrificed slightly.

2 (*a*) The danger of fire being produced by lightning striking the antenna is apparently less than the danger in ways mentioned under headings 2 (*b*), 3 and 4. Personally, I have never seen lightning strike an antenna, nor have I seen evidence that lightning has struck an antenna. However, I have frequently seen antennæ discharge to ground when lightning apparently struck at some distant point.

2 (*b*). At one time a report was brought in that lightning had struck a radio burning up the receiving apparatus. On investigation it was found that someone had changed the antenna wires from their former position and had placed them across and above a 1,200-volt line.

3. The greatest number of fires I have noticed starting from direct discharge of transmitters have been where roof insulators or deck insulators leaked current to the roof or deck, and where the roof or deck was of some combustible material. However, none of these fires have resulted in serious conflagrations, probably because they almost invariably occurred during rain or very damp weather, the dampness or rain serving both to short-circuit the insulator and put out the fire.

Portions of transmitters, such as condenser supports, transformer supports, &c., have frequently been charred to some extent. There is less danger of fire being caused by the apparatus which is mainly in use now because, with the exception of auxiliary apparatus as used by one company, but now being discontinued, the plain antenna method of connection of the transmitter has been discontinued. This plain antenna connection brings the full spark gap potential to the roof or deck insulator, thereby causing it to break down. A majority of the cases observed where the roof or deck was set on fire were brought about by this type of apparatus.

In the earlier days of radio work a common method of bringing the antenna through the wall of the house was to bring this connection through the middle of a large window pane. This practice was usually fairly satisfactory and not very expensive.

For inside work the writer adopted a general rule of providing surface insulation equal to eight times the sparking distance through air. For example, if the wire used in the circuit would spark to objects at a distance of 1 in. (2·5 cm.) through air, this wire was held away by a porcelain rod 1 in. (2·5 cm.) in diameter and 8 in. (20 cm.) long. Porcelain cleats on series are probably as inexpensive an insulator as may be used for guying small antennas, considering their insulating qualities.

4. For the purpose of this Paper the currents which are set up in conductors not connected to antenna, but due to the radio frequency currents in that antenna, will be referred to as "induced radio currents," and the transference of energy from the antenna to other unconnected circuits will be referred to as "by radio induction."

The greatest damages from fire which are known to me have occurred where the transmitters were not connected with the point which took fire. In these cases the transmitter caused high potentials in conductors which were more or less distant from the transmitter; that is, these conductors acted somewhat as receiving antennæ, and were close enough to rise to a high potential. Where these conductors consisted of telephone circuits the lightning arresters provided on the telephone circuits usually short-circuited to ground by the fusing of the metal in the arrester.

This grounding of the telephone circuits usually rendered the telephone circuit inoperative. In the cases of lighting and power circuits carrying direct current or alternating current, such as 60 cycle alternating current, the high potential radio frequency alternating current induced on these lines was apparently superimposed on the direct current or audio frequency alternating current. The radio frequency current produced on these lines was frequently of very high voltage comparatively while the other current (direct or audio frequency) on the lines was of comparatively high amperage. When the radio potential occurred at a point within striking distance of an object at opposite potential it apparently discharged and carried the direct current or audio frequency current over after it. In many cases the arcs so formed held until the terminals of the arc or part of the circuit burned away. Power transformers, lighting transformers, motors, generators, relays, magnetos, wattmeters, ammeters, voltmeters, lamp sockets, rosettes, &c., burned out or were rendered inoperative apparently from this cause. On a number of occasions lamp cord carrying 110-volt direct current or 60-cycle alternating current, has been short-circuited, and on one occasion an 8 ft. (2·4 metres) drop cord disappeared in flame and a near-by motor was short-circuited. On other occasions lamp cord lying against wooden moulding short-circuited and burned, setting fire to the wooden moulding. On these occasions, people were near-by and put the fire out before it reached any material magnitude.

On one occasion receiving and transmitting apparatus were located very near to the transmitter. The result was that motor and generator windings, relay windings, reactance coil windings, &c., were repeatedly short-circuited. This was stopped by providing radio frequency paths through condensers across points which developed high radio frequency potential; also, by placing the wiring in grounded iron conduit, and the short sections of wiring of the switchboard in grounded lead-covered wires; and finally, by placing a grounded wire netting screen between the transmitter and the apparatus. All of these expedients were put into effect before noticeable potentials were avoided.

Radio frequency currents possibly in some cases have been superimposed on high-tension circuits of the transformers, at least across portions of the secondary of such transformers. It is not quite so easy to conceive how this radio frequency potential may occur in the secondary where so many turns of fine wire are used.* However, when transformers were placed in certain relation and near radio frequency circuits they broke down sometimes between sections and sometimes from secondary to primary, and similar transformers when substituted and moved further away or turned at an angle did not break down.

In the United States in 1901, in order to prevent induction in mast guys, these guys were made of rope. In 1902, owing to the stretching and contraction of the rope in dry and wet weather, the writer substituted steel guys with rope blocks and falls at the bottom of the guys to serve as both insulators and as means for adjusting the guys. About this time, or before, others used wooden strain insulators in the guys. On some occasions both the rope insulators and the wooden strain insulators were burned by current leakage between the guys and ground. Even on shipboard attempts were made at times to insulate guys and stays between masts. However, owing to the difficulty of providing indulation which would not leak, the principle of thoroughly grounding the stays and guys was adopted. Stays and guys and other metallic conductors, such as hand rails, occasionally discharged to passengers, causing considerable excitement and fear on the part of some steamship companies that passengers might be electrocuted. The remedy used for this was thoroughly to ground stays and guys, &c. Even the metal whistle cords on vessels occasionally discharged to damp woodwork, &c., and often a person who tried to manipulate the whistle received a shock. These were grounded by using flexible wire ground connection. Steel beams, steam pipes, long bolts, anchor chains, and other conducting materials, on vessels, have been known to spark to ground or to other conductors. Conduits containing electrical wiring have apparently discharged to the ends of wiring where the conduits were not

* Abstract of a Paper read before the Institute of Radio Engineers, New York.

* A probable explanation is the distributed capacity of the secondary windings and consequent internal resonance effects with breakdown.

Digitized by Google

grounded. Metal roofs in the vicinity of land stations, and metal roofs of wharves, have discharged to ground, causing charring of the wood to such an extent that fear of fire resulted.

On account of sparking on their vessels, one line had a tendency to accuse the radio apparatus of being responsible for nearly anything that went wrong with the electrical circuits on the vessel, even going so far as to say that the radio currents went down through the vessel and into the water condenser of the engine, and caused electrolysis to such an extent that the water condenser had to be replaced!

On a line where the vessels were almost entirely constructed of wood, sparking, charring, and injured apparatus resulted at a number of points. The mast stays were wrapped with houseline and passed through thimbles connected to the hull of the vessel, thereby insulating the mast stay from the hull of the vessel by the housline. This housline was set on fire and burned away, due to the sparking between the mast stays and the hull of the vessel via the thimble. On these vessels the mast head lights, running lights, and port and starboard lights, were connected to the pilot house signal light switchboard by means of rubber-covered twin conductors without metal covering. All of these signal light circuits were burned out from time to time due to sparking across the lines or between the lines and ground. Annunciator circuits and call bell circuits throughout the vessels discharged to metal portions of the ship, and in some cases caused slight charring of woodwork.

On one occasion a steamship company asked that their vessel be gone over with a view to preventing any possibility of igniting explosives which they expected to carry. In this case it was recommended that all metallic conductors in the hold and in the vicinity of the hold be thoroughly grounded and electrically connected together, even the short metal ladders and supports which extended from one deck to another.

Three instances are recalled of wooden masts set on fire due to the discharging of guys to each other through the woodwork of the mast. In two of the cases the masts were burned off several feet from the top. In these cases the guys were 50 ft. (15 metres) or more from the antennæ.

It has been found that radio currents were induced in the metallic paint on masts, and on some occasions the metal paint was removed and a portion of the mast varnished. Some years ago it was the rule to make all radio masts of wood. Also wooden top masts have been required on shipboard because of the radio apparatus.

Regarding the ability of sparks to start fire, that obviously depends on the heat developed by the spark and the heat required by the combustible material. Very small sparks are almost universally used for igniting gas or gasoline vapour in gas engine, and it is quite possible that similar gas might be ignited by equally small or smaller sparks on shipboard or at other points near radio stations. Sparks developed by radio transmitters might be capable of igniting oils such as are found, for example, in the paint lockers on vessels. Theoretically, radio might cause distress conditions by setting the ship on fire and then relieve these conditions by bringing aid!

While the Paper has been confined practically entirely to personal observations, the conclusion is not to be drawn that the damaging results always occur. The instances mentioned practically cover all the cases noted during a period of about 15 years' use of radio frequency circuits, including radio frequency apparatus operated under a large variety of relations to adjacent conductors at stations on both coasts of the United States, at numerous points inland, and on the vessels of several nations.

Protection against radio frequency currents of dangerous potential being induced in low potential direct current of audio frequency circuits may be brought about to a considerable extent by taking advantage of the ways in which radio frequency currents differ from direct current and audio frequency currents.

Condensers of small capacity impede radio frequency currents very much less than audio frequency currents (that is, radio frequency currents usually find an easy path through small condensers, while practically no 60-cycle current or direct current will flow through small condensers). For practical purposes small condensers may be assumed to be good conductors for radio frequency currents and insulators for direct current and alternating current having frequencies in the neighbourhood of 30 to 500 cycles.

Condensers have been installed in series with fuses to ground. This practice is objectionable because if the fuses burn out, the lines are left unprotected at a time when such protection is most likely to be needed, and unless the fuses are in some way arranged to notify some person, it is quite probable that they will not be known to have burned out until after damage occurs to the low-tension circuits.

Mica condensers in which lead foil was used have been found to provide automatic self-fusing devices without destroying the service ability of the condenser; for example, when a sheet of mica punctured making a small hole, the lead foil melted away from around the hole until the arc was extinguished and the condenser then operated as before.

Radio frequency currents do not penetrate very far into the conductor, or flow to any great extent in a conductor when that conductor is screened by a concentric conductor such that the radio frequency may flow in the concentric conductor; thus, for example, very little if any radio frequency current will be induced in a pair of rubber covered copper wires enclosed in an iron conduit, where the iron conduit is grounded at intervals.

Low potential circuits have often been protected from radio frequency potentials by grounding the low-potential circuits through high resistance rods made up of carbon and clay; and in some cases by using incandescent lamps between the conductors and ground. The writer has always considered this an objectionable practice, because to some extent it grounds the low-potential circuits, which are usually better ungrounded. Also, according to the experience of the writer, these high resistance grounds have apparently offered, as a rule, greater impedance to the radio frequency currents than small condensers offered. Slate switchboards sometimes served as protectors to low-frequency circuits because their resistance was sufficiently low to allow them to act much as the high resistance protective rods.

Less trouble has occurred since more metal has been used in the construction of ships, in the form of bulkheads, decks and supports. In addition, the doing away with wiring in wooden moulding and the substitution of metal moulding, conduit and metal-covered cable has prevented radio frequency currents from being produced in the direct current and audio frequency wiring. Lead-covered wire has been used sometimes, but has occasionally caused trouble when the lead has been mechanically forced through the insulation and against the copper. It is probably preferable to use lead-covered wire in protecting metal conduit with drains in the lower portions of the conduit to take care of sweating, &c.

Besides preventing sparking, another reason for thoroughly grounding the stays and mast guys on vessels was the assumption that less energy is absorbed from the radio waves by thoroughly grounding these stays than that which would probably be consumed in the resistance over leaking insulators.

The increasing knowledge and improving practice of professional radio engineers decreases the probability of damage. However, inexperienced persons install transmitting and receiving stations from time to time, using such various types of apparatus as their circumstances and knowledge provide. Such stations as these are frequently erected in private houses, where sparks may occur on combustible material, and where telephone and lighting wires may not be protected by conduit or grounded metal-covered wire, and where the antennæ may be above or may parallel near-by telephone, fire alarm, lighting and power wires. It might be useful to offer a set of rules to cover the various possibilities, but that would require very careful study, if these rules were drafted to prevent imposing hardship on the young experimenter and radio student, who generally is limited as to means.

Rules might be prepared by a joint committee of the American Institute of Electrical Engineers and the Institute of Radio Engineers. These would make a useful addition to the underwriters' rules and improve engineering practice.

The radio laws which require low decrement and practically single waves to be radiated from transmitters, made for the purpose of preventing interference, may serve as a protection against radio transmitters causing damage. These laws, with their resulting regulations, aid in eliminating the plain aerial type of transmitter whereby the antenna was raised to excessively high potentials, and because of the lower decrement, near-by circuits, unless their natural period is somewhat near that of the radio frequency, may not be excited to such an extent. High group frequency transmitters and especially transmitters of constant amplitude waves use lower voltage for equal power, which results in lower voltages being induced in near-by conductors. These types of transmitters are coming into general use, and the constant amplitude wave transmitters may be the transmitters of the future. Therefore the probability of damage should continue to decrease.

When the current flows in an antenna, magnetic and electrostatic fields are procured around that antenna; therefore, all conducting materials in these fields are conductors in the dielectric of a condenser, and at the same time they are conductors which cut a magnetic field. Considering the antenna as one plate and the earth as the other plate, and the air between all parts of the antenna and the earth as the dielectric, all conductors within this air space will be at a different potential from both the antenna and the earth, while this condenser is being charged. As the antenna may be per-

Digitized by Google

idically charged to a high potential, the conductors in the dielectric may be periodically at a high potential with respect to earth, depending on their distance from the earth and from the antenna. If these conductors are at any time raised to a potential sufficiently high to break down the solid or air insulation between them and earth, they will discharge or spark to earth. Now, if these conductors are carrying another current such as direct current with a direct-current P.D. to ground, then the direct current will, as a rule, it may possibly be said, follow the spark, and establish an arc which may hold until the circuit is opened by some portion burning away whether that portion be a fuse, a wire line, or generator winding. In the same manner both terminal wires of a motor or generator may spark simultaneously to the armature core, and produce a short-circuit. This may occur whether or not the motor or generator is grounded, because the motor or generator usually occupies a relatively different position in the dielectric from that occupied by the line wires.

Where conductors are within sparking distance of the antenna a discharge may take place, although the conductors may be insulated from ground and from the antenna, and this for the same reason that such conductors discharge to ground. For example, antenna circuits frequently discharge to such small masses of metal as wood screws, although the surrounding wood is a good insulator.

Conductors are usually so placed as to cut the magnetic lines emanating from the antenna or the closed circuit of the transmitter; and a P.D. between the ends or portions of a system of such conductors may result which will break down the insulation. If these ends or portions are, for example, the opposite terminals of a motor or generator, or the terminals of a magnet, a short-circuit may result. The electrostatic and magnetic fields may work together to produce such damage.

The shorter waves formerly used may have corresponded more nearly to the natural wave-lengths of conductors which were found on shipboard in the lower potential circuits than do the longer waves used at present. When the conductor which tends to spark to ground or to the frame of a dynamo is connected to ground or to the frame through a condenser, and where that condenser is relatively of much higher capacity than the capacity of a conductor to ground or to the object to which it tends to spark, the effect is probably somewhat similar to bringing the conductor quite near to the ground or the frame, and the nearer the conductor is to ground or to the frame the lower the P.D. that exists between the conductor and ground or frame; that is, the conductor will be brought to a point of lower potential in the potential gradient between the antenna and ground. Or this protective condenser may be possibly regarded with fair correctness as a very low impedance so far as the radio frequency potential is concerned; and where a relatively low impedance is in circuit the potential across that impedance must be relatively low. In other words, a relatively low impedance is provided for the radio frequency current around the insulation provided for the direct or audio frequency current.

Particulars are given of some tests made at the United Wireless Telegraph Company's Manhattan Beach station on August 21, 1909, to show conditions of discharge.

Considering the antenna and earth together with the intervening air as a condenser, if we wish to protect conductors in this air dielectric against discharges from one plate or the other of this condenser, we must do one of two things. Either thoroughly insulate the conductors to be protected or connect them electrically to the plate to which they have a tendency to discharge; that is, they must be thoroughly insulated or made part of one plate or the other. As the insulation between low-voltage circuits and ground is, as a rule, only sufficient to insulate the normal potential on the low-voltage circuits, it is necessary to provide means for connecting these circuits to ground so far as radio frequency currents are concerned, or to enclose them within the ground plate of the condenser rather than in dielectric.

The case is one of conductors subjected to alternating stress in the dielectric of a condenser and at the same time to an alternating magnetic field.

The problem is to prevent these conductors from sparking. The usual solution is to ground thoroughly all conductors which are not there for the purpose of carrying current, and to enclose current-carrying conductors in grounded metal coverings (*e.g.*, metal conduit). Where this is not practicable it is desirable to connect the current-carrying conductors to ground and to each other through condensers (*e.g.*, lead foil and mica condensers of approximately 0·17μf. capacity tested at 500 volts 60-cycle alternating current, and enclosed in copper watertight cases). In building a radio station it is desirable to place all current-carrying conductors (other than radio) underground so far as practicable (and especially telephone conductors). The first continuous-grounded metal deck of a vessel, below the radio transmitter, may be usually considered as the surface of the ground in so far as this protective effect is concerned.

WATER POWER AND POWER TRANSMISSION IN THE UNITED STATES.*

BY DR. LOUIS BELL.

During the past 12 months developments in power transmission have been in the direction of consolidation rather than striking new methods.

One point of interest is the prospect of legislation affecting the use of water-power. There is, however, little danger of such a thing as a water-power trust, nor, with sane regulations, is there likely to be. At present legislative enactments have tended to restrict the free development of water-power, and have, therefore, hindered rather than helped the development of power transmission.

Another debateable question is the linking-up of transmission systems so as to cover the country with an adequate network and facilitate the free use of power. Most of the consolidating schemes of this kind have been beneficial, although in a few cases they have served as an excuse for watering of capital and no useful service served.

Every addition of an electric power station to a growing network means greater security against interruption of service and more efficient use of conducting material; with copper costing nearly 2s. a pound this is no mean advantage.

The chief technical advance is still in the direction of higher voltages. With the advent of suspension insulators the limitations of earlier days have for the most part disappeared, and with copper at its present price the tendency must be steadily upward. 50,000-100,000 is now regarded as quite reasonable, and conservative. The rapidly increasing use of outdoor sub-stations means lessened cost of supply from ramifying lines, enabling labour to be used for inspection and control rather than for idly watching the operation of transformers and switches.

The earlier high-tension switch gear was costly, bulky and inconvenient to control. The linking-up of stations to a common system of supply is leading to greater simplification. Each plant acts as a reserve for the other, and need not be elaborately equipped for reserves. A generator and its high-tension transformer are now regarded as one unit, the units being linked together with sufficient electro-dynamic cushioning to secure safe operation.

The time is coming when networks will be regulated as a whole, and not merely in parts. The use of synchronous apparatus, loaded if convenient or unloaded if necessary, for regulating purposes has long proved its value, and is capable of giving wonderful steadiness to the performance of systems covering hundreds or even thousands of square miles.

In these days the difficulties of simple straightaway transmission are almost negligible, granted sound construction methods and reasonable care. Attention will therefore be centred more and more upon working our mass operations, a campaign of the organised armies of industrial science.

Steel for Aeronautical Purposes.—In a Paper before the Aeronautical Society of America, Mr. G. A. Richardson discusses the selection of steels for air-craft work. Originally wires for stays were made as strong as possible to reduce weight, but this resulted in a wire so hard that difficulty was experienced in forming the eye and bend for the terminal connection of the wire. The best material, as now used, combines with sufficient hardness and tensile strength and toughness, a certain ductility. High grade carbon steels are now regarded as best for the purpose. Protection against corrosion is important; galvanising and tinning with a protective coating of paint should be used. This also applies to struts, for which chrome-nickel steels are suitable For the engine it is necessary to avoid steels that corrode easily. Prof. Lucke, of Columbia University, recommends the use of ordinary comparatively low carbon steel, and objects to alloy compositions on the ground that they are easily spoiled by over-heating. A 25 per cent. nickel steel is free from this objection and has the additional advantages of being highly resistant to corrosion and is non-magnetic. Three per cent. nickel steel is recommended for valve parts.

---

* Abstract of an article in the "Electrical World."

Digitized by Google

The Electrician.
FRIDAY, JULY 13th, 1917.
Editorial and Publishing Offices:—
8, BOUVERIE STREET, LONDON, E.C. 4.
Telephone: City 9853 (4 lines). Telegrams: "Benbrotric Fleet London."

THE DISTRIBUTION OF COAL.

We are glad to find that at last more serious attention is being paid to the question of the control of our coal supplies during the war. We have frequently urged the importance of this subject. So long ago as May, 1915, a conference of the Institution of Electrical Engineers and the Institution of Gas Engineers was held to urge upon the Government the necessity of doing something in this direction. Unfortunately, Government action so far has been tardy and unsatisfactory. Last Friday, however, the Controller of Coal Mines issued a statement showing how it was proposed to deal with the distribution of coal during next winter, the scheme to be put into operation on September 10th. Briefly, this scheme consists in the division of the country into a number of coal-producing districts, and the limitation of supplies in any district to those from its own collieries or from the nearest coal-producing districts if these collieries are insufficient for the purpose, and the elimination of long distance transit.

One effect of this restriction will be that certain consumers will no longer be able to obtain such good coal as that to which they have become accustomed. In many cases this will be a minor disadvantage, to be accepted as one of the many evil accompaniments of war. On the other hand, mineral traffic on the railways will be relieved. It is estimated that by this means no fewer than 700 million ton-miles annually will be saved on the transport of coal by rail. This sounds a very large figure, and will strike the popular imagination. Actually, however, the proportion is not so enormous when it is borne in mind that the Coal Control Department, according to the official statement, will have to deal with 42 million tons of coal per annum. From this it follows that the saving in truck mileage, which is the important point, is not a great percentage of the whole. This figure, however, does not take into account the mileage of empty wagons. There should, therefore, be a large saving of truck mileage by this scheme, and, what is probably more important, the elimination of a considerable amount of marshalling and shunting of coal trains, which at present interferes with other traffic and renders the working of our railways more difficult than it need be. The scheme refers chiefly to coal which is being conveyed over long distances or on cross-country journeys —*i.e.*, to that class of traffic which is a prolific source of trouble in view of the depletion of railway staffs and rolling stock.

We are glad to note that there has been a free interchange of opinions with the District Coal and Coke Supplies Committees as representing the colliery owners and with representative factors and merchants so that the scheme should prove generally acceptable. Water-borne coal, anthracite, and coke will be unaffected by the proposed arrangement. In order to meet the needs of special consumers arrangements are being made to issue certificates authorising supplies of coal of special types required by steam raisers, users of gas producers, etc. From the point of view of the owners of railway wagons the scheme should be attractive, as it will permit of a better turnover for the wagons and tend to minimise stoppages at collieries due to delays in the working back of empty wagons.

It is noticeable that the Controller of Coal Mines also has under consideration various details in connection with the use of coal. In a statement which was published in our last issue various suggestions are made with a view to effecting economy. In this statement we are glad to note that the Controller acknowledges the economy secured by public power supply. To increase this economy, factory owners are urged to give up private generating plants and to take their power requirements from an outside source. Any such policy, of course, will necessitate the enlargement of existing power stations to meet the load, and with this end in view the Controller will assist as far as possible in obtaining priority for plant, provided a substantial coal saving can be demonstrated.

Attention is also called to the desirability of using locally produced coke and coke breeze in place of coal, to the curtailment of early and late tramway running, and to the desirability of electric cooking and heating. We doubt if much is to be gained by the curtailment of tramway services. On the other hand, the cutting down of domestic fuel in the shape of raw coal is highly desirable; but here again any serious extension of electric cooking and heating means that the supply authority must have means to meet the load so obtained.

Further, attention is drawn to the desirability of interlinking existing power stations by means of underground cables, or, "in suitable cases, by temporary overhead wires over the intervening country." The reference to "temporary overhead wires" strikes us as somewhat curious. For many years power engineers have been striving for the use of overhead transmission lines which would be far from temporary. The idea of using underground cables if they can possibly be avoided, or of erecting transmission lines with a view to their replacement by underground cables at some later date, will not be a pleasant prospect to any supply engineer.

We regret that in the official statement so far issued there is no reference to the regulation of coal prices. We trust that something will be done in this direction before next winter; otherwise there will be widespread dissatisfaction. The Coal (Limitation of Prices) Act has by no means produced the desired effect, and we doubt if it has reached the middleman. There is also one other point. Electric power stations have suffered severely during the last year or more from the inferior quality of the coal which they now obtain. The present scheme provides for the abrogation of contracts, though at the same time it permits of special qualities of coal being transmitted from one area to another for manufacturing purposes where any special varieties are necessary. Under these conditions it may well be that the power engineer will find himself in a still worse plight through being supplied with coal which is still more inferior. It is important that the authorities should learn that the capacity of a power station does not depend merely upon the size of plant which it contains, but also upon the quality of the fuel with which it is supplied. If the boiler capacity is, for all practical purposes, largely reduced by burning inferior coal, the full capacity of the turbines ceases to have a meaning. It appears to us that in any scheme for the efficient utilisation of fuel, attention should be paid to this aspect of the question. Coal of good quality should be supplied to power stations. To carry on our railways coal containing 20 per cent. of ash is not merely bad policy from the point of view of cutting down the capacity of our stations, but it is also utilising railway rolling stock inefficiently by carrying a large proportion of worthless material.

Digitized by Google

EFFECT OF CURRENT-LIMITING REACTORS ON TURBO-GENERATOR SYSTEMS UNDER CONDITIONS OF SHORT CIRCUIT.*

BY P. B. JUHNKE.

Summary.—A cable breakdown near a generating station which resulted in a second breakdown on the same line within the station, prevented the oil-switch from automatically disconnecting the fault. The conclusion is drawn that without reactors the damage resulting would have been considerable and the service interruption far more general and serious.

This Paper contains an account of a cable breakdown near the generating station, which resulted in a second failure on the same line within the station, between the current transformer and the automatic oil switch, thereby preventing immediate operation of the latter. The system in question is amply protected by reactors on the generators and between sections of the 'bus.

Events Before and During Trouble.—The system in question is that of the Commonwealth Edison Co. The breakdown occurred at the Quarry-street station on line No. 223. When, after about 15 seconds, the short circuit had cleared itself, about 80,000 kw. of system load had been automatically disconnected by the operation of the protective devices in the sub-station. This resulted in a rise of the system frequency, which caused three of the four Quarry generators to trip out on the steam end.

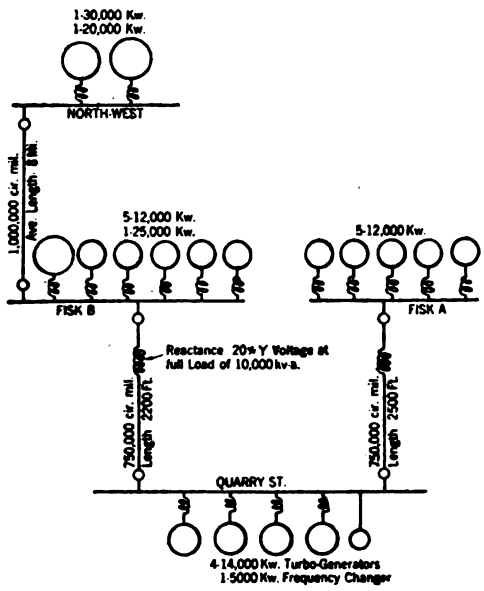


FIG. 1.—DIAGRAM OF SYSTEM AS OPERATED AT TIME TROUBLE OCCURRED.

An investigation revealed the fact that the connector between oil-switch leads and current transformers on *B* and *C* phases of this line had burned off and that one of the leads had established an arc to a ground 'bus and the other to a bolt embedded in concrete. The arc had damaged the relay wiring on *B* and *C* phases of line No. 223, making these two relays inoperative, but leaving *A* phase relay intact. A test indicated that the line had burned open on *B* and *C* phases outside of the station, and that *A* phase was grounded.

When repairs were made it was found that this burn-out had occurred within a very few feet of a previous burn-out on another line, and it was thought best to dig up the conduit. It was found that an adjacent duct wall had been broken and that the lead had been burned from one side of another line in this same duct.

Analysis of Sequence of Events.—It is believed that when the fault outside was established, the great rush of current, largely due to the nearness of the fault to the station 'bus, caused the joint between the lead from the oil-switch and the current transformer to break apart on both *B* and *C* phases. It is probable that when the arc to ground was established, the arc to the short-circuited cable was maintained until *A* phase broke down either to ground or to one of the other phases, which caused the *A* phase relay to open the oil-switch, thereby clearing the trouble from the 'bus.

Description of System.—The total capacity of the 25-cycle, 9,000-volt system here concerned consisted of 17 generators and a 5,000-kw. frequency changer of a combined capacity of 251,000 kw., each of the generators having, including its external reactance, a total reactance of approximately 8 per cent. The load carried was approximately 200,000 kw. This system, at the time of the trouble, consisted of :—

Station or Section.	Generating capacity.	Number of machines.	Load.
Northwest	50,000 kw.	2	50,000 kw.
Fisk *A*. Section	60,000 ,,	5	48,0 0 ,,
Fisk *B*. Section	80,00 ,,	6	55,000 ,,
Quarry St.	61,000 ,,	5	49,000 ,,
	251,000 kw.	18	202,000 kw.

The relays on the tie-lines are of the bellows type, with a setting on each line as follows : Minute, 9,375 kv.a.; 2 seconds, 11,700 kv.a. and inst., 14,000 kv.a. Fig. 1 is a diagram of the system as it existed

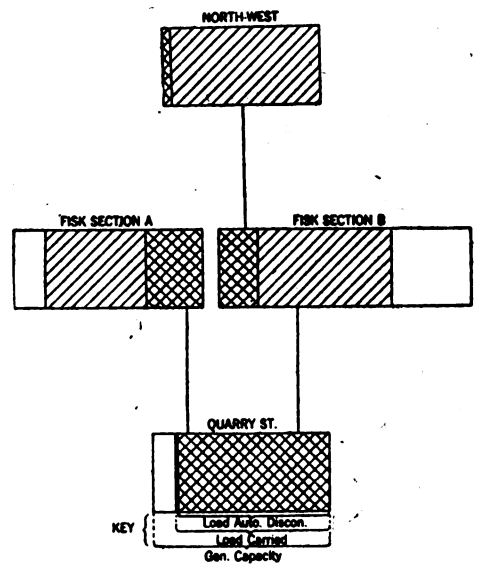


FIG. 2.—DIAGRAM OF GENERATOR CAPACITY—LOAD CARRIED AND LOAD AUTOMATICALLY DISCONNECTED.

at the time the trouble occurred. The synchronous apparatus supplied by the different sections was :— .

Sections.	Apparatus in sub-stations.	
	Synch. conv.	Synch. motors.
Northwest	9 sub-stations	2 sub-stations
Fisk *A* Section	20 ,,	3 ,,
Fisk *B* Section	18 ,,	1 ,,
Quarry St.	15 ,,	1 ,,

Effect of Short Circuit on System.—At the time the trouble occurred nearly all the synchronous apparatus feeding from Quarry-street lines was automatically disconnected, about 70 per cent. through operation of alternate-current overload relays opening oil switches, apparently due to back feed into the short circuit; about 28 per cent. due to reverse current or low-voltage release relays tripping direct-current circuit breakers. This ratio of apparatus disconnected by operation of oil switches to that disconnected by operation of direct-current breakers is exceedingly small in the stations supplied by either of the Fisk-street sections, while none of the apparatus on Northwest lines was disconnected on the alternating-current side. The only machine which was automatically disconnected on the alternating-current side on Fisk *B* section tripped out because it was operating in parallel on its direct-current end with a machine twice its size, feeding from Quarry-street, due to the overload caused by the reversal of the latter, on which only the direct-current breakers opened. Fig. 2 is a diagram of generating capacity, load carried and load interrupted when trouble occurred.

* Abstract of a Paper read before the Am. Inst. E. E.

Digitized by Google

This diagram clearly demonstrates the beneficial effect of current-limiting section or 'bus reactors on the stability of apparatus on the sections protected by them. The rather considerable loss in load on Fisk *A* and *B* sections was mostly due to direct-current circuit breakers opening in some of the sub-stations supplied by *A* and *B* sections, which in a large measure was caused by overloads from the interruptions to sub-stations which had been supplied by Quarry-street lines.

Probable Values of Short Circuit.—Calculations to determine the dimensions of the short-circuit current and stresses due to them can only be approximate. Certain assumptions, however, can be made which will permit of determining the maximum values of the current into the fault. These are :—

1. That the fault in the cable was of negligible resistance.
2. That the behaviour of the Quarry-street machines is comparable to that of the Fisk-street machine.
3. That the synchronous apparatus connected to Quarry-street at the time the trouble occurred, returned energy at a power factor of about 10 per cent. for the 230-volt synchronous converters and motors and 5 per cent. for the railway converters.

Based on these assumptions, the maximum short-circuit current is made up of the following components :—

(*a*) Current supplied by the Quarry-street generators.
(*b*) Current supplied by the Fisk-street generators, over tie-lines *A* and *B*.
(*c*) Current supplied by synchronous apparatus directly connected to Quarry-street lines.

This is determined by taking the short-circuit currents of the three parts and combining them vectorially. This gives the combined impedance, to which then is added the impedance of the faulty line, giving the resultant short-circuit impedance.

The calculation is carried out in detail for the Quarry-street machines as follows :—

Maximum short circuit between phases on four 14,000-kw. turbo-generators $= 4 \times 900 \times 11{\cdot}9 = 42{,}840$ amperes, at a generator open-circuit voltage of 9,000 volts.
Total maximum effective short-circuit current = 49,240 amperes.
Generator open-circuit voltage corresponding to excitation with load carried before trouble occurred = 10,200 volts.
Impedance of armature circuit = 10,200/49,240 = 0·206 ohm.
Power factor taken as 7 per cent.
Resistance of armature circuit = $0{\cdot}07 \times 0{\cdot}206 = 0{\cdot}014$ ohm.
Reactance of armature circuit = 0·205 ohm.
Maximum effective short-circuit current = 45,800 amperes
Power factor = 7 per cent.
In like manner the combined Fisk *A* and Fisk *B* section current, limited almost entirely by the sectionalising reactors, can be shown to be ..... 5,800 amperes.
Power factor = 2·8 per cent.

Short-Circuit Current of Synchronous Apparatus.—This calculation assumes approximately 5× full-load current for railway machines and 20× full-load current for the 230-volt converters and the frequency changers.

Total capacity of railway machines connected to Quarry-street	42,000 kw.
Total capacity of 230-volt converters and frequency changers connected to Quarry-street	17,100 ,,
Maximum effective short-circuit current of railway machines at power factor 24·7 per cent.	11,500 amp.
Maximum effective short-circuit current of 230-volt converters and frequency changers at power factor 54·5 per cent.	11,800 ,,
Total maximum effective short-circuit current supplied by synchronous apparatus at power factor 40·6 per cent.	23,000 ,,
Total maximum effective short-circuit current of Quarry-street generators, Fisk *A* and *B* Section generators and synchronous apparatus connected to Quarry-street	73,300 ,,
Power factor = 17 per cent.	
Combined armature impedance = ...	0·14 ohm.
,, ,, resistance = ...	0·024 ,,
,, ,, reactance = ...	0·138 ,,
Impedance of line No. 223 to fault, neglecting resistance of arc = ...	0·062 ,,
Resistance of line No. 223 to fault = ...	0·06 ,,
Reactance ,, ,, = ...	0·018 ,,
Total resistance of armature and line = ...	0·084 ,,
,, reactance ,, ,, = ...	0·156 ,,
,, impedance ,, ,, = ...	0·176 ,,
Power factor of circuit = 48 per cent.	
Maximum effective short-circuit current into fault, added vectorially = ...	58,000 amp.
Maximum effective value of energy in arc at a resistance of 0·025 ohm = ...	74,100 kw.

Had the system been without reactors in the generators and between the sections of the 'bus, the total short-circuit current would have been approximately 106,000 amp., and the power factor 83 per cent. This would have multiplied the short-circuit stresses by 3·3 and would have given stresses of approximately 1,140 lb. per foot of parallel conductors below oil switch. Such stresses more than likely would have damaged the 'bus structure, would have immensely increased the task of oil switches and made the service interruption far more extensive and serious.

Behaviour of Sub-Stations.—While synchronous apparatus in a number of sub-stations was automatically disconnected through operation of either the alternating-current or direct-current relays, the interruptions in the sub-stations so affected were of remarkably short duration and the recovery was exceedingly rapid. As nearly as can be determined, the service interrupted from sub-stations connected to the section in trouble amounted to about 50,000 kw. for five minutes, on one of the two sections protected by sectionalising reactors to about 20,000 kw. for three minutes, and on the other to about 10,000 kw. for two minutes.

Conclusion.—Considering results in their entirety, the influence of the reactors must be pronounced as exceedingly beneficial. Not a single piece of generating station apparatus was disabled, as was almost invariably the case before the installation of current limiting reactors. Even on the section directly affected everything was ready for immediate resumption of service as soon as the trouble was cleared. The value of the reactors seems to have been happily chosen ; no evil results attended the operation of the system during and after the trouble ; no oil switches failed ; and, most important of all, comparatively little load was interrupted on the section protected by the sectionalising reactors.

SHALL GREAT BRITAIN AND AMERICA ADOPT THE METRIC SYSTEM?

In THE ELECTRICIAN of June 8th, p. 394, we gave an abstract of a Paper by Mr. W. R. Ingalls on this subject. This Paper has now been published along with the discussion which ensued. In what follows we reproduce briefly some of the chief points of interest. Space does not permit a reference to all the speakers who contributed, but as far as possible we have given what seem to be the chief objections raised to the metric system ; the advantages have been often shown in our columns.

Mr. HARRY ALLCOCK pointed out that if we followed the author's advice and decimalised our existing units of weights and measures we should thereby accept all such difficulties as were incidental to any change, and in the end find ourselves in the possession of an inherently bad system because of the absence of correlation between our units of length, weight, volume and area. It must be remembered that if uniformity was desirable—and he thought in these days everyone was prepared to admit that it was—it must come down ultimately to the choice of either the Imperial System or the Metric System. No intermediate course was now possible. Let them also remember that whether we would or not we must use the Metric System to an ever-increasing extent in this country because of our trade with other countries. On the other hand there was no compulsion for us to perpetuate the two systems, which we had been doing for many years past. Another point was that he thought the author laid too much stress on the value of what he described as the accumulated knowledge stored in the library of an engineer. The engineering industry continued to advance so rapidly that they all knew that the literature which was standard even a few years ago was now quite out of date, and he thought, on consideration, it would be found that the value of such accumulated knowledge as is expressed in English weights and measures was not so great as the author would have them believe. On the question of interference with standards, the author apparently held the view that all existing standards were sacred. Standards were good and valuable, it was true, but it was wrong to assume that the standard of to-day was likely to be the standard of next year. Then in regard to the " practical man " argument, the taunt was thrown out against metric advocates that they were all scientists or dreamers or idealists, and, in fact, anything but " practical men." He thought it must be admitted that many such practical men had long since realised the advantages of the metric system. At a symposium in New York of all the principal engineering institutions to consider the question of the metric system, he was informed they all, with the single exception of the representatives of the mechanical engineers, were in favour of the metric system. Now, wherein did mechanical engineering differ, for instance, from electrical engineering to-day ? The answer presumably was that the electrical industry was a more modern industry. Many people feared that if an Act were passed to render the use of the metric system compulsory instead of permissive, they would forthwith have to scrap all their valuable stocks of patterns, tools, jigs, gauges and the like. Such was certainly not intended, and such would not be the case. No doubt manufacturers under the compulsion of selling their goods on the metric basis would, in course of time and at their own convenience, arrange to manufacture such goods to metric dimensions. There was, however, a

Digitized by Google

bigger question—the bigger national aspect of the question to-day. Everyone knew that in order to pay off the huge war debt we were now accumulating it would be necessary for us, after the war, to export enormously increased quantities of all kinds of British manufactured goods, and it was therefore our duty to examine, and if sound to adopt, every proposal put forward which would be even likely to assist our export trade. It was frequently urged that so long as such nations as the British Empire and the United States stood aloof there was not much hope of the metric system being universally adopted. Why had not America adopted the metric system in the past? He submitted it was primarily because the demand for her goods was essentially a domestic demand.

Prof. HENRY LOUIS said it was, perhaps, fair to say at the outset that all his predilections were in favour of the metric system to begin with. He had had a great deal of work to do on the Continent of Europe and in countries using the metric system, and had constantly to use it himself in surveying, and in taking out quantities and so forth. Nevertheless he had quite come to the view that the attitude taken up by the author was the correct one. He wanted to put the point clearly as he saw it, in this way: They were not discussing the question of the metric system versus the imperial system, but the question of the metric unit versus the imperial unit. He was a thorough believer in the use of a decimal system, but the decimal system and the metric system were two very different things. Our units were for practical purposes the most useful we could have. The advantages of the metric system were distinctly more marked when one came to deal with weights than when one dealt with measures. Determination of length by direct measurement being so obviously a matter of direct reference to a unit, was one of the main reasons why the mechanical engineer was so strongly in favour of adhering to our present units. People who agreed with his own line of argument maintained that the foot was a handier standard than the metre, and that the lb. was a handier standard than the kilogramme. If ours were a new industrial nation starting in business to-day he would not argue as he was doing; he would certainly advocate the adoption of the metric system. But this was not a new industrial country; it was an old-established one, with centuries of industrial experience behind it, and that experience was based upon the units with which we were all familiar. Any change of those units would lead us into expenses that he did not dare to think of. Let them take the commonest example possible. He supposed there must be in Great Britain at least 5,000,000 gas meters, measuring gas by the cubic foot; how much would it cost to change all those gas meters to record in the metric system, and how many rows and arguments would each individual householder have with the gas companies (which gave us trouble enough as it was) if he had to pay for his gas as measured by the metric system. He was not in the least convinced by Mr. Allcock's argument that we should not need to scrap our patterns and jigs and gauges and so forth. We should have to. A man could not sell things in metric measure and make them by his present patterns. If he had to sell things in millimetres he would obviously have to manufacture by that unit, and all that enormous quantity of material, worth no one knows how many millions of pounds, would have to go by the board. There was no evidence whatever that our foreign trade would be improved by working in the metric system, and as for the internal economics of the country, no one knew what would happen. What kind of bricks was one going to put in on a metric system to repair a 9 in. wall? We had all our old standards of feet and inches in our minds in our every-day work, in our legislation, on every side of us, and the dangers and difficulties of changing those would to his mind be enormous. He emphatically agreed with what had been said: By all means, decimalise as far as possible; certainly let us adopt the ton of 2,000 lb.; let us adopt a definite unit of a mile of 5,000 ft., and so on throughout the whole gamut. He was a thorough believer in decimalisation; he was a thorough believer in the decimal system as far as it was a decimal system; his attack was wholly and solely upon the proposed compulsory change of units.

Dr. FRANK L. TEED remarked that it was true, as Prof. Louis had pointed out, that one could decimalise any unit. Of course one could decimalise any linear measurement, the inch, the foot or the mile, but when one had done it and wanted to convert one into the other there was the same old trouble as if one had not decimalised at all; one had to remember that 12 in. made a foot, and that three times 1,760 ft. went to the mile. The recommendation of the Institution was that the ton should be a ton of 2,000 lb. If one wanted a ton which was not quite the same as the 2,240 lb., why not adopt the metric ton, which was 2,204·6 lb.—very close to the 2,240.

Mr. R. GILMAN BROWN said the question of standards, of jigs and templates and so on, had been referred to. He had not the remotest idea of what the value of those things in this country came to, but it possibly amounted to more than half the present war debt. Even if the change were going to come slowly, as was proposed in what had been quoted, each year must bear its share of the burden. They would be scrapping good plant by changing the standard, and would be depriving themselves of that capital which would otherwise go into constructive work.

Mr. H. M. MORGANS pointed out that the particular unit in which things were visualised was entirely independent of the system. It was the result of habits, and those habits could change. Drawings in metric measurements were very easy to make and read. There was no question of mixing up feet and inches. There were no decimal points; everything was in millimetres. He saw drawbacks in the metric system. The number of figures in a long calculation grew rapidly, necessitating recourse to the slide rule or to approximate methods of multiplication and division, taking care to achieve the necessary degree of accuracy. Simple factors disappeared. The value of the Paper to his mind was that it pointed out the great difficulties there would be in changing over to the metric system. It was not an argument against the need for the change to the metric system, but it did call for care in instituting the change. It seemed to him that in changing over to the metric system the business should be in the hands of some standing committee on which all interests would be represented, and which would fix dates for the stages. He had no doubt that the change was necessary, and would have to be undertaken. It was difficult to undertake it now, but it would be ten times more difficult to undertake it in a few years' time.

Prof. S. J. TRUSCOTT said his experience had been rather unique, inasmuch as he had lived for many years in a country where the English milestones had been taken down and kilometres put up. He had been in favour of the metric system, but what he thought now was that it was not so much our principal units which were at fault as the use of so many secondary units. In collieries, for instance, they purchased hoisting ropes by the fathom to work in shafts so many yards deep, when the unit of length was the foot. If the fathom and yard were given up except in very special cases a good deal of confusion would cease. The inch was the twelfth part of the foot, it was true, but within a certain range it was a most useful unit. At the particular mine to which he had referred the workshop staff was entirely German, and in that shop these men themselves used the inch, they spoke of bars of iron in inches; so that this unit was largely used in Germany still, probably because Germany had adopted the Whitworth standard of threads.

Mr. EDWARD C. BARTON remarked that the scrapping bogey had been repeated by many of the speakers; it had been said, indeed, that half the cost of this war would be incurred by the enormous scrapping of machinery. The last speaker had given them a most interesting piece of information—viz., that even in Germany at the present day the inch was still in use, and that there were machines in use on that standard. It was extraordinary to hear that on the one hand, and, on the other, to hear that all that gigantic scrapping which had been referred to must take place as the immediate result or as the ultimate result of 10 or 15 years' work, at a cost of 100 millions per year.

CORRESPONDENCE.

FUEL ECONOMY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of June 29th, under the heading of "Notes," reference is made to Mr. J. A. Robertson's Paper on "Fuel Economy" presented at the recent meeting of the I.M.E.A. In this Paper Mr. Robertson refers to higher steam pressures and temperatures than at present used as a means of obtaining economy in fuel.

As the writer has been a consistent advocate of these means for securing fuel economy, and has designed and operated a plant of this nature for a considerable time at Rugby, perhaps you will permit the following information being put before your readers:—

At the British Association meeting at Dundee, 1912, Dr. Dugald Clerk read a Paper on the "Gas Turbine," and in the discussion following the Paper the writer suggested that, whilst waiting for the gas turbine to become practicable, a good deal might be done to improve the economy of steam plants by using higher steam pressures and temperatures. He contended that a fuel saving of 15 to 18 per cent. was certain, and that experiments on a fairly large scale were about to be started to prove this contention.

The directors of the British Thomson-Houston Co. (Ltd.) provided means for manufacturing and installing a plant of 1,500 kw. capacity, using extra high pressure steam, and this plant was successfully put into commercial service about $2\frac{1}{2}$ years ago.

Engineers interested in thermodynamics will know that for a given temperature the total heat required to be put into the steam decreases as the pressure goes up, and at the same time more heat is available for work. For readers not familiar with the properties of steam it may be of interest to see this relationship in the form of readily interpreted curves. The curves in Fig. 1 are based on adiabatic expansion, on the feed water entering the boiler at 80°F., and that the expansion is taken down to a pressure equal to $28\frac{1}{2}$" vacuum (bar. 30"). The efficiency ratio shown on the curves is derived from the relation of $\frac{\text{heat available in steam}}{\text{total heat in steam}}$.

From the curves it is seen that the improvement in efficiency is greater the higher the temperature. For instance, at 175 lb. absolute pressure an increase in temperature from

Digitized by Google

700°F. to 800°F. increases the thermal efficiency nearly twice as much as does the rise in temperature of from 400°F. to 500°F. The relationship of pressure and efficiency is also readily observed. For instance, the same efficiency is obtained with steam at 300 lb. pressure and 500°F. temperature as at 175 lb. pressure and 800°F. temperature. The highest permissible safe working temperature of steam is about 800°F. as applied to ordinary boiler, piping and turbine material now in use. With the temperature limit thus given, higher economy can only be obtained by increasing the pressure.

When the experimental plant at Rugby was decided upon it was hoped that a pressure of 500 lb. could be used. After consultation with Messrs. Babcock & Wilcox a compromise pressure of 350 lb. was decided upon, the steam to be superheated to a total temperature of 700°F. The capacity of the boiler was to be 18,000 lb. of steam per hour, and the type selected was the makers' well-known self-contained marine type, with boiler, superheater and economiser sections inside one casing, and fitted with chain-grate stoker and induced draught. The turbine, which is of the impulse type, was built to standard design modified to suit the new conditions. The generator is totally enclosed, and the air used for cooling is delivered to the boiler grate. The plant auxiliaries call for no special comment. The plant was first put into service at the end of 1914. Steam consumption tests have been taken, and the results are given in Fig. 2; the figures obtained include generator losses and excitation, but do not include power for the auxiliaries.

It should be stated that with a turbine designed specially for the high steam conditions an improvement in the steam consumption at full load of about 0·4 lb. per kilowatt-hour can be obtained; but this was not possible with the present machine, because, as stated above, standard parts as were available in 1913 were used in its construction. Tests on the boiler show an efficiency varying from 80 to 83 per cent. To ascertain the actual consumption of coal per kilowatt-hour a 10-hour test was taken which gave 1·83 lb. of coal per unit generated, the vacuum obtainable being but 27·7". The average heat value of the coal as fired was 10,985 B.T.U.s per lb., or the equivalent to 20,000 B.T.U.s per unit generated. The mean heat value of the coal was ascertained from three

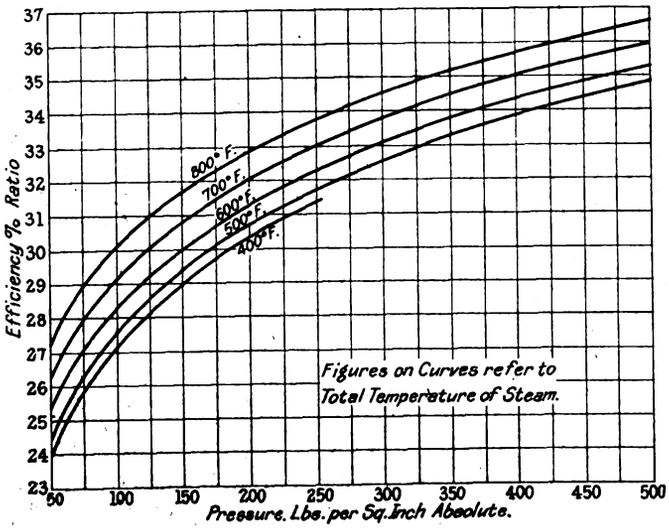


FIG. 1.—RELATIVE EFFICIENCY OF ADIABATIC EXPANSION.
Feed Water Temperature 80°F. Vacuum 28½ in.

average samples, tested by three independent laboratories, all agreeing very closely. The above coal consumption refers to the turbo-generator unit only, and does not include the power taken for auxiliaries, which could not be properly estimated, the circulating pump also supplying other condensers.

The new plant proved so successful and economical that it was put in commercial operation on the power circuit for the works.

The saving in coal has exceeded the 15 to 18 per cent. already mentioned owing to the improved efficiency of the new plant under the constantly varying load and power conditions in a large works, though the older power plant is of comparatively modern construction. Only minor troubles have been met with either in turbine or boiler. Some parts were found unsuitable for the high temperature, and had to be renewed; but these have been of minor character, and have not interfered with the operation of the plant, and it may be stated that the turbine and boiler have passed out of the experimental stage. The plant was opened up and examined during the last Christmas holidays and found in good condition. As only three days were available the inspection could not be as thorough as desired, and will be again inspected during the present month, when time will permit of a more careful examination. Should anything of interest be found, or faults discovered which would alter the writer's present opinion, he would like the hospitality of your columns to return to this subject.

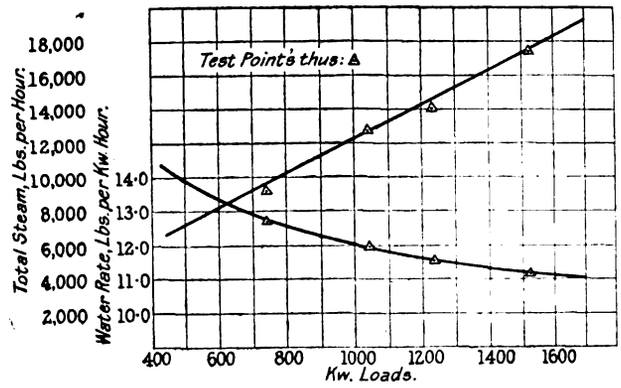


FIG. 2.—CURVES OF 1,500 K.W. TURBO-ALTERNATOR RUNNING AT 3,000 R.P.M.
Pressure Gauge 350 lbs. Total Temp. 700°F. Vacuum 28½ in.

The writer recently had occasion to look into a large power plant scheme with favourable load factor, and found that with a boiler pressure of 350 lb., steam temperature 750°F., circulating water temperature 55°F., the heat consumption per kilowatt-hour generated works out at 15,000 B.T.U.s, which includes a boiler efficiency of 80 per cent., all losses in turbo-generator, but does not include power for auxiliaries. Allowing 6½ per cent. for the auxiliaries, the gross heat consumption per unit generated will be about 16,000 B.T.U.s.

Mr. Robertson in his Paper anticipates a coal consumption of 1·45 lb. per unit sold, and with a good quality of coal this seems to be well within the possibilities of the art to-day.—I am, &c.,

Rugby, July 9. FREDERICK SAMUELSON.

COAL SUPPLY AND DISTRIBUTION.

The Controller of Coal Mines has prepared a scheme, which will come into operation on Sept. 10, for re-organising the transport of coal for home consumption. It is estimated that the proposals will save 700 million ton miles annually in the transport by railway of the 42 million tons of coal needed each year for public consumption. Great Britain has been divided into 20 areas, and the scheme relates solely to that portion of the coal which is being transported from area to area for inland consumption. A map showing the areas is given on the page opposite and the directions of the Controller are set out in an advertisement in this issue. The principal features of the proposals, which are commented upon in the leader, are:—

1. That consumption of coal should take place as near the producing point as possible.

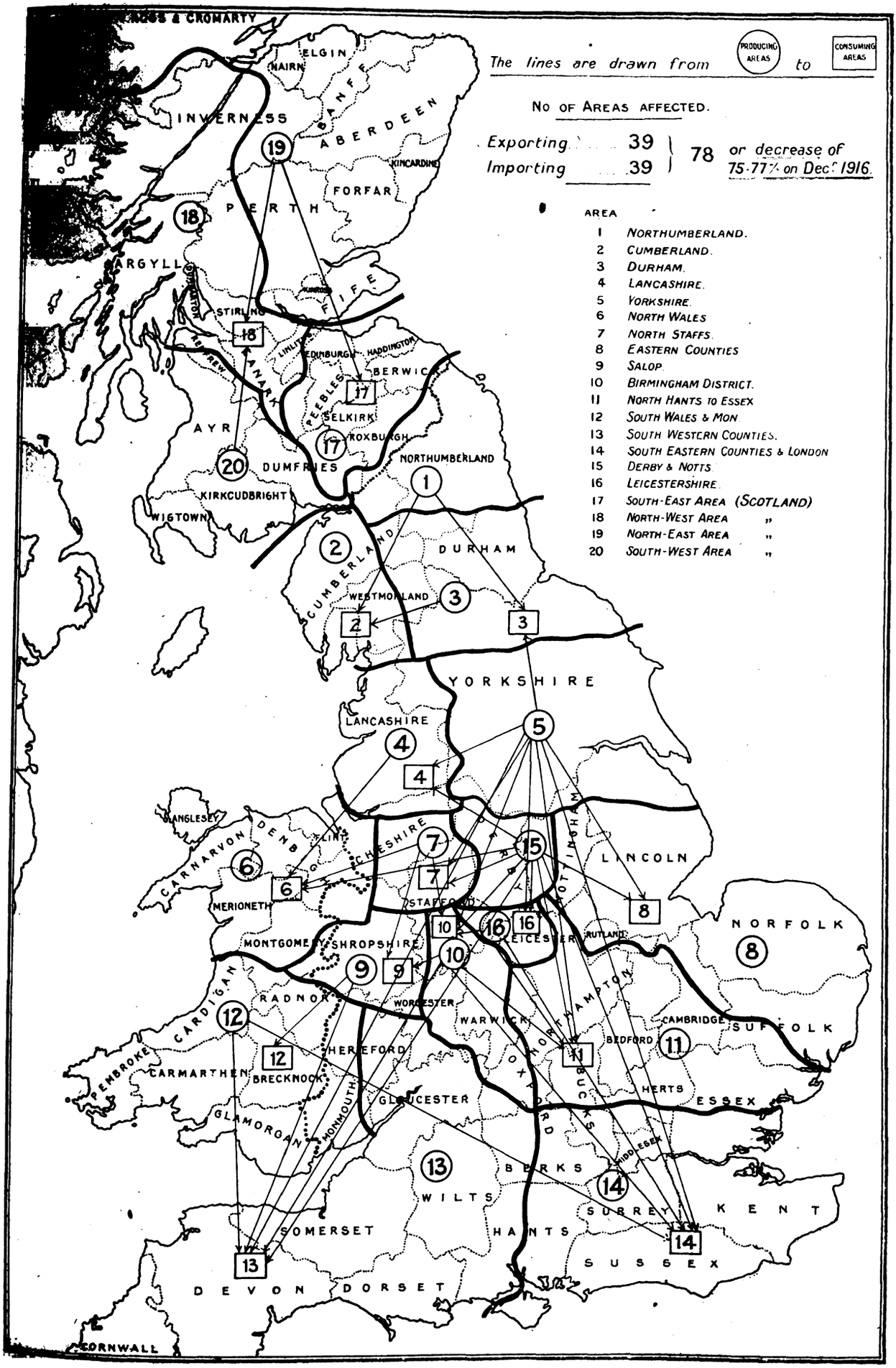
2. That in view of the superior facilities afforded by the main trunk lines the movement of traffic should follow these routes wherever possible.

3. That the movement of coal should, as far as possible, be in well-defined directions—namely, north to south, north to south-east, north to south-west, east to west.

4. That an area producing less coal than suffices for its own needs should not send any portion of its output to other areas.

An area producing more coal than it requires for consumption within the area itself will only distribute the balance to adjacent or convenient areas. The only limitation in regard to clause 4 is the need for providing fuel of a special type for certain purposes, and this need has been determined by getting in touch with consumers direct. Arrangements are being made for the issue of certificates authorising supplies of coal of a special type required by steam-raisers for special purposes—for example, mechanical stokers, gas producers, &c.—and collieries, factors and mer-

Digitized by Google



SKETCH MAP SHOWING INTERCHANGES BETWEEN PRODUCING AND CONSUMING AREAS OF RAIL-BORNE COAL (EXCLUDING ANTHRACITE) FOR INLAND USE UNDER THE COAL TRANSPORT RE-ORGANISATION SCHEME.

Digitized by Google

chants will be precluded from supplying special grades to consumers in the absence of a certificate issued to the latter by the Controller of Coal Mines.

In the various areas districts coal and coke supplies committees are acting as the Controller's representatives in all matters relating to coal. These committees have been empowered by the Controller to conduct the necessary arrangements for putting the new scheme into force.

The movement of coal within the areas themselves—that is, coal produced and consumed in the same area—remains undisturbed and contracts will not require to be cancelled. In the case of coal affected by the scheme, however, existing contracts will be cancelled at 6 p.m. on Sept. 8, and new contracts (to be arranged between now and that date) will come into operation on Monday, Sept. 10.

The scheme does not affect water-borne coal, either export, coastwise or bunkers, anthracite or coke of any description.

A table given in the advertisement sets out the areas to which the coal produced in each of the areas may be forwarded by railway for inland consumption, and there is also a list of the District Coal and Coke Supplies Committees, with the names and addresses of the secretaries, &c.

LEGAL INTELLIGENCE.

Centrifugal Fan Patent Revoked.

A petition by the James Keith & Blackman Co. for the revocation of a patent for a centrifugal fan was heard by Mr. Justice Sargant last week. The petitioners were the registered owners of patented inventions in connection with centrifugal fans for the delivery of air and other gases under pressure. The patent atteked was Ralph Hancock's patent 21,353 of 1913.

Mr. Moritz appeared for petitioners, and there was no appearance for Mr. Hancock, who it was stated was in America. Evidence having been given on behalf of petitioners by Mr. Jas. Swinburne and Mr. Chas. Inson,

His LORDSHIP, in giving his decision, said a petition in regard to which the evidence was all on one side was rather unsatisfactory, especially when the whole subject matter was an exceedingly difficult one. But it had been shown that when that particular patent was compared with Mr. Hancock's patent in America there was only one distinction between the figure 3 of the American patent and figure 6 of the present patent, namely, that there was a want of symmetry in the design in the English patent, the two ends of the fan being different, while in the case of the American patent the two ends of the fan were equal, so that in the one case there was symmetry, in the other there was a want of symmetry. That being so, there was also this to be noted, that no reason was given in the English patent for the want of symmetry. The patentee did not seem to have placed before himself the problem to be solved by means of turning that which was symmetrical into that which was asymmetrical. There was no sufficient subject matter to justify the grant of the English patent. Further, there had been tests made by Mr. Swinburne and Mr. Inson of a fan designed in accordance with the English specification of Hancock as against the ordinary design by Keith, and it had been shown that in a comparison of equal speeds or power that the Hancock fan was less efficient than the Keith fan; and accordingly there was a presumption arising from that that there was no utility in the design. In the tests that were made advantages were given to the Hancock patent as against the Keith design, inasmuch as the Hancock specimen was a larger fan, at any rate as regarded depth, than the Keith fan. On the whole his Lordship thought he must grant the petition for revocation.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1913 SPECIFICATION.

27,657 PROGRESS MOTOREN-UND APPARATENBAU GES. Electric incandescent lamps (14/10/13.)

1916 SPECIFICATIONS.

3,067 WATSON & CO., T. H., GREAVES, H. A., & ETCHELLS, H. Electric furnaces (1/3/16.) 106,626.

4,067 SIMPSON, C. C. W., & LE NOIR, R. G. Magnetos. (18/3/16.) 106,628.

5,466 SOC. FRANCAIS RADIO-ELECTRIQUE. Wireless telegraphy and telephony. (1/3/15, addition to 5,458/16.) 100,282.

Relates to a telephone receiver, having a single coil, which receives high-frequency alternating current produced by a local generator, the circuit of said coil being coupled to the antenna of a wireless telegraphy or wireless telephony installation through an audion or de Forest lamp relay, in order that the antenna current may be amplified before passing through the telephone coil.

7,214 ATHERTON, C.A. Electric motors with reduction gearing. (20/5/16.) 106,518.

7,649 CROWLEY, J. F. Electric brakes, chiefly for looms. (30/3/16.) 106,863.

7,672 MORRIS & WHITHAM & ALLISON, J. A. Apparatus for forming enlargements on the stems of metallic filament electric lamps. (30/5/16.) 106,664.

7,708 CROMPTON & CO & PENSABENE, N. Rotary electric transformers. (31/5/16.) 106,667.

8,458 BENNETT, A. E. Electrical make-and-break devices. (15/6/16.) 106,693.

8,740 ELLISON, G., & ANDERSON, J. Protective devices for dynamo-electric motors. (21/6/16.) 106,697.

9,206 PARSONS, I. H., & BALL, A. E. J. Electric clocks. (30/6/16.) 106,702.

9,655 STERLING TELEPHONE & ELECTRIC CO., BELL, F. G., & DAVEY, W. C. Electrical signalling systems. (8/7/16.) 106,706.

9,866 MCLEOD, T. Electrical operating or controlling apparatus. (13/7/16.) 106,556.

10,622 WADE, W. O., & CHAPPELLE, C. C. Device or apparatus for registering the coasting and stoppage time of electrically driven vehicles. (26/8/15.) 101,290.

11,961 ARMSTRONG, WHITWORTH & CO., W. G., & CHEETHAM, A. S. Mountings for electric and other lamps and the fittings thereof. (23/8/16.) 106,569.

13,150 HENLEY'S TELEGRAPH WORKS CO., W. T., & NICHOLS, W. H. Electric cable terminals. 15/9/16.) 106,575.

13,173 COOKE, G. F. Dynamo-electric ignition apparatus. (16/9/16.) 106,745.

13,805 TILLINGS-STEVENS (LTD.) & SMITH, P. F. Automobile electrical apparatus for welding, searchlight and like purposes. (28/9/16.) 106,752.

13,874 TILLINGS-STEVENS (LTD.) & SMITH, P. F. Means in vehicles having an electric transmission for ventilating and cooling electric generators and motors. (29/9/16.) 106,754.

14,466 MOFFAT, J. W. Electric furnaces. (11/10/16.) 106,760.

14,739 ASKE, I. E. Use of reactances in alternating-current electric circuits. (17/10/16.) 106,762.

17,212 WIDEGREN, E. H., & WIDEGREN, K. A. System for controlling electric apparatus by wireless transmission. (20/12/15.) 102,942.

Consists chiefly in effecting by means of the pulsating currents created in the local circuit of the receiver a magnetising effect corresponding to the effective value of said pulsating currents, said magnetising effect serving to effect the desired control at the receiving station by moving a damped armature or winding in accordance with said effective value.

18,046 AUTOMATIC TELEPHONE MFG. CO. Automatic telephone systems. (14/2/16.) 104,164.

19,300 AUTOMATIC TELEPHONE MFG. CO. Automatic telephone systems. (31/12/15.) 103,116.

1917 SPECIFICATIONS.

1,346 VOLKERS, E. Small electric motors. (17/2/16.) 104,170.

1,581 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (Westinghouse Electric & Mfg. Co.) Vapour electric converters. (31/1/17.) 106,591.

A blast of superheated vapour is caused to impinge on the incandescent cathode of a vapour converter, whereby the operation of a converter of the pure-electron emission type is much improved. The resultant action cannot be clearly explained, but there is apparently a much more pronounced electronic emission and an increase in the current-carrying capacity, possibly due, in part, to the mechanical action of the blast in sweeping electrons toward the anode.

2,487 PETERS & CO., G. D., HIBBERD, F. C. & KING, W. Electromagnetically-operated contact-makers or switches. (27/6/16, divided application on 16,765/15). 106,597.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

May 7, 1917.

6,461 CONNER. Electric starters for engines.

6,467 FELL. (Bignami.) High-tension magneto machines for ignition systems of engines.

May 8, 1917.

6,508 CROMPTON & CO. & PERCY & PENSABINE. High-frequency alternating-current dynamos.

6,525 REYNOLDS. Electric connections for switches, plugs, &c.

6,528 DEAN. X-ray exploration couches.

6,530 PIRELLI & CO. Electric cables containine several conductors.

6,531 ELECTRICAL IMPROVEMENTS (LTD.) & GREGORY. Electric switches.

6,532 ELECTRICAL IMPROVEMENTS (LTD.) & POYNDER & BEARD. Stabilising self-exciting direct-current dynamos.

6,536 B.T.-H. CO. (G.E. Co.) Apparatus for manufacture of electric lamps.

6,542 STERLING TELEPHONE & ELECTRIC CO.-BELL & DAVEY. Electric signalling systems

6,556 B.T.-H. CO. & WEDMORE. (G.E. Co.) Fusible cutouts.

May 9, 1917.

6,584 RANSOMES & RAPIER & LEWIS. Electromagnetically operated brake, &c., mechanisms.

6,600 B.T.-H. CO. (G.E. Co.) Forming filaments.

6,603 CRACKNELL. Spring device for electric lamp shades.

6,610 CADETT & PERCY. Electric starters for engines.

May 10, 1917.

6,631 SAINT. Momentary-contact electric switches for cancelling mining visual signals.

6,659 BARR & STROUD. Mechanical and electrical relays.

6,668 PARSONS' MARINE STEAM TURBINE CO. Turbine blade attachments.

May 11, 1917.

6,699 & 6,700 BRITISH INSULATED & HELSBY CABLES & BLADES. Lead-covered cables.

6,725 ELECTRICAL IMPROVEMENTS (LTD.), BEARD & HUNTER. Protection of elec. distribution systems.

6,732 QUAIN. Electric furnaces.

6,746 HELLYAR. Electric batteries.

6,752 CLEATHERO & SPUR. Magneto-electric machines.

May 12, 1917.

6,787 MONEY. Secret switch or cutout.

6,794 MARCONI'S WIRELESS TELEGRAPH CO. & WRIGHT. Employment of thermo-ionic devices for magnification.

6,802 B.T.-H. CO. (G.E. Co.) Systems of phase modification.

6,805 S. SMITH & SONS & ROGERS. Electric measuring instruments.

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Orders for the Week.

Lieut.-Colonel C. D. CLAY, V.D., Commanding.

Officer for the Week.—Platoon Commander A. Gerard.

Next for Duty.—No. 3 Company.

Appointment.—Dr. Hugh Gibbon to be Medical Officer.

Promotions.—Acting Corporals Gillespy and Salisbury to be Corporals.

Monday, July 16.—Technical Instruction, for No. 3 Company, Right Half Company, Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' drill, 6.30.

Tuesday, July 17.—Lecture, 6.30. Physical drill and bayonet fighting, 7.30.

Wednesday, July 18.—Drill, No. 1 Company, Left Half Company.

Thursday, July 19.—Drill, No. 2 Company, Left Half Company. Ambulance Class, 6.30. Signalling Class.

Friday, July 20.—Technical Instruction for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' drill, 6.30.

Saturday, July 21.—N.C.O.'s Parade, Map reading.

Sunday, July 22.—Parade will be at Esher for Engineering Instruction.

Armlets.—Members are warned that armlets must be worn at all plain clothes parades.

Musketry.—For all companies, see Notice at Headquarters.

Note.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street, W.)

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Machine Tools. The Minister of Munitions desires to call the attention of the public to the fact that under the Defence of the Realm Acts and Regulations, no person is allowed to sell, purchase, hire or loan, or send on approval any new or second-hand machine tools without the permission in writing of the Ministry of Munitions.

* * * *

Ministry of Commerce. There is an increasing volume of opinion in favour of the establishment of a Ministry of Commerce. Not only is the demand being kept up by Chambers of Commerce, by commercial and industrial firms, by those interested in the export trade, but the question has now been taken up energetically by the Commercial Committee of the House of Commons. Already 135 members of the Committee have adhered to the demand for the creation of a Ministry of Commerce for the publication of the Faringdon Report on the Consular service abroad. It is to be hoped that the Committee will persevere in its task, for there can be no doubt that the proper organisation of a Ministry of Commerce is, apart from the successful prosecution of the war, one of the most urgent and important of the moment.

* * * *

Commercial Organisation. At the last meeting of the Advisory Committee to the Board of Trade on Commercial Intelligence a report was presented on the work of the Department of Commercial Intelligence during the past quarter, and among the other matters considered were the future organisation and scope of the British Industries Fair, the co-operation of the Board of Trade with trade associations in the investigation of foreign markets, the revised instructions to Trade Commissioners, the Commercial Mission to Spain, and proposals for the formation of a Latin-American Association.

* * * *

Excess Profits Duty. Elsewhere we give an abstract of the white paper which has been issued in accordance with the promise of the Chancellor of the Exchequer, giving the proposals of the Government as to the valuation of stocks, allowances for wear and tear, depreciation, &c. The proposals in regard to the valuation of stocks are based upon the opinion of the committee of consulting accountants advising the Ministry of Munitions in regard to the munitions levy. This committee considers that there is only one sound general principle of valuing stocks for the purposes of these Acts, and that is :—

That all stocks of every sort or kind should be valued at the end of each accounting period on the basis of cost price or market value, whichever is the lower. This principle rests upon the theory (which is perfectly sound) that profits can only be realised by the sale of commodities and that no profits can arise by mere increase of value unaccompanied by a sale. To follow this out consistently stocks, therefore, should be carried at their cost price until they are sold and the profit is ascertained. Where, however, the market price is lower than the cost a precautionary reserve is permissible for the difference between the cost and the market value. We are of opinion that this principle should be adopted throughout in determining profits, whether for the purposes of the munitions levy or excess profits duty.

The memorandum dealing with allowances for wear and tear, depreciation and obsolescence of assets is given at considerable length because the subjects dealt with are of considerable importance to electrical manufacturers, electric supply and tramway undertakings, &c.

* * * *

Indian Mica Exports. The Indian Department of Commerce and Industry has made an announcement in connection with the exportation of mica. The Government of India, having been informed that there is a keen demand for ruby block mica in London for munitions purposes, gives notice that all qualities and sizes, both of Government and trade descriptions, may be shipped freely to London without any restriction whatever.

The Government agency for certifying exports no longer exists, and dealers and shippers are invited to sell their stocks of block mica freely for export to London. Although mica may be consigned freely to any private importer in London, the British Government reserve the right to requisition any consignments on arrival if required for military munitions. There is no objection to shipments being made under contract for sale to the United States on condition that the cases are shipped via London and landed there for inspection, and, if necessary, requisition by the British Government. If not required for military purposes in London, re-export to the United States will be permitted. But in no circumstances whatever will direct shipments be permitted to the United States of America, or to any destination other than the United Kingdom.

* * * *

Western Union Telegraph Report. The report of the Western Union Telegraph Co., which was recently issued, shows that, like British telegraph companies, the past year has brought increased prosperity to it. The operating revenues of the company, which controls the Anglo-American and the Direct United States systems, increased by $10,747,300, or 21 per cent., and in spite of heavier working expenses the net profit advanced in the same ratio, or $2,227,800. The total receipts were $63,621,600, and the net profit was $13,561,800. The dividend has been increased from 5 to 6 per cent., and a special distribution of $1,166,400 is also made to employees, though additions to the pay roll during the year represented $2,614,000. In addition $1,000,000 is transferred to cable maintenance reserve, making the total $1,179,100. The system has 25,234 offices working, or 92 more than in 1915, and all plant has been augmented and improved. Betterments cost $3,060,700, and every effort has been made to increase cable efficiency. The President reports that "the installation of the automatic printing telegraph system, known as the multiplex, has been continued with satisfactory results. The extended use of this method of operation has greatly increased the capacity of the telegraph plant and has made possible the generally satisfactory handling of the increased traffic."

* * * *

The General Electric Report. From the report of the directors of the General Electric Co., which appears in another column, it will be seen that the company's record for the past year is even better than for 1915-16. Notwithstanding a remodelled staff, the high price of raw materials and the transport and other difficulties the trading profit was £188,100, against £157,900 in 1915-16, and the income from investments amounted to £77,100, compared with £38,200. The net profit is £195,700, against £156,200, after allowing for an increase in the depreciation provision by £11,200, and in the managing directors' and employees' bonus by £5,800, and after setting aside £12,500 for income tax reserve. For the fourth year in succession an ordinary dividend of 10 per cent. is paid, tax free, and the preference shareholders are also to participate in the prosperity of the company by having the income tax deducted from their dividend refunded to them. This is equivalent to a return of 1½ per cent. The transfer to reserve is again £40,000, and the total of the fund is now £400,000, with the addition of the £100,000 placed to special reserve to cover pre-war contingencies, which have not matured. The carry forward is increased from £48,100 to £89,800.

* * * *

Commercial Education. The London Education Committee, desirous of knowing whether the present educational system is providing an adequate equipment for future commercial life, recently took steps to obtain the views and criticisms of representatives of commercial houses, of the engineering, shipping and other industries.

The commercial view generally is that the London County Council is not in touch with the requirements of business men, and that firms knew little of the facilities for education offered by the Council. It is alleged that in the main the elementary schoolboy is deficient in handwriting, arithmetic or spelling, and that a sense of obedience, thoroughness, common sense and manners was lacking.

The secondary schoolboy (including the public schoolboy) is deficient in handwriting, spelling and arithmetic, he is unable to express himself in good English and he requires more grit and energy in work.

In regard to university men the general view was they might succeed. It was generally, if not always, the product of older universities and not the graduate of the newer universities that was the subject of criticisms. The evidence showed that relatively few university men who had not family connection with business had been appointed by any of the firms represented. In certain large houses university men were said to have failed ; in others, such as life departments of insurance offices, to have succeeded.

To bridge the gulf which separates education from commerce and industry, the Education Committee suggests the formation by the L.C.C. of consultative committees for banking, chemistry and engineering, to visit the Council's institutions at which instruction in these occupations is given, and offer criticism and advice on the spot. The education authority will also offer its assistance to employers in engaging staffs.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Bath.—The Council has approved an expenditure not exceeding £1,200 for providing and fixing an underfeed stoker and transporter at the electricity works.

Ald. HOLT, chairman of the Electric Lighting Committee, stated that the necessity for obtaining the underfeed stoker arose out of the difficulty with regard to the coal position, and it also offered them the means to effect very considerable economies. At present they were obliged to use large steam coal, which cost them 30s. per ton, but with the underfeed stoker they would be able to use slack, costing 16s. 8d. per ton. It was estimated that the saving during the year would amount to something like £1,000.

Erith.—The Council has applied for sanction to borrow £1,000 for additional equipment for a sub-station to enable a supplemental supply of electrical energy being given to Callender's Cable & Construction Co.

An additional boiler is being put in at the generating station.

Rotherham.—On the 4th inst. the Corporation authorised the purchase of a 25,000-kw. turbo-generator set, with boilers, stokers, condensing plant, &c., for the generating station, at an approximate cost of £275,000. In March last the Council authorised extensions estimated to cost £400,000, so that the total estimate for extensions within the year is £675,000.

Sheffield.—A feeder cable is to be laid at a cost of £6,145 to supply electric power to a factory and for distribution purposes. A plot of land at the junction of Lake-street and Alfred-road is to be purchased for the purpose of a sub-station.

Notices have been given to the Rural Councils of Wortley, Rotherham, Kiveton Park, Norton, Chesterfield and Clowne, and the Urban Councils of Stocksbridge, Donfield and Handsworth of the intention of the Corporation to apply for a provisional order to supply electricity in their districts.

Walthamstow.—The Treasury has agreed to a loan for £16,387, at 5½ per cent. interest, for extensions of the electricity station, the sum to be repayable in equal half-yearly payments in 15 years.

The Electrical Engineer has been instructed to make arrangements for the erection of an electrical siren on the Town Hall to give warning of air raids.

GENERAL.

Bedford.—Mr. Kilpin, who has been chairman of the Electricity Committee for the past 17 years, has resigned from the position and he has been thanked for his services.

Burton-on-Trent.—The Council has authorised the borough electrical engineer (Mr. T. Hall) to devote part of his time to assist locally in carrying out the Government coal distribution scheme.

Colchester.—The salary of the borough electrical engineer (Mr. Frisby) has been increased by £50 per annum.

Doncaster.—Last week the Electricity & Tramways Committee reported having considered the re-arrangements necessitated by the acceptance by Mr. E. S. Rayner, borough electrical engineer and tramways manager, of an engineering appointment at the Admiralty during the war, and recommended that Mr. G. A. Roberts, the assistant electrical engineer, be appointed acting electrical engineer during Mr. Rayner's absence, and that Mr. T. Potts be entrusted with the control and supervision of the electrical department, and that he be appointed tramways traffic manager for the same period.

The recommendations were agreed to, and it was also agreed to increase the tramway fares on the Edlington and Balby route.

The Board of Trade recently sanctioned the reconstruction of the tram track in St. Sepulchregate, but as the Minister of Munitions has declined to grant a certificate for the manufacture of the manganese steel required, the work has had to be postponed.

Increased Charges for Electrical Energy.—The rates for supply of current are being increased at the following places :—

Belfast Tramways and Electricity Committee have decided to increase their rates by ¼d. per unit from July 1.

At Morecambe a resolution of the Council to charge 4d. per unit for power has been rescinded and has been fixed at 3d.

Southend electricity department is adopting the following charges from Sept. 30 (old rates being given in parentheses) :—Contract rate L. and N. sections 10 per cent. increase ; flat rate 5d. (4½d.) ; kilowatt rate £7. 10s. (£6. 10s.) per kw. m.d. and 1½d. per unit ; places of worship 4½d. (4d.) ; motive power 2½d. (2d.) ; Corporation departments 4d. (3d.), showrooms £12 (£10) per 3,200 units per annum ; light railways 2d. (1¾d.) ; A rate 7d. and 3d. (6d. and 3d.) ; slot meters 6d. per unit with minimum of 1s. 6d. per month ; various contracts, increase ½d. per unit.

Heckmondwike Council has increased the charge for electric current by 33⅓ per cent. (making it 6d. per unit) for lighting, and from 2d. to 4d. a unit for power, according to the units taken.

Leith.—The burgh electrical engineer (Mr. A. Peden Rutherford) has been appointed local representative of the south-eastern area of Scotland under the Coal Mines Department of the Board of Trade.

Norton.—The Rural Council will confer with Sheffield Corporation in regard to a proposal to supply electricity in this district.

Hucknall.—The Urban Council will oppose the proposed application of Nottingham Corporation for a provisional electric lighting order for this district, as negotiations with the Sherwood Colliery Co. for a supply have been suspended until the termination of the war.

Scunthorpe.—The Urban Council has decided to apply for a provisional electric lighting order.

Stowmarket.—The Council has been notified that the directors of the Suffolk Electricity Supply Co. have decided that unless certain difficulties arising out of the war were overcome all efforts should be concentrated to maintaining the supply of the naval and military authorities, and so discontinue the supply at Stowmarket from June 30 until further notice.

The company stated that as there were 50 motors in Stowmarket, aggregating 150 H.P., and as many of them were used in factories, it would be understood that the decision of the directors had been arrived at most reluctantly.

The Council has protested to the military authorities for exceeding their instructions by removing men from certified occupations, and thus endangering the supply of current. A protest has also been made to the L.G. Board.

Stretford.—The Electricity Committee has approved the terms of the agreement for continuing until Dec. 31 next the supply of electricity to the Stretford Gas Co., subject to an increased charge of 15 per cent.

Tunbridge Wells.—In order to mark their appreciation of the work of the borough electrical engineer (Mr. R. N. Torpy), who has recently completed the work of putting down new machinery and other capital works, involving an expenditure of £7,800, the Council has voted him an honorarium of £50 for his services.

Worksop.—The Council has increased the wages of lamp-lighters of the electric supply department 2s. each per week ; other workmen 3s. each per week.

Wrexham.—We regret to learn that the borough electrical engineer (Mr. W. G. Pickvance) is again unwell.

The Chairman of the Electricity Committee (Councillor Sauvage) stated at the meeting of the Council last week that he was very sorry to report that Mr. Pickvance, who had attended a meeting with him at Chester on the previous day, subsequently had a seizure on the return journey. No doubt he had not been well since his motor accident some time ago, and perhaps he had been doing too much. It would be necessary for him to have a complete rest for a month or so, and in the meantime Mr. Thornton, Mr. Helsby and the others would do their best to carry on at the works.

The Mayor said they were all very sorry to hear of Mr. Pickvance's illness and expressed the hope that he would soon be completely restored to health.

LIGHTING AND INDUSTRIAL POWER.

Electric Furnace Progress in Canada.—The Imperial Trade Correspondent at Toronto reports that a company at Shawinigan Falls (Quebec) is manufacturing metallic magnesium.

It is also reported that a firm at Belville (Ont.), which owns six electric furnaces for treating molybdenite ore, has an output of from 500 lb. to 700 lb. of ferro-molybdenum per day. It is proposed to increase the number of furnaces and to run them night and day.

Transmission Line over River.—The Shawinigan Water & Power Co. is preparing designs for a 5,000 ft. clear conductor span for the transmission of electric energy over the St. Lawrence River at Three Rivers, Que., which will supplement the submarine cable transmission line already installed.

The "Electrical News" states that the two steel towers on which the line will rest at the extreme ends of this long span will have a concrete base, set some little distance from the bank of the river. The towers will be 350 ft. high, so as to provide a clearance of 160 ft. in the centre of the span. The three conductors will be placed approximately 50 ft. apart. The transmission line will not be anchored to but merely supported by the towers and anchored to concrete blocks located some distance to the rear of the towers.

Digitized by Google

ELECTRIC TRACTION.

Birmingham.—The Tramways, Public Works and Town Planning Committee have agreed upon a common policy in regard to the considerable and costly street-widenings and new arterial thoroughfares which are generally regarded as essential to improvements of the tramway system, and a report will be presented to the Council in the near future.

Burnley.—The Tramways Committee recommend that the salary of the general manager (Mr. H. Mozley) be increased from £450 to £525 per annum.

Coal Distribution by Tramcar.—Newcastle-on-Tyne Corporation has approved a scheme prepared by the tramways manager (Mr. E. Hatton) for distributing coal by tramway sand carts during the winter months.

Hull.—The Tramways Committee are making enquiries as to the advisability of employing women tramcar drivers.

Lincoln.—The Council has authorised an increase of 50 per cent. in the tramway fares as from July 9.

Manchester.—A ballot of the tramway workers on Friday last resulted in 967 voting in favour of a strike and 687 against. Since then matters have become normal owing to the decision to reopen the arbitration proceedings.

Northampton Tramways.—The Board of Trade has further extended for a year from Aug. 18 the time limited by the Northampton Corporation Act, 1911, for the construction of tramways, &c.

Wallasey.—Last week the Tramways Committee recommended the Council not to authorise the training of women as tramcar drivers. The recommendation was, however, referred back.

Walsall.—The salary of the tramways manager (Mr. R. L. Horsfield) has been increased by £100 per annum.

MISCELLANEOUS.

Causes of Industrial Unrest.—In the course of his presidential address at the Annual Conference of the General Federation of Trade Unions at Gloucester last week, Mr. J. O'Grady, M.P., said the Management Committee had done what it could to bring about conciliation and arbitration between employers and workmen during the war.

The success of that work was proved by the fact that the strikes during the past 12 months only numbered 123 against the pre-war average of 651 per annum. The Committee believed the best way to guard against disastrous conflicts between capital and labour after the war was to have a more perfect organisation. If they were thoroughly organised and had ample funds at their disposal that was the safest way to avoid industrial warfare in future. The relations between organised labour and the private capitalist was, on the whole, very good; they had had very few disputes. The employers' federations had been reasonable in conceding claims put in by the workpeople, but the relations between labour and Government departments were entirely different. He never knew a time when the relations between the Government and organised labour were so bad as now. He attributed the whole confusion and danger which had arisen between Government departments and labour to the fact that certain dilettante men of superior education with an academic mind, but no knowledge of the problems of life, certainly not of the workshop, were in control of workmen. How could they expect workmen to go on quietly under conditions of that character? Business men and labour men were now in the Government, and they had helped to save the Government and the country. Had it not been for their presence in the Government the industrial unrest would have expressed itself forcibly months ago. There was at the moment grave industrial unrest, and while he did not want to go into the causes or to analyse them closely, he would say it was due to high food prices, profiteering, the delay in arbitration cases in dealing with grievances and unnecessary restrictions. A group of faddists were doing immense harm, but he declared that the great industrial unrest and discontent did not affect the attitude of organised labour towards the war.

Committee on Production.—In order to obtain a speedy settlement of differences referred to the Committee on Production under the Munitions of War Acts, the following additional appointments to the Committee have been made:—

Mr. W. W. Mackenzie (Chairman), Mr. J. W. White (Employers' Representative) and Mr. W. Mosses (Workmens' Representative). This enlargement increases the number of members to nine and will enable three sections of the Committee to sit simultaneously.

Electrical Employees Support U.S.A. Liberty Loan.—As an indication of the general interest of electrical workers in America in providing the sinews of war, the following information taken from the "New York Times" is illuminating:—

40,000 employees of the General Electric Co., of New York, have subscribed for $3,000,000 worth of "Liberty" loan bonds, an average of $75 per individual. The subscriptions were received from the Schenectady, Lynn Harrison, Fort Wayne, Erie, Pitsfield and other works of the company, as well as from their district offices, and is symptomatic of the attitude of the whole of America.

Electricity in Agriculture.—At the last meeting of the Swansea Electricity Committee a report was submitted dealing with the value of electro-culture in agriculture.

The chairman (Councillor Sinclair) said it was a very important matter for allotment holders, and, although it would be too late to do anything this year, he suggested that a committee be formed (to include the chairman of the Parks Committee and the parks superintendent) to visit Hereford in order to see the results of the work that had been done there with regard to electro-culture.

This suggestion was adopted.

Hospital Equipment.—Warrington Guardians have been authorised to purchase Rontgen-ray apparatus for their Whitecross Hospital.

Munitions Cases.—At Sheffield Munitions Court last week, Charles Joseph Riley, electrician, was summoned for leaving work, not working diligently and refusing to clock in and out.

His Union representative said all three charges really related to one presumed offence, which consisted in leaving the works at 12 and not returning till 2.4, whereas the meal time was from noon to one o'clock.

DEFENDANT said he was asked about 11 o'clock in the morning of the day referred to to work overtime, and, though he was under notice (given to him by the firm), he agreed to do so. However, he had no food with him and was compelled to go outside.

The Union representative said he put in a plea of vindictiveness by the firm. Defendant was chief convener of the shop stewards in those particular works. During the recent strike he had been active, and when the settlement of the strike came a clause was inserted to the effect that the men should be allowed to return to work without prejudice or vindictiveness. On June 23 notice was given to all the shop stewards that they must cease their activities or resign their positions, the alternative being instant dismissal. At a meeting of the shop stewards held in the meal house it was decided to oppose this demand, and on Friday, June 29th, six of them (including Riley) were given their notices. These six had been particularly active in work of a perfectly legal character. No reason was given for the action of the firm, but afterwards a plea of loss of time was put forward. The whole thing was one of those actions which were responsible for the industrial unrest.

The representative of the firm contradicted the Union representative's statement in general terms, and said that was not Riley's first offence. He had been warned repeatedly.

The Chairman (Sir WILLIAM CLEGG): Then surely the remedy of the firm was obvious—to bring him here. There has been a great deal of extraneous matter imported into the case, but it will not be allowed to influence the Court. It was apparently a fact, however, that defendant, for the convenience of the firm, consented to work overtime on Saturday, the day after receiving his notice to leave. The Court thought that, considering the special circumstances, he was reasonably justified in going outside the works to obtain his meal, and the firm had not made out a case. There had been a certain amount of laxity in the working of the regulations. Having said that, he desired to say that the men when they wanted to leave the works must under any and all circumstances clock in and out, and any future case of breaches of that very necessary regulation would be severely dealt with.

An official inquiry was held at Sheffield on the 6th inst. into a complaint which had been made to the Ministry of Munitions that six electricians (four being shop stewards) had been dismissed by Messrs. Thomas Firth & Sons, and victimisation was alleged.

The finding, after a protracted hearing, was that there was no evidence of victimisation.

Scottish Electricians' Wages.—The Chief Industrial Commissioner's Department has issued the findings of the Arbitrator on the demands for increased wages in the electrical trades in the chief towns of Scotland.

The arbiter's award is that the workers concerned in the employ of firms in the Electrical Contractors' Association shall receive the war advances granted by the Committee on Production to the shipbuilding trades on March 1 last. No change is made in the payments for country money. The employees receive an advance of a fraction under 1½d. per hour as from the beginning of June, which is made up of the special advance of 5s., plus 9d., being the difference between the advance of wages in the electrical trade during the war (1½d. per hour, or 6s. 3d. per week), and the general advance of 7s., which by the award of the Committee on Production is presumed to have already been obtained by the employees.

University College (London).—The new chemical laboratories have been designed so as to meet the requirements of modern chemical teaching and research, including provision for physical chemistry.

The cost of the site, building and equipment will be £120,000. £100,000 has already been raised, leaving £20,000 to be found. In order to facilitate the immediate provision of this, Sir Ralph C. Forster, who has already subscribed generously to the cost of the laboratories, has promised £5,000 on condition that the remaining £15,000 is raised speedily. Subscriptions may be sent to Lord Glenconner at the College.

Digitized by Google

TENDERS INVITED AND ACCEPTED.

Rotary Converter, Transformer, &c.

MELBOURNE City Council require tenders by noon on July 30 for supply and erection of a 2,000 kw. rotary converter, with transformer and accessories. (Specification No. 388.) Specification, &c., from Messrs. Mellwraith, McEacharn & Co., Pty. (Ltd.), Billiter Square-buildings, London, E.C. 3.

Transformers.

DUBLIN Electricity Supply Committee invite tenders for 12 months' supply of transformers. Tenders to chairman of Electricity Supply Committee by noon, July 16.

X-Ray Apparatus.

ISLINGTON (LONDON) Guardians want tenders by 3 p.m. July 19 for a set of X-ray apparatus for their infirmary (a.-c., 100 volt., 5). Prices required for 16 in. and 20 in. coil respectively. Tenders to the Clerk, St. John's-road, Upper Holloway, N. 19.

Electric Motor.

DUNDEE Parish Council want tenders by 5 p.m. July 18 for the supply and installation of a 16 H.P. electric motor at their laundry. Tenders to the Clerk, Council Chambers, West Bell-street, Dundee.

Motor Ambulances.

WEST HAM Corporation require tenders for the supply of two motor ambulance vehicles. Tenders, which should contain details of chassis, &c., particulars of speed, consumption of petrol or electricity, &c., are to be sent to the Town Clerk by 4 p.m. July 17.

HAMMERSMITH (LONDON).—The Borough Council has accepted the tender of J. P. Hall & Son (at £359) for a boiler feed pump. There were six tenders, varying in amount from that of the accepted to £660. There were also three tenders (£440, £539 and £726) for turbine pumps.

MANCHESTER.—The Electricity Committee has accepted the following tenders for 12 months' supply of stores :—

L. Andrew & Co., adhesive tape, rubber tape and asbestos goods; W. T. Henley's Telegraph Works, W. T. Golver & Co. and Macintosh & Co., rubber tape; Griffiths & Co., enamels; Diatimite Co., asbestos; Ward & Goldstone, batteries; Callender's Cable & Construction Co., box compound and bitite tape; Coalbrookdale Co., c.i. cable troughing; Morgan Crucible Co., crucibles; London Elec. Wire Co. & Smith's, silk covered and Eureka wires; Isherwood Bros. and Doulton & Co., earthenware pipes; Connolly Bros., enamelled wire; Bullers (Ltd.), Doulton & Co. and Gaskell & Grocott, insulators; J. Walker & Co., jointing and packing; Vacuum Oil Co., grease; H. Wiggin & Co., nickel chrome wire and strip; W. N. Brunton & Co., tinned steel and armature wire; British Elec. Transformer Co., transformers and auto-balancers; British Insulated & Helsby Cables, trifurcating boxes; Brotherton Tubes & Conduits (Ltd.) and Simplex Conduits (Ltd.), tubing, &c.; Pinchin, Johnson & Co., varnish.

WOLVERHAMPTON.—The Council has accepted the tender of Melville, Dundas & Whitsun for the construction of a new boiler house wing, at £5,936, including overhead coal bunkers, foundations and skeleton structure for the boilers, economisers, &c.

APPOINTMENTS VACANT AND FILLED.

An electrician is required for the London Hospital (Whitechapel-road, E.1), capable of looking after lifts, motors, lighting and medical appliances. *See an advertisement.*

Switchboard attendants are wanted for a generating station in the Manchester district. *See an advertisement.*

A staff assistant is required for electrical office work in a Government Department at Portsmouth; must have had technical training and experience in design of electrical instruments and machinery. Salary £200 per annum. *See advertisement.*

A draughtsman is wanted for drawing electrical instruments in a Government Department at Portsmouth. Wages 54s. per week of 42 hours. *See advertisement.*

The Walthamstow Educational Committee invite applications for positions as assistants in their engineering and trade schools, to commence duties on Sept. 1 next. Assistants are required for experimental science, practical mathematics, engineering workshop practice and in mechanical drawing, &c. Commencing salary £160 per annum. Candidates must be ineligible for military service, and application forms (which must be returned by July 31) from Mr. R. Dempsey, Clerk to the Governors, 2, Tower-chambers, Hoe-street Bridge, Walthamstow, E. 17.

A lecturer in electrical engineering will be required in September at the University College, Nottingham. Particulars from the Acting Registrar.

A lecturer in electrical engineering will be required in September for the Liverpool Central Municipal Technical School. Commencing salary £250. Particulars from the Director of Education, 14, Sir Thomas-street, Liverpool.

A principal teacher of engineering (mechanical and electrical) is wanted in September for evening classes at Airdrie Academy Technical School. Salary £80 to £90 per session. Applications to the Joint Clerks, School Board, Airdrie, by July 17.

A lecturer in physics is required for Battersea Polytechnic (London, S.W.11). Salary £175. Applications by July 17. Particulars from the Secretary.

The Government of the Union of South Africa require an industrial adviser to the Industries Section of the Department of Mines and Industries. Salary, £2,000. Applications to the High Commissioner, 32, Victoria-street, London, S.W. 1, by July 31.

Mr. G. A. Roberts, assistant electrical engineer, has been appointed acting borough electrical engineer at Doncaster in the absence of Mr. E. S. Rayner.

Mr. G. L. Smith has been appointed station superintendent at Walthamstow at £175 per annum, rising to £200.

Mr. W. J. Best, who has been on probation as shift engineer at Sheffield since January, has been transferred to the permanent staff, at £180 per annum.

Mr. W. McConnell has been selected for the position of engineering assistant at the Temple Junior Technical School, Bristol.

BUSINESS ITEMS.

As the Caxton House offices of Messrs. Brown, Boveri & Co. (Ltd.) have been taken over by the Army Council, the company has acquired temporary offices at 9, Old Queen-street, Westminster, S.W. 1. Telephone "Victoria 2538."

The London office of Messrs. Ruston, Proctor & Co. (Ltd.) has been removed from 46, Queen Victoria street, E.C., to West Africa House, Kingsway, W.C. 2.

Messrs. Geo. Schultz & Co. (Ltd.), 10, Arthur-street, London, E.C., electrical insulation manufacturers and iron and steel merchants, ask us to notify that their managing director (Mr. Geo. Schultz), though not at any time a German subject, has by deed poll changed his name to George Leonard Scott. No change, however, has taken place in the title of the company, which is composed entirely of British subjects.

The partnership between Harry Brear and David Aynsley, formerly trading as electrical engineers at 458, Huddersfield-road and Albion Electrical Works, Ravensthorpe, Dewsbury, has been dissolved. Debts by Mr. Brear, who will carry on the business in his own name at Calder Wharf Mills, Aire-street, Ravensthorpe.

Plant for Sale.—Mr. R. H. Ruddock will sell by auction at Cannon-street, Manchester, on Tuesday, 31st inst., and the two following days, valuable and extensive newspaper and jobbing plant and machinery, including a number of electric motors, an electric hoist with travelling jib crane, pneumatic tubing installation, Magneta time installation, &c. Catalogues from Messrs. Nicholson, Graham & Jones, Solicitors, 24, Coleman-street, London, E.C. 2, and the Auctioneer, 71, Fleet-street, London, E.C. 4. *See an advertisement.*

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of creditors of the Universal Telephone & Electrical Co. (Ltd.) will be held on July 23, at 6, Old Jewry, London, E.C., and claims are to be sent to Mr. J. Percival at that address by Oct. 1.

Claims against Morris & Lister (London) (Ltd.) (in vol. liq.) are to be sent by Aug. 1 to Mr. H. S. Sugden, 36, King-street, London, E.C.

The Prentice Wireless Train Control (Ltd.) is being wound up voluntarily. Mr. F. V. Royce, 5, Broad-street-place, London, E.C., has been appointed liquidator, and a meeting of creditors will be held at his office on July 16.

Enemy Firm Wound-up.—Claims against the Bosch Magneto Co. (Ltd.) are to be sent by Aug. 13 to the Controller, Mr. A. E. Woodington, 5, Philpot-lane, London, E.C.

Digitized by Google

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Birkenhead.—In presenting the accounts of the electric supply department at the Corporation meeting last week, Councillor Clarke said that the gross profit for the past year was £18,825, an increase of £2,060 compared with 1915-16. The total income was £52,240, or £4,025 in excess of previous year, and the total working expenses were £33,414, an increase of £1,965.

Glasgow.—The tramway accounts for the year ended May 31 show a surplus of £160,984 (compared with £43,548 last year), which has been placed to the Common Good fund.

Revenue was £1,260,115 (against £1,157,336), total expenditure was £838,065 (£773,442), and with £78,637 (£81,202) interest on investments the total carried to net revenue account was £500,686 (£465,097). Rent of Paisley lines required £8,453 (£6,700), interest £78,846 (£90,473), sinking fund £114,377 (£109,614), income tax £64,622 (£39,853), parliamentary expenses £97 (£500) and renewals and depreciation £73,304 (£174,407); total £339,702 (£421,549).

During the year the remaining debt on the tramways was paid off by transferring the necessary sum from the depreciation and renewals investment account and the Corporation also agreed to subscribe £2,000,000 to the 5 per cent. War Loan.

Oldham.—The accounts of the electricity department for the year ended March 25 show gross capital expenditure £402,719 (increase £18,907), of which £226,288 is outstanding.

Revenue was £73,555 (compared with £63,920 in previous year) and total costs were £41,715 (£37,222), leaving gross profit £31,840 (£26,698). Sinking fund instalments were £11,361 (£10,465) and interest required £11,229 (£10,902) and expenditure on meters £218 (£224), leaving net profit £9,032 (£5,107). Total revenue costs were 0·690d. (0·852d.) per unit sold, and average price obtained per unit was 1·201d. (1·441d.). Units generated were 18,222,900 (13,288,641) and sold 14,506,010 (10,487,235). There are 2,843 (2,782) consumers with the equivalent of 426,082 (389,133) 8 c.-p. lamps connected. Maximum supply demanded was 5,350 kw. (3,900 kw.) for lighting and power and 1,460 kw. (1,460kw.) for traction. Load factor was 24·31 (22·27) per cent.

The report of the joint electrical engineers and managers (Mr. F. L. Ogden and Mr. W. Chamberlain) states that the plant installed and put into commission during the year included a 3,000 kw. British Westinghouse turbo-alternator, two Babcock boilers, with chain grate stokers, Green's economisers, &c., a 1,250 kw. British Westinghouse rotary converter, with switchgear and transformer, and a motor-driven centrifugal cooling tower pump. Power supply increased by 3,952,871 units and would have increased still more if all consumers had been able to obtain their equipment.

Rochdale.—The accounts of the tramways department for the year ended March 31 show gross capital expenditure £366,946 (increase £6,192), and the total amount of sinking fund is £134,248.

Revenue was £90,812 (compared with £87,908 in previous year) and working expenses were £50,397 (£48,124), leaving gross profit £40,414 (£39,784), or £42,432 (£41,654) with interest, sinking fund and rent contributions. Income tax required £6,463 (£3,864), interest on capital £11,850 (£11,970), sinking fund £9,753 (£9,593), rent of leased lines £5,918 (£6,309), payment to Heywood £3,032 (£3,044), half-wages to men on active service £2,981 (£2,741) and war bonus £658 (£521), leaving net profit £1,773 (£3,608). Average total revenue per car-mile was 13·342d. and average working expenses, including power, were 7·493d.

Walsall.—The annual accounts of the electric supply department were discussed by the Council on Monday.

The chairman of the Electricity Committee (Mr. Hayward) in moving that the annual balance-sheet of the electricity undertaking be referred to the General Purposes Committee for consideration, gave reasons for the loss of nearly £9,000 on the year's trading. The undertaking had gone through an extremely difficult and trying time. It had been made very plain on several occasions that a loss was certain to be made during the transition stage from the old to the new works. On top of that, however, the concern sustained an altogether unexpected loss through the action of the Ministry of Munitions in commandeering plant which was intended for the new station. The consequence was that instead of the new works being brought into operation early in 1915, it was not until Feb. 10 this year that any plant was available for use, and the loss incurred was almost entirely due to that cause. He agreed the outlook would be a serious one for the ratepayers if they had to find that £9,000; but he considered they had a strong claim against the Ministry of Munitions for compensation. With regard to the future of the undertaking, he said that everything depended on the number of new customers the undertaking could obtain. It was hoped that early in September the committee would be able to have the new works in full operation, and to close the old works at which the costs of generating current were very heavy.

The motion was carried.

COMPANIES' MEETINGS AND REPORTS.

ARBROATH ELECTRIC LIGHT & POWER CO. (LTD.)—At the recent meeting it was stated that the profit for the past year was £2,423, which, added to £713 brought forward, made a total of £3,135. Deducting charges for interest and dividend on preference shares, the balance was £2,186. The directors proposed to place £1,000 to reserve and renewals fund, to pay a dividend of 4 per cent. on the ordinary shares (less tax), leaving to be carried forward (subject to payment of directors' and auditors' fees) £498. The Chairman said the company had made steady and satisfactory progress. They had reason to feel gratified that they were able for the first time since 1914 to recommend the payment of a dividend, and at the same time to place £1,000 to reserve fund.

CHILI TELEPHONE CO. (LTD.)—The report for the year ended March 31 states that the aggregate number of subscribers at all centres at the end of the year was 14,243, an increase of 936 for the year. The total length of lines in operation was 22,698 miles 1,089 yards, an increase of 1,379 miles 405 yards. The gross revenue from all sources was £152,182, an increase of £30,209 over 1915-16. The total expenditure (exclusive of income tax) was £92,597, an increase of £26,674. The net revenue from all sources was £59,585, an increase of £3,535. The balance to credit of revenue account, after deducting income tax and including £4,302 from previous year, is £52,784, of which £2,796 has been expended on replacements, &c., of plant. An interim dividend of 3s. per share, tax free, was paid in January last, and after carrying £16,386 to general reserve and adding £2,000 to reserve against loss on investments, the directors now recommend a final dividend of 5s. per share, tax free, leaving £5,202 to be carried forward.

EDMUNDSONS' ELECTRICITY CORPN. (LTD.)—The net profit for the year ended March 31, after providing for mortgage and debenture interest and redemption and for £1,164. 12s. 11d. additional income tax, amounts to £12,293. 16s. 9d., compared with £13,259. 10s. 3d. for the previous year. With £4,625. 2s. 6d. brought forward, the total profit available is £16,918. 19s. 3d. The directors are applying £12,000 in paying the dividend for the year on the cumulative preference shares, leaving to be carried forward £4,918. 19s. 3d.

ELECTRIC SUPPLY CORPN. (LTD.)—At the meeting last week the chairman (Mr. J. G. B. Stone) said that the new connections during the past year were equivalent to 11,858 33-watt lamps. That was far below the figure of the previous year, but last year they had had an abnormal increase in Dumbarton. Excluding the Dumbarton figures, there had been an increase of 9,461 lamps in 1916, against 6,906 in 1915. Their progress was continuing despite the war, and they hoped that with the return of peace conditions the company would reap the benefit of those extensions. Of the companies in which they were interested Hendon was doing extremely well, but Dawlish and North Berwick had both been seriously retarded by the war, particularly the latter. The Dumbarton Tramways Co. had obtained much better traffics, and there were hopes that they would continue in times of peace. For the second time they had to regret diminished profits. Their revenue had increased £1,773, but the actual profit on working was reduced by £1,830 owing to increased costs. The net balance was £6,363, compared with £7,957 in 1915, and they were proposing to pay a dividend at rate of 1 per cent., less tax. They had succeeded in renewing the Chelmsford street-lighting contract for four years, and had compromised their difference with the Chelmsford Council in regard to the late street-lighting contract.

GENERAL ELECTRIC CO. (LTD.)—The directors report that the net profits for the year ending March 31, 1917, amount to £265,219. 14s., to which has to be added £48,053. 4s. 2d. brought forward, giving a total of £313,272. 18s. 2d. After deducting debenture interest, together with normal and special depreciation (£38,541. 4s. 3d.), there is an available balance of £274,731. 13s. 11d. The directors recommend payment of a dividend at rate of 6 per cent. per annum on the preference share capital for the year (£42,000), the allocation to the employees' and managing director's bonus of £18,467. 17s., payment of dividend at rate of 10 per cent. per annum (tax free) on ordinary share capital for the year (£62,500), placing to reserve account £40,000, grants to dependents of men on active service £11,477. 9s. 5d., repayment to preference shareholders of income tax already deducted (subject to confirmation in extraordinary general meeting) £10,500, leaving to be carried forward (subject to excess profits duty, if any) £89,786. 7s. 6d. The reserve account has been increased by £100,000, transferred from pre-war suspense accounts of provision for contingencies which have not arisen, and, with the further addition of £40,000 recommended above, the total amount at credit of this account will be £400,000. The company's operations during the past year have consisted mainly in continuing and developing the policy initiated at the outbreak of the War. The results have again been satisfactory. All the company's works have been fully occupied throughout the year, and have been almost exclusively employed in the production of material and electrical equipment essential for the purposes of war. In consequence, practically the whole of the output of the works, normally employed in the supply of the electrical trade, has had to be diverted to meet the requirements of various Government departments and con-

Digitized by Google

trolled establishments throughout the country. About 1,700 members of the staff and workpeople are now serving with the Colours, so that substitution and dilution of labour has become more imperative than ever. Thanks, however, to the loyalty and united efforts on the part of those members of the company's technical and commercial staff whom the authorities have allowed to remain, it has been possible to overcome successfully most of the difficulties with which the company has been confronted. The scarcity of raw material and the difficulty in obtaining machinery, together with the Government restrictions placed upon all building operations, have not enabled the company to proceed with the preparations for the developments awaiting the electrical industry after the War. Capital expenditure during the year on new works of immediate importance has amounted approximately to £15,000, and a sum of £11,000 has been expended, under permit from the authorities, to advance the Kingsway building sufficiently to protect the steelwork. The sales organisation at home and abroad has adapted itself well to prevailing conditions. The investment account of the company has again considerably increased, with an eminently satisfactory return. Nearly £300,000 has been invested in the Osram-Robertson Lamp Works, a further £50,000 has been required by the Pirelli-General Cable Works, and certain smaller sums have been invested in minor factories essential for the production of material for the Company's requirements. The Pirelli-General Cable Works, in which the company is largely interested, has this year (the second year of its existence) shown satisfactory results. All the allied and subsidiary companies continue to do well, with the exception of one or two who have been adversely affected by conditions of war.

HAVANA ELECTRIC RAILWAY, LIGHT & POWER CO. (LTD.)—The accounts for 1916 show a net profit of $2,421,291, compared with $2,236,257, and an available sum (including $1,709,956 brought forward) of $4,131,248, out of which dividends amounting to 6 per cent. on the common shares have been paid, compared with 5½ per cent. for the previous year, and after transferring $75,000 to reserve for depreciation and $123,083 to reserve for bad and doubtful debts, &c., $2,024,501 remained to be carried forward.

IMPERIAL TRAMWAYS CO. (LTD.)—Mr. Samuel White, who presided over the recent meeting, said that the receipts of the Middlesbrough, Stockton and Thornaby electric tramways were £70,223, compared with £66,529 in the preceding year, and the passengers numbered 12,850,555, against 12,299,230. The net profit was £14,228, against £15,431, and the working expenses increased by £4,897. The main business of the Imperial Tramways Co. was to engage more particularly in the operation of tramway undertakings or their shares, and the income and the capital value of their assets were bound to vary considerably from year to year. A few years ago they distributed 100 per cent. in dividends to their ordinary shareholders, but if they got 100 per cent. on one occasion they must not be surprised on another to receive only 2 per cent. With the return of favourable conditions after the war he could see no reason why the company should not be the means of carrying out further profitable management or financial transactions.

MADRAS ELECTRIC SUPPLY CORPN. (LTD.)—Mr. J. G. B. Stone, who presided over the meeting last week, said that further progress had been made in the development of the undertaking. The gross revenue for 1916 was £54,997, against £50,177 in 1915. The increase, having been earned in that portion of the company's area where mains were already laid, must be regarded as satisfactory. It had been impossible to obtain materials for extensions, and consequently the supply of current to the districts of Kilpauk and Adyar was still in abeyance. For the same reason it had been impossible to commence the supply of current to various large power consumers with whom contracts had been completed. Although there was now a prospect of procuring part of their requirements, it was evident that the accounts for 1917 would not obtain the benefit of any extension of importance. Applications from consumers who could be supplied from the existing mains were still numerous, and the directors trusted that the local supplies of material would enable them to connect new consumers who were contiguous to the existing mains until the present restrictions against shipping had been removed. The increase in revenue for 1916 had been derived proportionately from current for lighting and fans and from power. The total costs for 1916 were 1·06d. per unit sold, compared with 1·15d. for 1915. The net balance was £29,871, against £25,661 for 1915. Adding £4,580 for dividend from the tramways, the total was £34,451. Interest on debentures and loans and the debenture sinking fund absorbed £16,615, leaving £17,836, or £5,410 more than for 1915. In addition to the £4,439 transferred to debenture sinking fund, the directors had also transferred £6,000 to a depreciation and renewal fund, and they recommended payment of the dividend on the preference shares, leaving £5,836 to be carried forward. The rate of progress would be accelerated when times were normal, and they saw no reason to modify their confidence in the ultimate success of the undertaking.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—Mr. Godfrey C. Isaacs, who presided over the annual meeting last week, said that Mr. Marconi was representing his Government on a Special Commission to the United States. After giving an analysis of the various items in the accounts, he said that, in view of the fact that their business was still being conducted under exceptionally unfavourable conditions, they had every reason to be satisfied with the figures submitted. Practically the whole of their profits were derived from ships' subsidies, for there was practically nothing doing at present in commercial or private telegrams at sea. Normally they derived a very substantial revenue from those telegrams, and when peace conditions prevailed again they would no doubt see a substantial increase in receipts derived from that source. Not only had the number of ship telegraph stations been immensely augmented during the war, but there had been also a large addition to the coast stations, which would give far greater facilities for communication with the land than obtained prior to the outbreak of hostilities. Further, they were making very considerable losses in consequence of the submarine warfare, all of which they were debiting to profit and loss account. In past years it had been their custom to insure against the risk of losses at sea, but the premiums having become so very high in consequence of the submarine warfare they determined to take the risk themselves, and, notwithstanding the severity of the submarine warfare, they saved during the past year in insurance the sum of £1,174 and in marine risk £451, or a total of £1,600. They felt justified, having regard to the sound development of their business, to recommend payment of an increased dividend, which they felt confident of being able at least to maintain, notwithstanding the necessity for increasing the capital. The number of public telegraph stations owned and worked by the company on the high seas increased from 1,008 at the end of 1915 to 1,472 at Dec. 31 last. They would be able to appreciate the considerable capital expenditure involved when he told them that up to June 30 last they had already fitted 595 additional ships, bringing the total number of ships installed, after deducting losses, to 1,855, which was by far the biggest rate of increase in the history of the company. Orders in hand were considerable. They contemplated those being very largely augmented in the near future, and for that provision must be made. Their subsidies alone at June 30 had increased to £451,713 per annum, compared with £24,445. 6s. 6d. for 1909. Mr. Allen and Mr. Bradfield, who had been connected with the company since its formation, had been added to the board, and Mr. Maurice Bramston, who had been for some years associated with another of their companies, had also accepted a seat on the board. He referred to the immense amount of heavy and responsible work which had fallen upon the staff, who had been untiring in their efforts, working continuously day after day very long hours with hardly a day's holiday. They should express their great appreciation and profound admiration for their operators at sea. They had 3,347 operators and students; of those (at June 16) 333 had been saved from vessels sunk, 45 were drowned, 29 had been injured, one killed and 19 had been taken prisoners of war. Notwithstanding the great increase of risk and danger in their services, in no single instance had any one of them murmured, and in no case had any one failed in the critical moment to do a full and heroic duty. Mr. Isaacs gave several instances of the heroism of their operators, and said that when the war was over no doubt a book would be written upon the experiences of wireless operators. It would certainly be a most interesting book, and would add to the very high respect and admiration which they had for those who followed that occupation.

The report and accounts were adopted, and at a subsequent extraordinary general meeting it was decided to increase the capital of the company by the creation of 250,000 new shares of £1 each.

WEST AFRICAN TELEGRAPH CO. (LTD.)—The revenue for the year ended Dec. 31 last amounted to £53,214. 10s. 8d., from which is deducted £18,684. 16s. for the ordinary expenses, and £22,800. 9s. 10d. for expenditure relating to maintenance of cables, sundry differences in exchange, income tax abroad and war payments to staff and other expenses in connection with the War, leaving £11,729. 4s. 10d., to which is added £991. 3s. 3d. brought forward, making an available total of £12,720. 8s. 1d. The sum of £766. 3s. 2d. has been provided for income tax, less adjustment in respect of excess profits duty, £2,000 has been transferred to general reserve fund, and the usual interim dividend of 2 per cent. (absorbing £4,621. 16s.) was paid on Dec. 1 last. An additional payment, equal to a dividend of 2 per cent. was made on May 15, bringing the total distribution for the year up to 4 per cent., tax free. The balance of £710. 12s. 11d. is carried forward.

CITY NOTES.

DUBLIN UNITED TRAMWAYS CO. (LTD.)—An interim dividend of 4 per cent. per annum (4s. per share), less tax, has been declared on the ordinary shares for the past half year.

DIRECT UNITED STATES CABLE CO. (LTD.)—The directors have declared an interim dividend of 2s. per share (less tax), being at rate of 4 per cent. per annum for the quarter ended June 30.

ELECTRO-BLEACH & BY-PRODUCTS CO. (LTD.) — This company is issuing at par the balance of its authorised share capital (7,956 preference and 8,000 ordinary shares of £1 each) in order to provide capital for completing the extensions of their works at Middlewich.

FRASER & CHALMERS (LTD.)—The directors have declared an interim dividend of 7½ per cent. on the preference shares, less tax.

METROPOLITAN CARRIAGE, WAGON & FINANCE CO. (LTD.)—The Treasury has given sanction to the proposed issue of £1,424,712 shares as fully paid and £150,576 shares for cash.

SAO PAULO TRAMWAY, LIGHT & POWER CO. (LTD.)—The directors have declared a dividend of 2½ per cent. on the common stock.

SINGAPORE ELECTRIC TRAMWAYS (LTD.)—An interim dividend of 5 per cent. (3d. per share) has been declared.

STOCK EXCHANGE NOTICE. — Dealings in 117,000 £1 fully paid preference shares of the Llanelly & District Electric Lighting & Traction Co. (Ltd.) (Nos. 60,001 to 128,456, 131,457 to 135,000 and 150,000 to 195,000) have been specially allowed by the Stock Exchange Committee, and the shares are now included with those in which special settlements have already been granted.

Digitized by Google

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—The gas industry receives another serious set-back. Sir A. Stanley prohibits the import of foreign matches. On! Stanley, on!

* * * *

The Electric Supply Corpn. congratulates itself upon obtaining the renewal of the Chelmsford street lighting contract for a further period of four years. Who, after this display of optimism, will dare claim that the war will not soon be over?

* * * *

Since the appointment of the Coal Controller and the issue of his elaborate transport directions, we ought to hear no more silly talk about "carrying coals to Newcastle!"

* * * *

While on the subject of coal, I would like to ask why a prominent London daily is allowed to haul coal into Fleet-street for its isolated power plant, when so many of its lesser contemporaries purchase electric power and save coal cartage? Will Mr. Guy Calthrop ask the electric supply company and the newspaper in question "What about it?"

* * * *

This column had gone to press last week when the news of Seaton's death came to hand. His demise is most untimely, and will be a big loss to Manchester engineering circles especially. He possessed a fund of humour which he could turn loose at a moment's notice, often to the discomfiture of his foes and the delight of his friends. By foes I mean his business opponents, for I have yet to hear that Seaton ever made an enemy. Though he had been dubbed "Satan" (that was when P. C. Pope and he were rivals), there was nothing "devilish" in his nature. He will always be remembered for his contributions to the discussions of Inst.E.E. and I.M.E.A. Papers, in which he invariably "got home" with some remark which raised a hearty laugh, but was apropos every time. His bête noire was the "guaranteed" steam consumption of turbines, upon which he did some very plain speaking on numerous occasions. In this regard I may appropriately reproduce Hill's parody of the song "Sweet Genevieve," which embodies Seaton's views on the subject to a nicety:—

A guarantee I gave one day
When I was young and rather green.
How I regret that yesterday,
And that commission's might have been.
I sold that wretched turbine set,
Eleven pounds I swore we'd touch.
The test came fairly near, and yet
It showed we took five pounds too much.

Oh, guarantees, sad guarantees,
From superheat to contraflo,
The engineers were hard to please,
They measured only H_2O.

A guarantee I give to-day
For anything that they may need.
I've found out how to make it pay,
Consultants are but men indeed.
And, being men, they're often dry;
And so I always find it best
To lunch them first, and bye and bye
We wander off to see the test.

Oh, guarantees, soft guarantees,
From superheat to contraflo,
An engineer you quickly please
With whisky in the H_2O.

E. L. H.

I can hardly realise how the Manchester Engineers' Club will get on without him.

BON MOT OF THE WEEK.—"A man does not live more cheaply or eat less because his labour is unskilled." The "Manchester Guardian" in a leader on the tramway dispute in Cottonopolis. This ought to encourage the wireman's mate to start a "Union."

* * * *

"Chester" Britton is going to make the Dee grow hydro-electric corn and crops. More power to the elbows in his pipe line!

* * * *

"Some Motor 'Bus Reports" says a headline. Yes; we hear them in Fleet-street, and in these days they "put the wind up" in the offices and start the staff for the basement.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, July 10, 1880.]

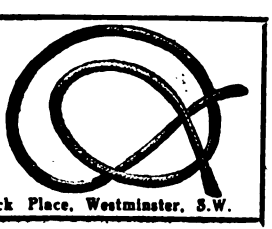
NEWS FROM AUSTRALIA IN FIVE HOURS.—The telegram conveying the news of the capture of the Kelly gang of bushrangers was despatched from Sydney at 12.30 p.m. (Sydney time) on the 28th ult., and reached London at 7.33 a.m. (Greenwich time) on the same day, and was published in the second edition of *The Times* on that day. Allowing for the difference of time between Sydney and London, Sydney being 10 hours and 5 minutes in advance of Greenwich time, the actual time occupied in transmission was 5 hours and 8 minutes, thus enabling events at the Antipodes to be published in the London morning papers on the day of their occurrence. This speaks well for the organisation of the Eastern and Eastern Extension Cable Companies.

A COW CHARGED WITH ELECTRICITY.—Mr. W. Woods, F.R.C.V.S., Wigan, writes to the *Veterinary Journal* as follows: "On February 21st last I was requested to visit a dairyman's cow which had calved the previous night, the owner stating that he did not understand what was the matter with the animal, as every time he touched her a trembling sensation ran up his arm, and he involuntarily twitched away. He seemed perfectly astounded, and kept impressing it on me that he was not afraid of the cow, but he could not help shaking when he touched her. I visited the cow. When I placed my hand upon her I received a perfect electrical shock, the animal evidently receiving the same, for as often as she was touched by anyone she bellowed, and jumped forward, apparently terrified. The pulse and temperature it was impossible to ascertain. The owner was unable to milk her, as she went almost wild when touched, but was perfectly tranquil when not meddled with, with the exception of a wild look about her eyes. No matter how many times the animal was touched the same result followed. With great difficulty I administered a strong saline purgative, combined with 15 croton beans, followed in a few hours by a pint of linseed oil containing a small quantity of chloroform. At night the cow was considerably better, and the following morning I was pleased to find her quite convalescent."

Winnipeg Hydro-electric Power.—The latest Bureau of Labour figures show that there are 396 factories operating in the city of Winnipeg. Through the enterprise and foresight of the civic authorities the city of Winnipeg has provided itself with hydro-electric plant which is able to supply power at a very low rate.

The report of the Dominion Water Powers Branch states that the plant of the Winnipeg Electric Railway Co., on the Pinawa Channel, and the municipal plant of the city of Winnipeg, at Point du Bois, are already in existence. After fully protecting the interests of these two plants, it has been possible to divide the remainder of the river drop into seven concentrations for power development, having a total possible output of 175,000 continuous 24 hour horse-power available at 75 per cent. efficiency under the present unregulated minimum flow and 313,000 continuous 24 horse-power available from the proposed 20,000 second-ft. dependable minimum flow under regulated conditions. Including the two existing developments, the total resources of the former reached at nine sites are 249,000 and 418,000 continuous 24 hour horse-power under the above respective conditions of flow. This means that there will eventually be as much, if not more, power available from the Winnipeg river than is now being developed at Niagara. All the power is within 65 miles of the city of Winnipeg.

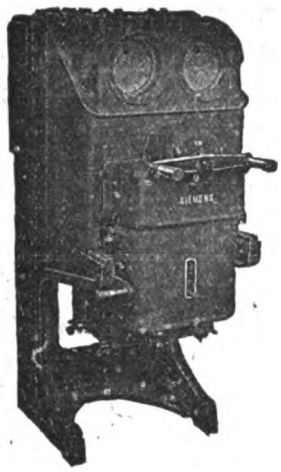
L.P.S. INSULATING SLEEVING.
BRITISH MADE & ALWAYS IN STOCK.
A most efficient insulation for all internal connections in electrical apparatus.
An excellent substitute for perishable rubber tubing.
Very flexible, water and oil proof; and of high dielectric strength.
Write for Particulars:—
THE L.P.S. ELECTRICAL COMPANY, 14, Howick Place, Westminster, S.W.



SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

Digitized by Google

SIEMENS



IRONCLAD
SWITCHGEAR
FOR ALL
PURPOSES

Control Pillars
Distribution Boards
Main Switchboards

Write for particulars to —

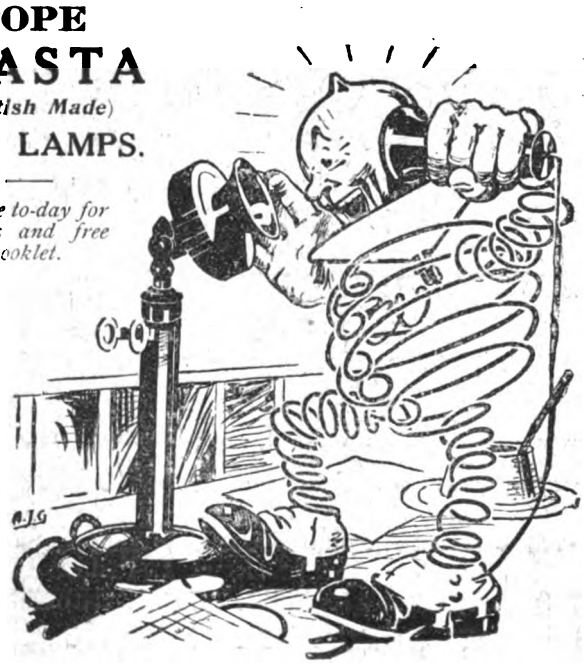
SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

Give me a Ring!

If you want a *better* lamp, give me a ring—Willesden 1170. I am in big demand. I shall make satisfied customers for you.

POPE
ELASTA
(*British Made*)
WIRE LAMPS.

Write to-day for terms and free booklet.



Advt. of Pope's Electric Lamp Co., Ltd., Hythe Road, Willesden, N.W. 10.

EXCESS PROFITS DUTY.

A White Paper, issued on Saturday last, contains the proposals of the Government in regard to the valuation of stocks, the allowance for wear and tear, depreciation and obsolescence of assets, &c.

Valuation.—In regard to the valuation of stocks the Government proposes to adopt the following modifications—which will not require legislation—of the general principle that stocks should be valued at cost price or market value, whichever is the lower :—

1. A period of 12 months will be allowed after the termination of the war in which to ascertain by actual realisation the value of the stock appearing in the account at the end of the last accounting period, and an allowance made from the profits of that period for any difference between the valuation and the sum realised.

2. Certain classes of industry require to keep stocks of raw or semi-manufactured goods for manufacturing purposes, and these goods are frequently of such an imperishable character that a minimum quantity required for a business could be held untouched for a long period. Accordingly in any class of trade (*a*) which requires for its manufacturing processes to keep such stocks, and (*b*) in which a recognised practice has obtained of taking a constant quantity at a constant price, the Government is prepared to accept the practice. The Government would regard goods as imperishable which are of sufficient durability to last without material deterioration during a period equal to the length of the war Any individual member of the class who has not adopted the method in his business may be allowed to do so for the purposes of excess profits duty, but may not claim as the constant quantity of stock so valued a greater quantity than the minimum amount held at any stocktaking in the three pre-war trade years. The balance of stock above the minimum quantity is to be treated as in (1).

3. Profits derived from sales which reduce stock below the particular minimum or constant quantity adopted for any business are not the less trading profits. Where, however, a raw material is associated with plant in a manufacturing process (*e.g.*, metal kept to a constant level in galvanising baths) the Board of Inland Revenue will consider a claim under sec. 40 (3) of the Finance (No. 2) Act, 1915, that it is akin to a capital asset, like plant, which has been exceptionally depreciated (by depletion), or of which the renewal has been postponed.

4. Where in an industry or as respects a class of stock to which the foregoing (2) does not apply, the owner of a business has taken a quantity of stock at a base price, the stock will fall to be valued during the periods of liability at cost or market value, whichever is the lower, but from the final valuation (on that basis) there will be allowed a deduction of a sum equal to the original difference (at the end of the standard period) between the valuation on the base method and a valuation on the cost or market value method. Alternatively the first stock valuation may be revised and put upon the general basis of cost or market value when the modification outlined in (1) will apply.

Wear and Tear.—In regard to allowances for wear and tear, depreciation and obsolescence of assets, the following memorandum has been issued by the Board of Inland Revenue :—

1. Excess profits duty is chargeable, generally speaking, by reference to profits which are computed on income-tax principles ; but the temporary character of the duty and its relation to the existing war conditions have rendered necessary special allowances for depreciation in the value of assets additional to the allowances granted for income-tax purposes.

2. So far as income-tax is concerned, it is well known that allowances are restricted to the diminution in value due to wear and tear of plant and machinery (sec. 12 of Customs and Inland Revenue Act, 1878). For excess profits duty purposes, further allowances are admissible, and sec. 40 (3) of the Finance (No. 2) Act, 1915, provides for special relief being granted in respect of—

(*a*) Postponement or suspension, as a consequence of the present war, of renewals or repairs ;
(*b*) Exceptional depreciation or obsolescence of assets employed in the business due to the present war ; and
(*c*) The necessity in connection with the war of providing plant which will not be wanted for the purposes of the trade or business after the termination of the war.

3. These allowances extend to any material assets employed in a business and not merely to machinery and plant. Where these assets have been constructed or acquired during the war at an inflated price and will sink to a lower level of value, or even to scrap value, at the end of the war, full relief can be claimed. The measure of the allowance to be made in respect to such assets will be the difference between cost and post-war value. An allowance of the like nature is applicable also to assets in use before the war, the value of which has fallen owing to war causes. The measure of the allowances in such cases is the difference between the value of the assets (depreciated or written down for wear and tear) at the date when liability to excess profits duty began and their post-war value.

4. Inasmuch as post-war value and the duration of the war are unknown, the Board of Inland Revenue have been unable in most cases to make final allowances of the foregoing character, but where the necessary evidence is furnished that depreciation is taking place or is inevitable at the end of the war, they are ready to make provisional allowances subject to subsequent correction.

5. As a general rule these allowances, whether provisional or final, will be "spread" (*i.e.*, granted by instalments in successive accounting periods during the lifetime of the duty), but in exceptional cases where

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

Our Works Building Department has been continuously busy, carrying out extensions, for many years past.

If all the Big Men, from Confucius on, excogitated for ten thousand years, with bandaged brows, they could no thought express that, with such eloquence, would testify to the good service given to clients by the Company.

BRITISH INSULATED & HELSBY CABLES.

Cablemakers and Electrical Engineers, LTD.,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED **SECOND HAND**

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.

Phone: Victoria 4026. Grams: Victoplastic, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh. *See our Illustrated Advt. last week.*

Digitized by Google

"The Light that Never Failed."

MASTER
Tungsten-Light BATTERIES.

WE KNOW HOW MASTER

COST NO MORE—LAST LONGER.

Stock these long-lived Batteries for Fall trade. Though imported from America, their energy when not in use is wonderfully preserved; hence they are sold under a liberal guarantee.

Made in every standard size, each uniform in quality and best for its purpose.

Handsomelyfinished. Sealed in attractive cartons.

The MASTER line includes a complete range of unique and beautiful Flashlight Cases. Deliveries of any size from large London stock or by direct importations from the U.S. Request catalogue and interesting quotations for next season's business.

THE RIVER PLATE COMMERCIAL COMPANY
EXPORT ORDER DEPARTMENT,
UNITED BATTERY CORPORATION.
MANSION HOUSE — 15, GEORGE ST. — LONDON, E.C.

FOR

High and Low Tension SWITCHGEAR

THE

NEW SWITCHGEAR CONSTRUCTION CO., Ltd.

SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

Manufacturers of

PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE

TRADE MARK.

Brass & Copper
Tubes and Sheets.

BRASS CONDENSER TUBES FOR STANDARD SHIPS, &c.

CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.

new assets are being regularly acquired during successive accounting periods, and the taxpayer desires that the allowances for each asset or group of assets should be wholly or mainly granted in the accounting period in which the asset is acquired, the Board will not object to that course being taken.

6. Where in the case of businesses which are "controlled" under the Munitions of War Act, 1915, allowances of the foregoing character for depreciation or obsolescence have been determined by the Minister of Munitions for the munitions levy, the amounts so ascertained have been adopted by the Board of Inland Revenue for excess profits duty purposes. The repeal of the munitions levy as at Dec. 31, 1916, and the transfer to the Board of Inland Revenue of the duty of assessing and collecting the levy (up to that date) involve an alteration of existing arrangements to the extent that depreciation allowances not already ascertained by the Ministry of Munitions will fall to be determined by the Board of Inland Revenue, who have made arrangements to secure continuity of practice.

7. Where a taxpayer is dissatisfied with the allowances granted by the Board of Inland Revenue in respect of special depreciation or obsolescence of assets he may require his case to be referred to the Board of Referees appointed under Part III. of the Finance (No. 2) Act, 1915, or in the case of a "controlled firm," to the Board of Referees appointed under the Munitions of War Act, 1915.

8. For excess profits duty the allowance for wear and tear of plant and machinery will usually be similar to the allowance granted under the Income Tax Acts. Its amount is to be that reasonably and properly attributable to the accounting period. The income-tax allowance for wear and tear (which is fixed by the Income Tax Commissioners) is not limited by statute to any specific amount or rate, the only provision being that it shall represent the diminished value of the plant and machinery by reason of wear and tear during the year. Where for any special reason it is claimed that the allowance for wear and tear of machinery and plant should, for excess profits duty, exceed that allowed for income-tax, application should be made in the first instance to the surveyor of taxes dealing with the excess profits duty assessment. An appeal may be made either to the District Commissioners of Taxes or to the Special Commissioners.

9. Generally speaking, the ordinary allowance for wear and tear in the case of excess profits duty is of comparatively small importance in so far as it relates to plant and machinery which may be the subject of an allowance for special depreciation owing to the war. In such cases the difference between war value and post-war value necessarily includes the ordinary allowance for wear and tear.

10. As regards the allowance authorised for the postponement or suspension, as a consequence of the war, of renewals or repairs, the amount admissible is usually capable of estimation and agreement when an excess profits duty assessment is made. The taxpayer has the right of appeal to the Board of Referees.

11. Reference may also be made to the following points, on which questions sometimes arise :—(*a*) Where pre-war machinery or plant has become obsolete from causes not actually relating to the war, but arising during the war, and is then replaced, an allowance for the difference between the written-down value and the scrap value is admissible, and where the replacement is not effected during the war, but shortly after, a like allowance may be claimed under sec. 40 (3) of the Finance (No. 2) Act, 1915. (*b*) Special depreciation of pre-war buildings due to the war may be allowed for under the same sub-section. Normal depreciation taking place equally in the past and in the present, if allowed, would not, in most cases, affect the liability to excess profits duty. (*c*) It will happen from time to time that a manufacturer will purchase machines, &c., for the purpose of specific contracts and will wish from motives of prudence to write down the value of the machines to a low figure out of the profits of the contracts. In cases in which purchases of this character have regularly occurred, both in the past and in the present, the non-allowance of a special depreciation beyond the ordinary wear and tear allowance would not normally affect the liability to excess profits duty. Where, on the other hand, purchases of this kind take place only during war periods, they would usually be attributable to war conditions, in which event a special allowance can be claimed under sec. 40 (3) of the Finance (No. 2) Act, 1915.

Some comment is made on the above statement in our Editorial Notes.

GENUINE
M & M VULCANISED FIBRE.
MOSSES & MITCHELL, 122 & 124 GOLDEN LANE LONDON, E.C.

INSULATION BEADS

SAMPLE STOCKS

HOLDER-HARRIDEN, LTD.

Digitized by Google

FERRY **FERROZOID**

CONSTANTAN **CHRONIC**

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:
HENRY WIGGIN & CO., Ltd.
George Street, Birmingham.
TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."

AGENT:
LIONEL ROBINSON,
3, Staple Inn, London, W.C.
TELEPHONE: 6328 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

H. TINSLEY & CO.

have removed to

WERNDEE HALL, SOUTH NORWOOD, S.E. 25.

Our Laboratories are well equipped for:—

RESISTANCE WORK AND STANDARDIZATION.

1, 2 AND 3 PHASE WATTMETERS.

CONDENSER MANUFACTURE AND ADJUSTMENT under all conditions up to 2,000 cycles per second.

WESTON AND CLARK CELL MANUFACTURE.

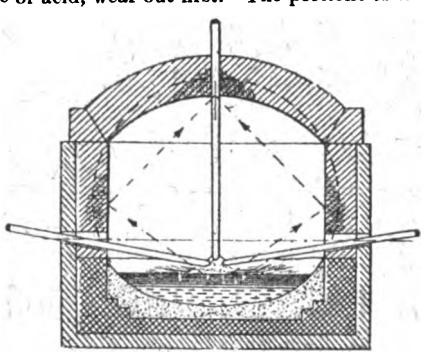
SPEED MEASUREMENT.

Digitized by Google

RENNERFELT ELECTRIC FURNACE.

A Paper read by Mr. C. H. Vom Baur at the May meeting of the American Electrochemical Society gives particulars of recent improvements in the American Rennerfelt electric furnace. From an abstract of the Paper in the "Mechanical Engineer" it appears that the furnace hearth is now circular, with one set of electrodes, and oval-shaped with two sets; the side electrodes are adjustable in a vertical plane, allowing them to dip toward the bath; and the available power, or instantaneous available heat, has been largely increased.

The operating results obtained in making these three changes have not only kept up the quality of the steel, but the cost has been reduced materially. With a circular hearth and the flame, in the centre, the heat distribution is equal at the slag line. There are consequently no cold corners, obviating overheating when melting, so detrimental to both side-walls and roof. The side-walls, slag-line and roof, especially the latter, now dome-shaped, are easier to repair. Often, only the centre portion of the roof bricks need replacing, the other roof bricks lasting twice as long. In the illustration below the shaded portions show how the refractories, either basic or acid, wear out first. The portions of the central part of the roof being directly over the flame would naturally wear more there, and it seems that this is accentuated by reflection from a too thick slag first reflecting from the side-walls substantially as indicated by the broken lines. The dotted lines show the tendency towards eventual wear.



TILTING ELECTRODES OF RENNERFELT FURNACE.

Tipping the side electrodes down from a horizontal position has several advantages. When charges less than normal are made the most efficient height over the metal when melted can be maintained. During melting, the electrodes at the start, whether for partial or full heats, are usually only 2·5 cm. over the bath. As the charge melts the electrodes are continually lowered, thus keeping the flame about 6·2 cm. to 7·5 cm. (2½ in. to 3 in.) over the bath. By bringing the flame closer to the bath the melted steel more readily absorbs the heat and the large flame, being farther away from the roof, lengthens its life. The possibility of tilting the electrodes up and down helps when slagging off, and lessens the breakage of electrodes. The flame nearer the bath, and with the same potential, has a tendency to circulate the slag faster. A more shallow bath facilitates the refining, as the metal comes in contact with this slag on a larger surface. The flame itself, depending on the size and electric power of the furnace, seems to make a circular patch on the thinned slag directly beneath the flame 20 cm. to 25 cm. (about 8 in. or 10 in.) in diameter and then mushrooms out. In a two-flame furnace the flame at times seems to spread over the entire bath, an appearance due to incandescent gas. The hearth is made more shallow and thus the rammed-in bottom coming up at the sides makes the sides less steep. This shallow bath shortens the time of melting down, and the lining is less affected at the slag line. The regulation of the heat applied to the bath is made easier by the variable position of the flame above it and it also lessens the danger of overheating, which is of great importance. Having the electrode tips never more than 7·5 cm. (3 in.) above the bath has materially reduced the time of melting. Thus far no Rennerfelt furnace in the United States is using fluid charges. With basic bottom the dephosphorising time has remained unchanged and the desulphurising period, with the aid of calcium carbide slags, has been reduced. When refining and reducing sulphur with a built-up slag from ferro-silicon and lime, as used in the induction furnace, this was accomplished with good effect.

With furnaces having 300 kw. power per ton of output, heats have been made on basic bottoms, taking off one slag in 2½ hours with 670 kw.-hr. per ton when operating continuously. With acid bottoms and 200 kw. power per ton of output, taking off one slag, good steel and full heats have come off in 3¼ hours, with 635 kw.-hr. per ton. The electrode consumption is 3 kg. (less than 6 lb.) per ton of steel made, operating continuously. Even with the present high cost of refractories, this cost has been reduced in the smaller furnace of one ton from $2.91 per ton of steel made to less than 80c. per ton. Roofs are lasting over 100 heats, and approximate the longer life made in Europe with better refractories. With a higher power input the heats are shortened, due to the shorter melting period (the heat being considerably reduced during the refining time), thus roofs are lasting more heats than formerly, though the actual time is not much changed. Side-walls of brick outlast two or more roofs, while the bottom lasts a year or two.

The higher powered furnaces, besides lowering the cost per ton in every way, steadies the consumption of electricity, which has already been very constant. For instance, a 3-ton furnace operating with 600 kw., with hand-regulated electrodes, will reduce in four or five minutes to about 550 kw. without any fluctuation (except during the first part of the melting period) and without touching the electrode regulating mechanism. With smaller furnaces the steadiness is not so marked, whereas with still larger ones the effect is but little improved. The power factor is about 90 per cent., with 60 cycles. All sudden strains on the power supply are avoided. The arc voltage has been raised and is now 110 to 120. Regarding non ferrous metals, the results already published have frequently been duplicated and in some instances bettered. For instance, railroad journal-bearing metal (70 per cent. copper, 10 per cent. tin, 15 per cent. lead and 5 per cent. Zn, Mn, Fe and impurities) was melted in a hot furnace in 29 minutes, and with less than 160 kw.-hr. per ton net. Aluminium-nickel alloys were melted in less than 15 minutes, consuming about 300 kw.-hr. per ton net.

THE GREAT CENTRAL RAILWAY passes from the Metropolis Northwards through the centre of industrial England, throwing out its branches Eastward and Westward to the Coast.

¶ Its Lines run over the Great Midland Coalfield (of over 4,000 square miles area) which extends into the Counties of York, Nottingham, Derby and Lincoln. This Coalfield is the largest in the British Isles, and is estimated to contain not less than forty-nine thousand million (49,000,000,000) tons of coal.

¶ The important Coalfields of Lancashire and North Wales are also traversed by the Company's lines.

¶ There is thus afforded an easily accessible source of fuel supply.

¶ The New Eastern Port of Immingham should particularly attract traders, as its modern equipment and accessibility at any time of the day or night, irrespective of tides, are important time and labour saving factors.

¶ Adjoining the Great Central Railroad at various parts of the system are situated Valuable Sites for Works, where, by the introduction of siding accommodation, goods can pass right into and directly out of the works, which greatly assists the Manufacturer to attain his desired position in the World's Markets.

¶ For information please communicate with the G.C.R. Publicity Office, 216, Marylebone Road, London, N.W.

¶ Owners and Agents of LAND and BUILDINGS for SALE or TO BE LET near the Great Central Railway are requested to send particulars to the G.C. Estate Office, 12, Paton Street, Piccadilly, Manchester.

SAM FAY, General Manager.

ADMIRABLE SITES FOR NEW WORKS, FACTORIES, &c.

BASTIAN METERS FOR DIRECT CURRENT ONLY.

Made in ENGLAND with

BRITISH CAPITAL and BRITISH LABOUR.

THE BASTIAN METER COMPANY, LTD., BARTHOLOMEW WORKS, KENTISH TOWN, N.W.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,044. [Vol. No. 18 LXXIX.] FRIDAY, JULY 20, 1917. PRICE SIXPENCE. By post. 7d. Abroad, 9d.

CONTENTS.

NOTES 611
Arrangements for the Week 613
The Characteristics of Iron in High Frequency Magnetic Fields. By Ralph Bown. Illustrated 614
The Effect of Heat on Cotton and Paper. By L. Schuler. Illus. 617
Flywheel Load Equalisers. By M. J. E. Tilney, A.M.I.E.E. 618
The Prospects of the Accumulator. By Dr. Ludwig Strasser.... 619
Research Work in the U.S.A. 620
Electric Vehicles in Municipal Service 621
Standard Methods of Testing Moulded Insulation. Illustrated .. 622
THE RIGHT MAN IN THE RIGHT PLACE..... 624
REVIEWS 624
Electric Vehicles and their Use on Cleansing Work in Sheffield. By J. A. Priestley..... 627
CORRESPONDENCE 629
University Training for Workshop Managers 629
Symbols Recommended by the Institution of Heating and Ventilating Engineers 629
The Wild-Barfield Process for Hardening Steel 629
B.T.-H. Ironclad Draw-Out Oil-Break Switchgear. Illustrated .. 630
LEGAL INTELLIGENCE..... 630
PARLIAMENTARY INTELLIGENCE 632
Patent Record 632
Volunteer Notices..... 632
COMMERCIAL AND INDUSTRIAL SECTION 635
Electricity Supply 636
Tenders Invited and Accepted 639
Financial Matters..... 640

NOTES.

Standard Tests on Moulded Insulation.

MOULDED insulation has now become such an important part of the electrical manufacturer's equipment that it is highly desirable to adopt some standard methods of testing such materials. We believe that this matter is at present under consideration by the Institution of Electrical Engineers. In the United States they have gone a step further, and the Associated Manufacturers of Electrical Supplies have issued details of standard methods, dealing with some of the main points that have arisen. Elsewhere we reproduce the substance of this bulletin. The tests described deal with dielectric strength, tensile strength, compressive strength, transverse strength, softening on heating and the absorption of moisture. It will be noticed that the test piece is in the form of a cup, which has the great advantage that it can be floated on mercury, and can also contain mercury, so that this metal is used for both electrodes; and there can be no question as to the form of contact adopted. The only disadvantage appears to be that micrometer measurements of the thickness of the bottom of the cup, which is the part under test, cannot be made easily except by breaking up the cup. The thickness adopted for the bottom of the cup is 5 mm. and results are to be stated as the breakdown voltage per mil or the voltage per millimetre. Considering that the relation of dielectric strength to thickness does not follow a straight line law for small thicknesses, it is desirable that some uniform practice should be adopted and some recognised thickness selected for test; but it is doubtful whether there is much value in reducing the results to the equivalent for very small thicknesses, such as the voltage per mil, merely on a *pro rata* basis which is false.

Temperature Tests.

DETAILS are also given of apparatus for testing the temperature at which softening takes place. There is, of course, no precise temperature of softening, but for the purpose of this test the temperature is taken as that at which a test piece, of half an inch square in section and supported on steel supports 4 in. apart, deflects to the extent of 10 mils under a certain load. Provision is made for a loading of 2½ kg., 5 kg. and 10 kg. It is noticeable that some of the tests are carried out not only at room temperature, but on samples which are supposed to be heated to a temperature 10° below the softening point as determined by the test to which we have just referred. These tests are to be made while the test pieces are hot, with an allowed variation of plus or minus 5 per cent. It is difficult to see how this kind of test can be carried out effectively. It is, of course, impossible to have the testing apparatus at such a temperature except by very special arrangements, and if the test pieces are to be merely heated up and then removed for testing, there is no guarantee that their temperature will be anything definite, as comparatively rapid cooling must necessarily take place. Parenthetically we may remark that the present bulletin shows internal evidence of the conflicting claims of the metric and non-metric systems in the United States.

The Absorption Test.

IN the test for absorption of moisture we notice that the standard test cup is also used, and this is weighed first, then thoroughly dried by heating, or otherwise; and subsequently, after immersion in water for a definite time, the excess water is removed with a dry cloth. This method of removal strikes one as being a very approximate method, though it may be difficult to suggest a method that is more suitable. In making this test we believe that some makers break up the sample so as to expose fractured surfaces. We do not think there is much point in adopting this course. In fact we are of opinion that the method suggested in the present Bulletin is the correct one, as the character of surface which is of greatest interest is that in its finished state. We feel, however, that the Committee has followed a wrong course in expressing the results as the percentage increase over the weight of the dried sample. Absorption is essentially a surface effect, and, as such, we think it should be referred to surface area and not to weight, which latter may, of course, vary greatly for a given surface according to the geometrical character of the test piece.

The Electric Vehicle in Municipal Service.

THERE is no doubt that the electric vehicle is becoming increasingly popular in municipal services for the purpose of removing refuse and for similar work, and before many years the horse vehicle for this purpose is likely to be in the minority. Elsewhere we give the results obtained at Manchester as reported by Mr. S. L. PEARCE, and the results at Sheffield as shown by Mr. J. A. PRIESTLEY in a Paper read before the Institute of Cleansing Superintendents. The results at Manchester were obtained with a 1-ton Edison lorry, the

Digitized by Google

total number of miles run being 10,486. The electric energy required (including motor generator losses) has averaged 1·08 units per mile and the tyres have completed the guaranteed life of 12,000 miles, giving a cost of 0·5d. per mile. With electrical energy at 0·5d. per unit and interest at 4½ per cent., which with depreciation comes to 18·9 per cent. on the original cost of the vehicle, the total cost per mile amounted to 7·11d. Even with interest at 5 per cent. and electrical energy at 1d. per unit the cost only comes up to 7·73d. per mile. It is always a little difficult in these cases to compare electric haulage with horse haulage, the only satisfactory basis being to replace one service by the other. Mr. PEARCE, however, gives an estimate showing the cost of horse haulage for a week as £10. 19s. 10d., as against £5. 19s. 7d. for an electric vehicle, thus showing a saving of £5. 0s. 3d. by the use of electricity.

The Results at Sheffield.

SIMILAR results have been obtained at Sheffield. In this case a 2-ton Edison vehicle was put to work in September, 1915, and the results proved so satisfactory that further orders were quickly given, so that the Paper is based on the working of five such vehicles, and a fleet of ten is now at work or will shortly be so. The amount of refuse removed by the horse service was 51,499 tons and by the electric service 7,040 tons. It is shown that the cost per ton by horse haulage is 5s. 5·4d., against 4s. 9·8d. for electric haulage in one case, and 3s. 3·85d. per ton for horse haulage compared with 2s. 2·3d. for electric haulage in another case. This is with electric energy at the standard rate of 1d. per unit. It has been found that 3½ electric vehicles, notwithstanding their comparatively high price, working for one year have cleared off more than the entire initial cost of 1½ vehicles. This, moreover, is on a basis which is not altogether favourable to the electric vehicle. The number of horses actually replaced per electric vehicle is found to be a fraction under six.

The Hardening of Steel Gauges.

WE give on another page an account of the Wild-Barfield process of hardening steel, which presents some interesting features. The most novel element in the process seems to be the utilisation of the loss of magnetism at the decalescence point as an indication of the correct temperature preliminary to quenching. This device, together with special selection of the heating and quenching salts, is claimed to eliminate the inconvenient distortion that is apt to accompany the hardening of steel gauges; for which the process is at present being mainly used. According to this process it is unnecessary to know the actual temperature to which the material is raised. The loss of magnetism is assumed to be always an indication that the decalescence point has been reached. We understand that this assumption, besides applying to the qualities of steels used for gauges, is in general correct, except possibly in the case of certain tungsten and chromium steels. With a view to the possible wider application of this process it would be interesting to have fuller information on this point. It is known that the composition of steel has a distinct influence on this property. For example, Messrs. HILPERT and MATHESIUS in 1912 remarked that manganese steel is practically non-magnetic after any heat treatment, and Dr. S. W. J. SMITH, in a paper before the Physical Society in the same year, considered that it is possible to determine the percentage of carbon in a given steel by studying the variation in permeability with temperature. Later Messrs. S. W. J. SMITH and J. GUILD showed that loss of magnetism occurs at the same temperature in specimens of varying carbon content, whereas the temperature of the return of magnetism is generally not constant.

Royal Society of Arts.—At the annual meeting of the Royal Society of Arts on June 27th, it was announced that Sir Henry Trueman Wood, who has been secretary of the society for 45 years, had decided to retire in September next. Mr. G. K. Menzies, who has been the assistant-secretary of the Society since 1908, has been appointed to succeed Sir Henry as secretary.

Electric Supply Company's Majority.—In commemoration of the completion of its 21st year of working the County of London Electric Supply Co. (Ltd.) has presented silver matchboxes to members of the staff, and gold medallions to the chief officers. These were inscribed as follows :—

"To commemorate the 21st year of working. 3,000 kw. per annum in applications, and 1,000,000 units sold per week.—1916."

The directors and chief officers of the company also presented to the Chairman (Mr. J. B. Braithwaite) a rose bowl and salver in commemoration of the above, and of his association with the Company since its formation.

British Association.—In consequence of the cancellation of the annual meeting, the organising committees of the various sections, the delegates of the corresponding societies, the Committee of Recommendations and the General Committee have met, and it has been decided to continue Sir Arthur Evans as president for another year. The Hon. Sir C. A. Parsons, who was to have presided over this year's meeting at Bournemouth, will preside over the meeting which has been arranged to take place at Cardiff next year. It is announced that grants amounting to £286 were made in aid of such researches as were looked upon as essential to carry on, having regard to present conditions.

Coal Transport Re-organisation Scheme.—In connection with this scheme the Controller of Coal Mines is considering the requirements of steam raisers in regard to supplies of special coal fuel. Forms have been sent out to steam raisers throughout the country asking for information in regard to the class of coal used, consumption, &c. A considerable number of the forms sent out have not been returned, and steam raisers who have received such forms should note that their requirements in the way of special fuels cannot be considered in the absence of the information called for by the forms, which should be filled in and despatched to the Controller of Coal Mines immediately. In cases where steam raisers have not received forms it is desirable that they should apply at once to the Controller of Coal Mines, 8, Richmond terrace, Whitehall, London, S.W. 1.

Definition of Cross-Talk.—The following definitions of cross-talk, over-hearing and secrecy have been framed by the Telephone Manufacturers' Association, and approved by the Institution of Electrical Engineers :—

"Cross-talk" in telephone systems is the unintentional overhearing between one circuit and another not due to any such metallic connection as arises from accident or is effected by a user or third party. In practice the "cross-talk" may be due to disturbances arising from electromagnetic or electrostatic induction, to leakance, or to insufficient conductance, in a common portion of circuits.

"Secrecy" in telephone systems is secured by an arrangement of circuits making it impossible for a third party by any normal use of the system to cut in and listen to the conversation taking place between two users, at any rate without the knowledge of the parties conversing.

The term "secrecy" must not be confused with freedom from "cross-talk."

Palladium-Gold Crucibles as Substitutes for Platinum.—The shortage and high prices of platinum, according to "Metallurgical and Chemical Engineering," has led a firm in Los Angeles, California, to construct crucibles of an alloy of gold and palladium, termed "Palan," which, in some respects, is claimed to be even better than platinum. Thus, according to a recent test by the Bureau of Standards, the loss of weight on severe heating is less, and the resistance to the chief acids greater, than is the case for platinum; on the other hand, it is less suitable for potassium pyrosulphate fusion, and there is also the possibility that its constituent metals may, to some extent, pass into solutions, which would have a small but possibly appreciable effect on a delicate analysis. A curious fact stated by the makers is that this material will not "wet." The meniscus is upward, as in the case of mercury.

Digitized by Google

Researches in Acoustics.—In a recent communication to the Société Française de Physique, Mr. W. C. Sabine points out some of the fundamental difficulties attending researches in acoustics. Most quantitative experiments have been conducted on simple tones, for the high sensibility, and great range of the ear to complex vibrations makes their study extremely difficult. It is probable that in a room of moderate size the inverse square law rarely holds; it is even possible to obtain a greater intensity of sound at an increased distance from this source. This is due to the high reflecting power of the materials (wood and brick) commonly used for walls, the resonance of objects with the sound emitted, and the interference that takes place between vibrations of different frequency. In some cases it is possible by the choice of suitable porous and absorbent materials to clarify a complex sound, checking the harmonics and allowing only the fundamental note to be clearly apparent.

An Air-Blast Rectifier for High-Tension Alternating Currents.—In the "Physical Review," Messrs. E. R. Woolcot and C. J. Erickson remark that partial rectification of a high-tension alternating current occurs on the passage of a discharge from a point. This fact has been known for years, but there is difficulty in making use of this effect in practice, especially if a considerable current flows. The authors have found that complete rectification and smooth operation can be obtained by utilising a current of air flowing from the point to the plate. An apparatus is described making use of this principle, and oscillographic curves are reproduced to illustrate the effect produced. The discharge when rectification occurs is quite rhythmic and snappy as distinct from the coloured arc, which results when no air is flowing. Difficulties are experienced at relatively low voltages. Some good results are recorded with about 15 kv. and 12 to 25 milliamperes flowing, and up to 350 kv. and a frequency of 500 cycles per second satisfactory rectification was secured.

Electric Iron Smelting.—In an article in the "Iron and Coal Trades' Review," Mr. J. O. Boving remarks that there is no carbon steel or alloy steel, and no kind of castings, whether heavy or small, that cannot be made better or more profitably in an electric furnace than by older methods. In Sheffield, where the cost of electricity for such purposes is comparatively high (0·7d. per kilowatt-hour), it is found that the cost of current is of small importance in refining operations as compared with the results. The types of refining furnaces now most generally adopted are those patented by Héroult and by Electro-Metals (Ltd.). The former utilises three-phase or one-phase current with only top electrodes, whereas the latter is built for two-phase working with a bottom electrode (enabling three-phase to be substituted if desired). The author estimates the number of "Electro-Metals" refining furnaces now in operation or building as follows:—

Number of furnaces.	Country.	Aggregate charging capacity (tons).	Output per 24 hours, working from cold scrap (tons).
22	Great Britain	56½	226
9	U.S.A.	44	176
3	France	12	48
1	Italy	3	12
1	Spain	2½	10
1	Russia	1½	6
2	Australia	3	12

Electro-culture.—In our issue of the 29th ult. we gave brief particulars of a scheme prepared by the borough electrical engineer of Chester (Mr. S. E. Britton) for the utilisation of electrical energy for agricultural purposes. Mr. Britton's proposals are the outcome of a desire to effect economies in the use of fuel, and in view of the results which had been obtained from the Chester Hydro-Electricity Works, an application has been made by the Corporation for a grant of £200 from the Development Fund in order to continue the investigations and to collect data, &c. The money will, we understand, be used for the purpose of carrying out experiments upon a considerable length of the River Dee, which passes through a rich agricultural area. The Chester hydro-electric works have been in operation for 3½ years and have generated 5,734,000 units at a cost of 0·087d. per unit and interest and sinking fund charges of 0·1483d. per unit.

At present Mr. Britton is dealing with three fields of 1½, 10 and 14 acres respectively. The 1½-acre plot was equipped 6 weeks ago, the equipment of the 14-acre field was completed in the first week of July, and the 10-acre field is approaching completion. Owing to this year's experiments being somewhat late the results may not be of great value as a guide, but next year the experiments will be carried out more systematically. The 1½-acre plot is planted with potatoes, peas, beans, carrots, turnips, beets, onions, lettuce, cauliflowers, brussels sprouts and cabbages; the 14-acre field is planted with potatoes, mangel-wurzels and swedes, while the 10-acre field is planted with oats.

The apparatus used in connection with the 1½ acres is a "Sanax" motor interruptor, Leslie Miller 10 in. coil and Lodge rectifiers; in the 14-acre area is a 12 in. heavy discharge coil, motor driven mercury interruptor (supplied by Messrs. Harry Cox & Co.) and four Lodge rectifiers. The apparatus for the 10-acre field has been supplied by the Agricultural Electric Discharge Co., and consists of a heavy discharge coil, motor-driven gas current interruptor and five Lodge valves. The current is carried from the apparatus to the fields by bare galvanised wire, strained from wooden poles and insulated with high tension strain insulators, to which is attached discharge wires of No. 30 S.W.G. steel wire. In each instance the source of the supply is direct-current.

PERSONAL.

Last week the Sheffield Corporation decided to increase the salary of the general manager and engineer of the electricity supply department (Mr. S. Edgar Fedden) from £900 to £1,000, rising by two further annual increments of £100 each to a maximum of £1,200 per annum. The salary of the deputy electrical engineer, Mr. H. E. Yerbury, has also been increased from £600 to £700 a year.

WAR HONOURS.—The following distinctions have been conferred: Sergt. J. W. Wood (R.A.M.C.), formerly an employee of the Marylebone (London) electric supply dept., and who had already received the D.C.M., has now been awarded the French Croix de Guerre.

The following former employees of the Liverpool tramways department have been awarded decorations for bravery: W. N. Fortune, E. Pritchard, J. E. Downes, T. J. Jones and F. Shields, Military Medal; D. Collum, Meritorious Service Medal. At various times during the war the following distinctions have been received by members of the same department: Capt. S. Carty, Military Cross and Medal; W. Broster (killed in action), Military Medal and D.C.M.; C. T. Pryce, J. H. Evans and G. J. Lazell, Military Medal; B. Williams and A. B. Jones, D.C.M.; C. F. Claxton, D.S.O. and Military Medal; T. Muncaster, Meritorious Service Medal.

OBITUARY.

Sir C. S. MILBURN.—The death is announced of Sir Charles S. Milburn, Bart., M.A., a director of the Newcastle & District Electric Lighting Co.

COMMANDER R. GREEY, R.N.R.—We regret to record the death, which occurred suddenly on board the cable ship "John Pender," of Commander Robert Greey, R.N.R., of the Eastern Telegraph Co.

The deceased officer held the rank of Commander R.N.R. since November, 1902. He was in command of the c.s. "Amber" when the s.s. "Utopia" was lost in Gibraltar Bay, and he received the Royal Humane Society's vellum certificate and the Italian Commemorative Medal for assisting to save life on that occasion.

Lt.-Col. A. H. DUMARESQ.—We also regret to learn of the sudden death of Lieut.-Col. A. H. Dumaresq, R.E., at the age of 47.

The deceased officer had held various appointments at the School of Military Engineering, and for some time prior to his death was Inspector of Electric Lights to the War Office.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported:—

Lieut. O. J. T. Runge, M.C. (M.G.C.), who has been missing since Oct. 15 last, and is now officially presumed to have been killed on that date. He was 27 years of age, had received engineering training at the City and Guilds Central Technical College, and was subsequently in the service of Messrs. Fraser & Chalmers and the Canadian Pacific Railway Co.

Second-Lieut. Leonard Solomon (R.O.S.B.), aged 32, who was killed on April 23, was an Associate Member of the Institution of Electrical Engineers. He went to Canada four years ago, and sailed for England early in 1916, and obtained his commission at the end of November last.

We regret to record the death of Major Basil de Ferranti, M.C. (R.G.A.), eldest son of Dr. and Mrs. S. Z. de Ferranti, who died of wounds on July 12.

Sergt. Geo. Gurney (Worcester Regt.), aged 23, has been killed. Prior to enlisting he was employed by Messrs. Chamberlain & Hookham (Ltd.).

Gnr. A. Hesketh (R.E.A.), who has died of wounds, was formerly a driver on the Blackburn tramcars.

Pte. J. Charnock (Liverpool Regt.), aged 24, previously reported as missing, has now been officially reported as killed on Oct. 12 last. He was employed by Messrs. Dick, Kerr & Co., at Preston, prior to the war.

Another former employee of Messrs. Dick, Kerr & Co., L.-Corp. Wm. Hesketh (L.N.L. Regt.), aged 21, has also been killed in action.

Amongst those killed in the recent explosion on H.M.S. "Vanguard" were Eng.-Comm. W. N. Macdonald and Electricians Geo. Jordan and Jas. Allright.

Gnr. A. Riley (R.G.A.), who has been killed, was formerly in the service of Messrs. Belliss & Morcom (Ltd.).

Digitized by Google

THE CHARACTERISTICS OF IRON IN HIGH FREQUENCY MAGNETIC FIELDS.*

BY RALPH BOWN.

Summary.—Not many years ago it was quite generally believed that iron was unable to follow rapid magnetic changes. Experiments which showed an apparent decrease in the permeability of the iron with an increase in the frequency of the magnetic cycle furnished a basis for a theory that iron was magnetically sluggish. Further and more accurate experiments proved, however, that the effects which had previously been ascribed to a peculiarity of the material were in reality caused by eddy currents in the sample. Theoretical calculations were made which demonstrated that eddy currents in an iron test increased as the square of the frequency, and that for even the lower frequencies it was necessary to use quite thin laminations in magnetic circuits in order to eliminate deleterious effects. Furthermore, it was found that, due to eddy currents and the magnetic properties of iron the magnetisation in high-frequency fields was confined to a thin surface layer of the piece. Careful experimental measurements compared with theoretical calculations proved that the real permeability of iron remained unchanged at frequencies up to about 10^6.

The use of iron magnetic circuits in ordinary electrical generating and transmitting apparatus is so necessary that it is surprising to find that iron is in many cases worse than useless in high-frequency magnetic circuits. The behaviour of the iron under these latter conditions has been made the subject of many researches in the past 20 years.

THE FIRST EXPERIMENTERS (1827-1900).

In 1827 Savary noticed that a steel needle was magnetised when near the discharge current of a leyden jar. This was probably the first observation of the effect of an oscillating field on a magnetic material. However, the discharge of the leyden jar was not recognised as oscillatory until 1842. Hertz, in 1888, remarked that the magnetic properties of the iron did not come into consideration with high-frequency oscillations. In the particular experiments of Hertz this was doubtless true, but that the conclusions had no general significance was indicated when J. J. Thomson and others in 1891, showed that iron in a rapidly oscillating field absorbs energy which can only be accounted for as a magnetic hysteresis loss. Birkeland (1893) records his conclusion that "μ decreases with the period of the oscillations." In a more extended investigation in 1893, Klemenoic used Rayleigh's and Stefan's formula in the following form:—

$$\omega' = \omega\pi a\sqrt{\frac{n\mu}{\sigma}},$$

where ω'=the high-frequency resistance, ω=the continuous-current resistance, a=the radius of the wire, σ=the specific resistance of the wire, μ=the magnetic permeability, and n=frequency. From measurements made at a frequency of 9×10^7 cycles per second, and with a field intensity "H=290 Abs. E," he calculated that μ was 118 for soft iron wires 0·452 mm in diameter.

In the Marconi magnetic wireless detector, which was announced by Marconi in 1902, the received high-frequency currents were caused to act magnetically on a piece of laminated soft iron which was continually going through a very slow magnetic cycle. The high-frequency magnetic impulses seemed to have the power of altering the shape of the B-H curve for the slow cycle, so that the arrival of a wireless impulse was registered by a sudden change of flux in the iron of the detector, which produced an E.M.F. in the recording circuit. Experiments by Piola (1906), Eccles (1906) and Fleming and Coursey (1916) have indicated that the thorough shaking which the magnetic units of the iron receive under high frequency magnetisation produces somewhat the same effect on the slowly changing magnetic cycle as is produced by mechanical shock or vibrations; that is to say, that the oscillations by magnetically jarring the iron allow the impressed field to produce flux changes which would not be produced if the oscillations were absent.

At the beginning of the twentieth century the belief was common that magnetic changes of the little molecular magnets of the Weber-Ewing theory were by nature slightly sluggish and that therefore iron was not able to follow rapid magnetic variations as fully as slow ones. This assumption satisfactorily explained the previous experimental observation that the permeability decreased with rising frequency. However, an increasing attention was being paid to the effects of eddy currents and the magnetic skin effect.

Varley (1902) used a Braun tube to determine the maximum values of B and H produced by the discharge of leyden jars through a coil surrounding the test piece of fine iron wires. The B-H curve had the same shape at all frequencies, but smaller values of B are reached for a given value of H at the higher frequencies.

Braun (1903) made some experiments with iron powder embedded in paraffin as a core for the coil of an oscillating circuit vibrating at about 5×10^6 cycles per second. Zenneck (1903) showed experimentally that iron powder, the particles of which had diameters ranging from 1·5 mm by 10^{-3} mm. to 10 mm. by 10^{-3} mm., embedded in paraffin might have much higher permeability and much lower core losses at a frequency of 3×10^6 cycles per second than solid iron wires having a diameter of 0·24 mm. It is stated that the magnetic permeability of iron powder in magnetic fields at a frequency of 10^6 cycles per second is nearly the same as in stationary fields.

Undamped alternating currents were used by Schames (1908). The currents were obtained from a Poulsen arc at frequencies up to 220,000 cycles per second. Two similar coils were placed in series with a hot wire ammeter, and so arranged that the voltage at their terminals could be measured with an electrometer. One of the coils had an air core and the other a core composed of a bundle of 100 soft iron wires 15 cm. long and 0·0051 cm. in diameter each. Measurements of voltage and current in the two coils served as a basis for the calculation of the apparent permeability. The results were shown in the form of curves which exhibit the apparent permeability as decreasing when either the field intensity or the frequency increases. These curves are reproduced here (Fig. 1) because they give some

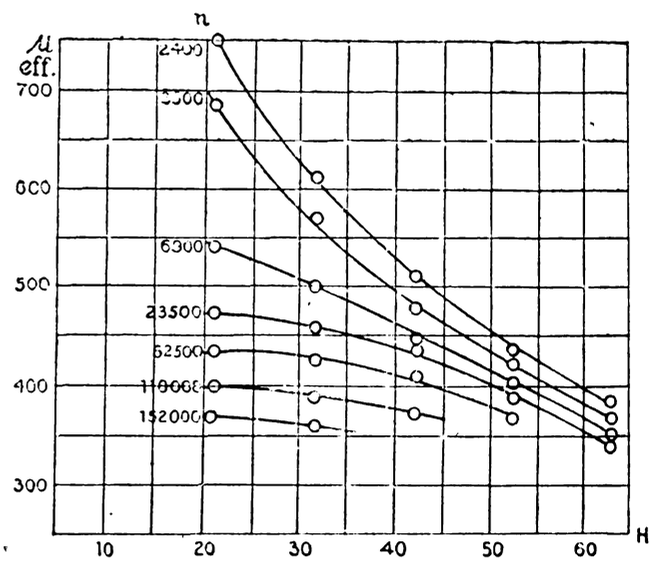


FIG. 1.—APPARENT PERMEABILITY OF FINE IRON WIRES AS A FUNCTION OF FREQUENCY AND FIELD INTENSITY (SCHAMES).

idea of the magnitude of the effects which may be expected when fine iron wire cores are used in high-frequency magnetic circuits. In commenting on Schames' Paper, "Science Abstracts" says: "As explaining this action an hypothesis is put forward according to which the μ in a rapidly alternating field has not time to arrive at the end value which it would reach with direct or slowly alternating current magnetisation. This hypothesis explains also the results obtained by other workers, notably Varley."

SHAPE OF THE HYSTERESIS LOOP.

At the time this work was going on experimenters were attacking the question of finding the exact nature of the hysteresis loop which the iron follows when acted upon by undamped high-frequency fields. The Braun Cathode Ray oscillograph was ingeniously employed in these researches.

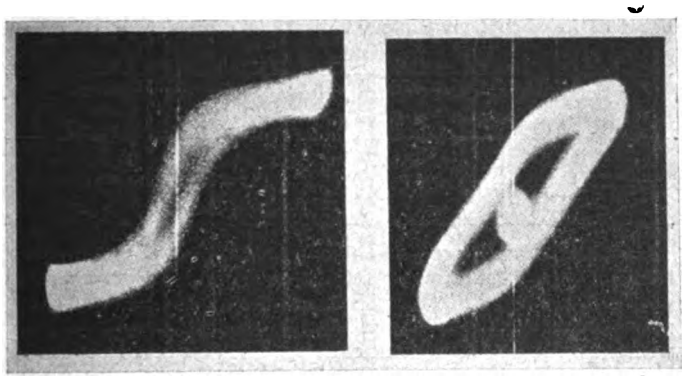
O. M. Corbino (1903) was not only the first to photograph the hysteresis loop of iron at the higher frequencies, but he also was the first to use undamped alternating currents from the Poulsen arc in this kind of work. The iron core tested was composed of wires 0·25 mm. in diameter. Photographs of hysteresis loops at frequencies from 4 to 20,000 cycles per second were shown in the original publication, the loops at the lower frequencies being slim and showing high saturation, while those at the higher frequencies were much thickened and distorted by the influence of eddy currents. Two of these loops are reproduced here as Fig. 2 and Fig. 3 respectively.

* Abstract of an article in the "Journal" of the Franklin Institute. We referred to this Paper very briefly in our issue of April 20, 1917, but we are now able to deal with it at greater length.

Digitized by Google

J. J. Thomson investigated mathematically the transmission of magnetic impulses along a wire. J. Zenneck in a résumé of the work on this subject indicates that a solid iron bar of 1 cm. radius acts, for high-frequency magnetisation, like a tube in the sense that practically all the magnetic field is in a thin surface layer. This phenomenon is called magnetic skin effect.

The attitude of some advanced thinkers at this time (1909) is put very clearly and concisely by Steinmetz, who says: "To fully utilise the magnetic permeability of the iron it therefore has to be laminated so as to give at the impressed frequency practically uniform magnetic induction throughout its section—that is, negligible eddy currents. This, however, is no longer the case even with the thinnest possible laminations at extremely high frequencies as oscil-



FIGS. 2 AND 3.—HYSTERESIS LOOPS OF IRON WIRES AT 4 CYCLES PER SECOND AND AT 11,000 CYCLES PER SECOND RESPECTIVELY (CORBINO).

lating currents, lighting discharges, &c., and under these conditions the magnetic flux distribution in the iron is not uniform, but the magnetic flux density B decreases rapidly and lags in phase with increasing depth below the surface of the lamination, so that ultimately hardly any flux exists in the inside of the laminations, but practically only a surface layer carries magnetic flux. The apparent permeability of the iron decreases at very high frequency, and this had led to the opinion that at very high frequencies iron cannot follow a magnetic cycle. There is, however, no evidence of such a "viscous hysteresis," but it is probable that iron follows magnetically even at the highest frequencies, traversing practically the same hysteresis cycle irrespective of the frequency of the true M.M.F.—that is, if the resultant of the impressed M.M.F. and the M.M.F. of the eddy currents in the iron is considered. Since with increasing frequency at constant impressed M.M.F. the resultant M.M.F. decreases, due to the increase of the demagnetising eddy currents this simulates the effect of a viscous hysteresis." A table is then worked out, showing the "penetration" in various materials at various frequencies. "Penetration" is defined as the thickness of a surface layer of flux which has the same density throughout as the real flux has at the surface and which has the same total flux as actually exists in the material. The table is here reproduced as Table I. By mathematical derivation it is shown, as had been shown by some previous writers, that the speed of propagation of a magnetic impulse into solid iron "is inversely proportional to the square root of the electric conductivity and of the magnetic permeability, but directly proportional to the square root of the frequency. This gives a curious instance of a speed which increases with frequency." It is further shown by calculation that with reference to the iron plate only 0·036 cm. thick, when the real permeability μ is 1,000 and the specific resistance 10^5 microhms per centimetre cube, the apparent permeability $\mu' = B_{av}/H$ will have values at various frequencies as follows:—

Frequency.	Permeability.
Very slow.	1,000.
10,000 cycles per second	198·0
1,000,000 cycles per second	18·8
100×10^6 cycles per second	1·98
392×10^6 cycles per second	1·0

Table I.—*Penetration in Centimetres.*

Material.	μ.	Specific resistance.	Frequency, cycles per second.				
			25	60	1,000	10,000	10^6
Soft iron	1,000	10^5	0·0714	0·046	0·0113	0·0036	0·00036
Cast iron	200	10^4	0·504	0·325	0·080	0·0252	0·0025
Copper	1	6×10^5	0·922	0·595	0·144	0·0461	0·0045
Resistance alloys	1	10^4	7·14	4·60	1·136	0·357	0·036

At still higher frequencies it is stated that the presence of the iron will actually reduce the magnetic flux.

In the experimental field again, Drysdale (1911) in some investigations on longitudinal magnetic waves along an iron bar found that the bar acted like an electric cable in which there is no capacity. According to his conclusions the reluctance of the bar corresponds to resistance in a cable, and the eddy current coefficient of the bar corresponds to the inductance of a cable.

CORROBORATIVE EXPERIMENTS.

Efforts to determine whether "iron follows magnetically even at the highest frequencies traversing practically the same hysteresis cycle irrespective of the frequency of the true M.M.F." (Steinmetz) were made by Fassbender and Hupka in 1913. It was remarked as surprising that "in the thickest plates the skin effect apparently exercises a smaller influence than in the 0·06 mm plate." The authors believe that with such thin laminations the rolling process may have a large effect on the amount of active material in the plates. The surface layers of oxide, &c., form a considerable part of the total thickness, and these surface layers are upon examination shown to be quite variable. The results of the experiments of Fassbender and Hupka substantiate the view that when magnetic skin effect is greatly reduced by the use of iron laminations having larger surface as compared with their cross-section, the permeability and the character of the hysteresis loop are but little affected by a wide range of frequency variation. Marchant (1913) using Leyden jar discharges at 5,000 to 100,000 cycles per second through coils with iron cores, photographed the spark discharge in a revolving mirror, and obtained results which show the same general characteristics as those of other workers. The author remarks: "The curve connecting μ the 'effective' permeability ($=B_{av}/H$) with H the magnetising force agrees within the limits of experimental error with that obtained on the assumption that the permeability of the iron is the same as it is under a steady magnetising force."

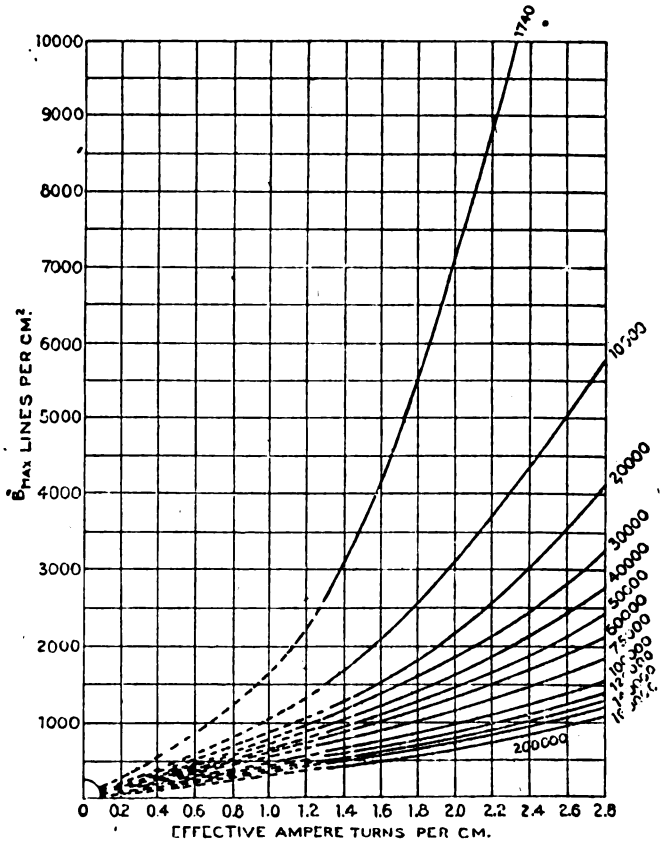


FIG. 4.—ALTERNATING-CURRENT SATURATION CURVES OF VERY THIN SHEET IRON (ALEXANDERSON).

The matter of the behaviour of μ having been fairly well settled, more attention was focussed upon the practical question of core losses. By means of his 200,000-cycle alternator, Alexanderson, in 1911, was able to collect a large amount of accurate data. The Paper says: "As a conclusion from these tests it may be stated that the opinion held quite extensively that iron does not respond to high frequencies is entirely without foundation. The iron not only responds but seems to have the same permeability at 200,000 cycles per second as at 60 cycles per second. The apparent permeability of the

Digitized by Google

iron in the sample which was tested is only about one-tenth as great at the high as at the low frequencies, but the decrease of the apparent permeability is substantially in agreement with the change that would be expected from purely theoretical considerations due to the skin effect, which indicates that the actual permeability has remained unchanged." Calculation by Steinmetz's formula shows the penetration at 200,000 cycles per second should be 0·00056 cm., while calculation from the data shows it to be 0·0003 cm. "The discrepancy between the measured and calculated values of the penetration is probably due to the fact that the coil has not a

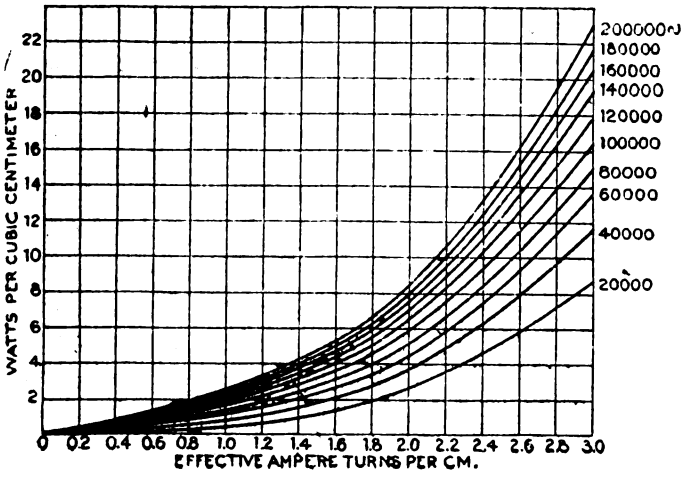


FIG. 5.—CORE LOSSES IN VERY THIN SHEET IRON AS A FUNCTION OF FREQUENCY AND FIELD INTENSITY (ALEXANDERSON).

completely closed magnetic circuit, but depends upon leakage from turn to turn of the laminations, whereby an additional skin effect is created." The iron sheets used by Alexanderson are about as thin as can be manufactured nowadays, and therefore his results are particularly interesting because they show what can be done with iron in high frequency fields when a proper method is pursued. The saturation curves and curves of core losses ar copied here as Fig. 4 and Fig. 5 respectively.

In the discussion of Alexanderson's Paper, Silsbee, in 1910-11, also studied hysteresis and eddy currents. The results showed that the real permeability of the iron after these factors had been allowed for was practically the same at 350,000 cycles as at low frequencies, "at least over the range of H used." This range is not stated. "The observed values of the energy component were uniformly low, which suggested that possibly the hysteresis loss per cycle might be less at higher frequencies when the molecules are subjected to such rapid agitation."

McLachlan (1915) made core loss tests on 0·33 mm. plates of two special steels known as Stalloy and Lohys, and reported data as in Table II. A strip of the steel placed in the magnetising coil became red hot in three seconds unless surrounded by water. These figures show the enormous values to which the core losses may rise under extreme conditions. Tests (1916) of apparent permeability and core losses at frequencies up to 10^6 cycles per second resulted in data consistent with those of previous work.

Behaviour at Extreme Frequencies.—While experiment has shown that the true permeability of iron is unaffected by frequency through a range from zero to perhaps 10^6 cycles per second, yet it must be noticed that this cannot be true at much higher frequencies, for at the frequency of light and heat waves the permeability of all metals is unity. What happens in the region between these widely separated conditions was investigated by Arkadief, who writes: "In the winter of 1907-08 I busied myself with measurements by different methods of the reflecting power of metallic wires for electric waves, and I have found that the difference in the relation between magnetic and non-magnetic wires is much larger for the longer waves (30 cm.) than for the shorter ones (3 cm.). This, one can only explain by the decrease of the permeability with wave-length. I have given mathematical formulæ for the calculation of the absorption coefficients for undamped electric waves in two parallel wires, and I have found that the measured values for non-magnetic wires are in good agreement with the theoretical values, which makes possible the calculation of the permeability of magnetic wires from the values of their measured absorption coefficient." The earlier investigations of Arkadief consisted in measurement by means of a delicate thermo-element of the attenuation or absorption of electric waves propagated along two wires. The energy of the waves is found to fall off according to an exponential relation. Calculations based on a theoretical formula showed that for non-magnetic materials the observed and calculated values of the absorption coefficient differed by less than the possible experimental error, which was small. Data from observations on similar magnetic wires were then placed in the formulæ, and, working backward, the value of μ was deduced. For soft Swedish iron wires 0·02 mm. in diameter in very weak fields the values were:—

Wave-length in centimetres.	Permeability, μ.	Wave-length in centimetres.	Permeability, μ.
72·7	80	4·82	33·5
23·8	58	2·31	14·7
10·63	51	1·31	4·5

The extrapolation of these data showed that μ became unity for iron with waves a few millimetres in length. A curve is drawn (reproduced here as Fig. 6), which exhibits Arkadief's results as connecting smoothly the results of Rubens in the region of heat waves with those of other experimenters at wave-lengths near 1,000 metres.

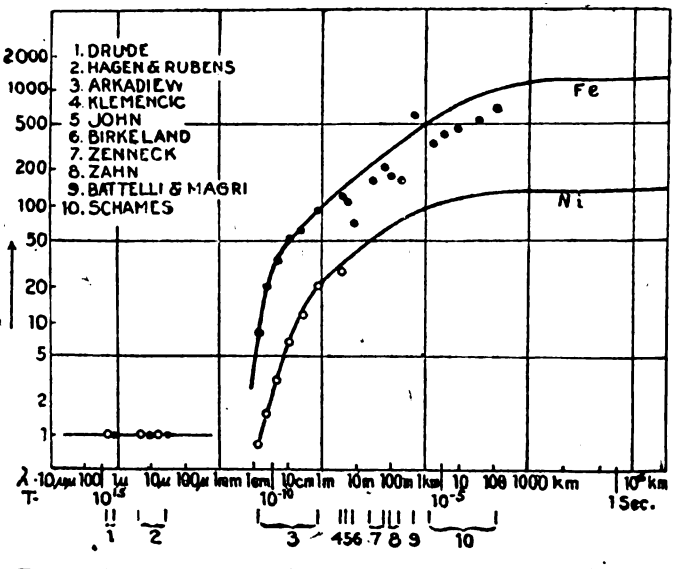


FIG. 6.—COMPILATION OF DATA ON HIGH-FREQUENCY PERMEABILITY (ARKADIEF).

The question of what happens to μ, or, in fact, of what meaning the ratio B/H has in the region of wave-length which lies about the natural radiation wave-lengths of atoms and molecules, is a question which is too undecided to even conjecture upon here. The matter obviously involved theories of the magnetic structure of materials which are far from settled. Arkadief has made some mathematical investigations of what is to be expected in this region.

Table II.

B max. apparent.	H max. apparent.	μ apparent.	Watts per kilogramme.	Frequency, cycle per sec.
3,500	21	170	48,000	$1·9 \times 10^5$
4,300	17	250	44,000	$1·7 \times 10^5$
3,200	25	130	57,000	$2·1 \times 10^5$

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"The Theory of the Submarine Telegraph and Telephone Cable," by H. W. Malcolm, M.A., Ph.D., D.Sc. (London: Benn Bros.) Pp. xi.+565. 18s. net.

"Electrical Engineering Practice," by J. W. Meares. (London: E. & F. N. Spon.) 3rd edition. Pp. xxi.+642. 25s. net.

"Mechanical Handling of Material, and its National Importance during the War," by G. F. Zimmer, A.M.Inst.C.E. (London: Crosby, Lockwood & Son.) Pp. 135. 10s. 6d. net.

"Science and Industry; the Place of Cambridge in any Scheme for their Combination." By R. T. Glazebrook. (Cambridge: University Press.) Pp. 51. 1s. 6d. net.

"Steam Turbines: A Practical and Theoretical Treatise for Engineers and Students," by J. A. Moyer, S.B., M.A. (London; Chapman & Hall.) 3rd edition. Pp. ix.+468. 16s. 6d. net.

Digitized by Google

THE EFFECT OF HEAT ON COTTON AND PAPER.*

BY L. SCHULER.

The German regulations for standardisation state that cotton used for insulating purposes should be able to withstand a temperature of 100°C. without becoming unreasonably fragile. Paper should withstand a temperature of 110°C. Dettmar carried out experiments on which these regulations were based; but they were of rather a primitive kind, though they have justified themselves in the course of the 15 years during which the regulations have been in force. But certain foreign critics have said that these figures were too high; especially it was said that a temperature of 105°C. for paper immersed in oil was excessive. Certain further experiments were, therefore, undertaken by the Elektrotechnische Verein.

For the experiments some raw combed make of yarn (No. 60) was used, and it was carefully heated in hot ovens at prescribed temperatures for long periods. Some of the tests were carried out by heating in oil supplied by the Allgemeine Elektrizitäts Gesellschaft, the proportion of cotton to oil being 1 to 500. Unfortunately, these oil tests led to no result, for the following reasons: After being heated for 100 days in oil at 100°C. the test string, which was 50 metres long, and immersed in oil in a porcelain beaker, was found to be divided into two zones. The zone at the top was of a clear colour, while the lower zone was dark. Thus there seemed to be two zones or layers in the oil to account for this effect. Probably the explanation is to be found in the assumption that the hot oil absorbs oxygen from the air, and this absorption causes the formation of some kind of acid. The acid is naturally formed in the upper layers of the oil. The lower layers of the yarn are less exposed to the action of the acid, partially because the acids become gradually converted into neutral asphalts, which are heavier than the oils and sink to the bottom. Further tests were made by immersion in oil at room temperatures, and these showed no diminution in the mechanical strength of the yarn over lengthened periods.

The behaviour of cotton when heated in the air is explained by the curves in Fig. 1; these results are sufficiently definite and free from objection; but it was thought well to repeat the oil tests, and to protect the oil from atmospheric influences, consequently a new set of tests was devised, to which the following remarks refer: The same raw material in the shape of yarn and oil was used as in the preceding tests, but the oil was heated in glass-stoppered vessels. The yarn was in the form of string, 50 metres long, and the paper in 12 strips, 9 mm. broad and 20 cm. long. Some iron and copper wire was also inserted in order to imitate practical conditions, but was kept from contact either with the yarn or paper or with one another. One of the glass vessels was removed after 20, 40, 70, 100 and 150 days had elapsed. The results are shown in the curves in Figs. 2 and 3.

From these various curves it will be seen that the mechanical strength of paper and yarn tend to reach a stationary value after prolonged immersion in oil. It is, therefore, fair to assume that a machine which has run for 10 days on full load, and has not broken down in the first year, runs little risk of burning out its insulation in the future. The usual guarantee, which covers the first year of working, is sufficient to tide over the period of danger. In order to determine the permissible maximum temperature, it is necessary to know to what extent the mechanical strength can reasonably be diminished. The greatest demands are made on the strength of the insulation during the act of winding. If the winding is successfully carried out a considerable diminution in the mechanical strength is permissible. Perhaps one-half or one-quarter of the original strength would suffice. Let us, by way of assumption, take 40 per cent. as sufficient. Fig. 4 shows the mechanical strength of the insulation as a percentage of its initial value, and as a variable dependent on the temperature. We notice that a fall to 40 per cent. of the initial value of the mechanical strength takes place with cotton, heated in air, at 102 deg. (this is after the cotton has reached a stationary condition in so far as mechanical strength is concerned). Cotton heated in oil can withstand a temperature of 114°C. under similar conditions. Paper heated in oil can withstand 125 deg. These temperatures are higher than those usually prescribed, even when account is taken of the fact that the actual maximum temperature is probably 10 deg. or 15 deg. higher than that measured electrically. The behaviour of paper heated in air was not examined, but probably it corresponds very much to that of cotton. On this assumption, the curve of dotted lines is drawn in Fig. 4.

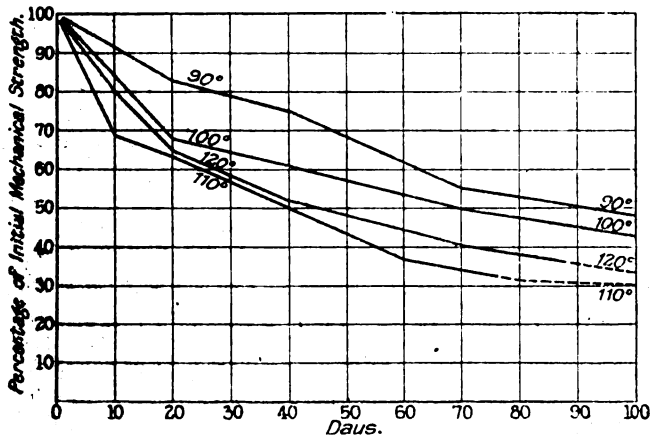


FIG. 1.—EFFECTS ON COTTON BY HEATING IN AIR.

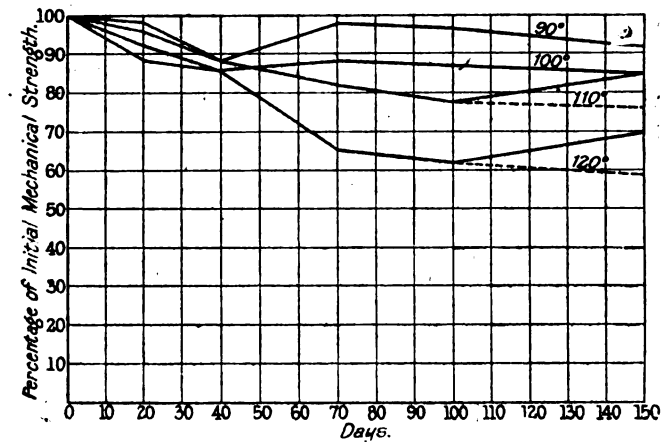


FIG. 3.—CABLE PAPER HEATED IN OIL.

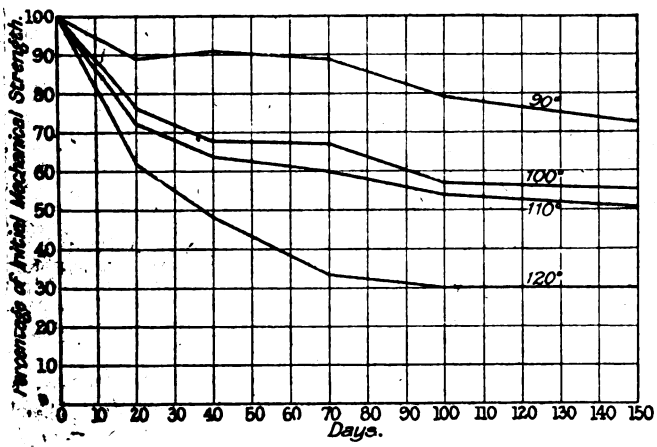


FIG. 2.—EFFECTS ON COTTON HEATED IN OIL.

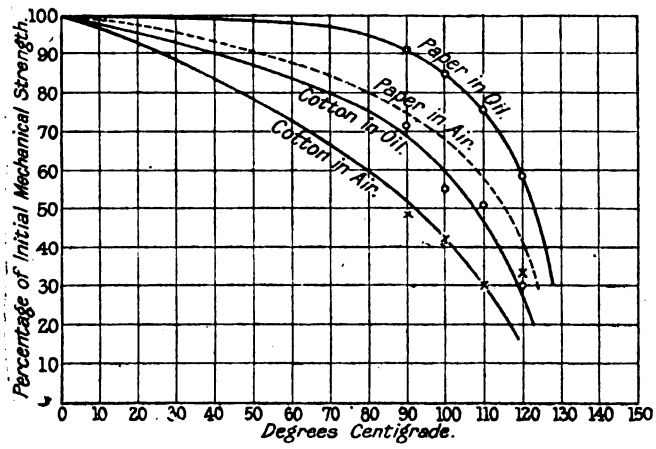


FIG. 4.—MECHANICAL STRENGTH AS DEPENDENT ON TEMPERATURE.

*Abstract of an article in the "Elektrotechnische Zeitschrift, heft 40, 1916.

Digitized by Google

FLYWHEEL LOAD EQUALISERS.

BY M. J. E. TILNEY, A.M.I.E.E.

The interest that has recently been shown in the development of these load equalisers has prompted the writer to look up the results obtained just on 10 years ago with a set which for some months was run on a large tramway system in the Midlands for the purpose of obtaining data as to the power that could be expected to be available in place of the more normal battery and booster arrangement.

The set in question was normally rated at 75 kw., but in practice peaks up to a maximum of 500 amperes at 550 volts were dealt with, and though naturally the machine sparked considerably at these high momentary overloads, the operation of the set was not impaired.

The set consisted of a multipolar machine mounted on an extended bedplate with a plate flywheel weighing approximately 4 tons coupled to the shaft, the flywheel being mounted between two bearings, one of which also took its proportion of the weight of the armature. The flywheel was 8 ft. in diameter, and was built up of two plates riveted together, and, though the makers stated that it had not been balanced in any way, there was never even at the highest speed reached— namely, 1,250 revs. per min.—any sign of vibration. All three bearings of the machine were fitted with continuous ring lubrication, and also with forced lubrication supplied from an eccentric mounted in each journal, which actuated a simple plunger pump feeding on to each end of the bearing.

The machine was fitted with interpoles, and also with two turns of compounding per main pole, this compounding being added subsequently to check a slight tendency to hunt with rapid variations in the load. The shunt field of the machine was controlled by a special auto-regulator devised by the writer, and of which details appeared in the "Proceedings" of the Birmingham Section, I.E.E., in 1906, but certain modifications had in the meantime been introduced which simplified the arrangement, and made it more suitable for controlling this type of machine without the intervention of a booster. The main principle, however, remained the same that the power supplied by the generators should be kept constant, and all variations dealt with by the flywheel set.

The speed variation arranged for was very much in excess of what is usual, being from 550 revs. per min. minimum up to 1,200 maximum.

The machine was so connected to the station 'bus bars that any feeder or combination of feeders could be put on the circuit which it balanced, and which was isolated from the rest of the circuit and the battery, the whole load to the section being metered from the generator to the 'bus bar, and the output to the feeders on that section being also metered; and a recording ammeter was also connected in the supply circuit to the section, so that not only could the results be observed, but when the set was not in use the areas above and below the mean could be taken out and compared with the results, as an average, obtained with the wheel set.

It was very early apparent that up to a certain limit the higher the average load dealt with for a given weight of wheel and a given maximum allowable speed the higher was the efficiency of the combination, and readings were taken on the same combination of feeders with the regulator set for different maximum speeds to determine the best position for the controlling regulator.

The feeders were found to maintain very exactly the same general conditions as regards load from day to day, and the efficiency obtained on one set of feeders on one day would approximate within small limits to the corresponding figures obtained on the same day of the next week.

For certain reasons connected with the supply the exciting current both for the main field coils of the machine and for the controlling coil of the regulator was taken from the lighting 'bus bars at 460 volts, and the average losses in this circuit were found to be 1·8 units per hour. These losses are in every case added to the total units supplied in the following figures:

Date, July 23, 1907.

Time of starting test, 11.55 a.m.; time stopping, 4.55 p.m.
Speed at beginning of test, 990 revs. per min.; at end of test, 820 revs. per min.
Four feeders connected, *Bi, D, Wi,* and *We.*
Total units supplied to section, including losses, 588 kw.-hours.
Units metered out to feeders, 493 kw.-hours.
Efficiency on six hours' run, 84 per cent.

Date, July 25, 1907.

Time of starting test, 2 p.m.; time of stopping, 10 p.m.
Speed at beginning of test, 736 revs. per min.; at end of test, 740 revs. per min.
Four feeders, as before.
Total units to section, including losses, 944·4 kw.-hours.
Units metered to feeders, 809 kw.-hours.
Efficiency on eight hours' run, 85·5 per cent.

Date, July 26, 1907.

Time of starting test, 10.15 a.m.; time stopping, 10.15 p.m.
Speed at beginning of test, 1,050 revs. per min.; at end of test, 1,000 revs. per min.
Four feeders, as before.
Total units to section, 1,494·6 kw.-hours.
Units metered to feeders, 1,266·5 kw.-hours.
Efficiency, 84·7 per cent.

The average load for which the generator was controlled in the section was about 250 amperes at 550 volts, in all the above readings, and the peaks as shown on the recording ammeter for these four feeders when the set was not in use would not exceed about 150 amperes above the average, and the load seldom if ever fell below 120 to 150 amperes. There would be, of course, momentary peaks above the maximum, when, for instance, a car was started on a gradient, but these are not taken into account, as the wheel set appeared to deal with them without any apparent reduction in speed as would have been observed by the movement of the regulator. The longest observed "discharge peak," as shown by the recording ammeter when the set was not in use and of which the area was taken was 230 kw. minutes, and this may be taken as the longest average peak with which the set had to deal before it was to some extent speeded up again by a period of "charge."

In the following month a further series of tests were taken on different combinations of feeders, the set having in the meantime been slightly altered, extra brushes having been added to each line, so as to reduce sparking on peak loads:—

Date, August 19, 1907.

Three feeders, *B, D* and *We.*
Time of starting test, 11.35 a.m.; time stopping, 5.35 p.m.
Speed at beginning of test, 985 revs. per min.; at end of test, 995 revs. per min.
Average load on section, 255 amperes.
Total supply to section, 750 units; delivered to feeders, 620 units.
Efficiency, 82·75 per cent.

Date, August 20, 1907.

Two feeders, *D* and *We.*
Time of starting test, 11.35 a.m.; time of stopping, 5.35 p.m.
Speed at beginning of test, 840 revs. per min.; at end of test, 810 revs. per min.
Average load on section, 145 amperes.
Total supply to section, 484 units; delivered to feeders, 363 units.
Efficiency, 75 per cent.

Date, August 21, 1907.

One feeder only, comprising the heaviest load, with two extremely severe gradients.
Time of starting test, 10 a.m.; time of stopping, 4 p.m.
Speed at beginning of test, 923 revs. per min.; at end of test, 755 revs per min.
Average load on section, 180 amperes.
Total supply to section, 595 units; delivered to feeders, 490 units.
Efficiency, 82·5 per cent.

Date, August 23, 1907.

The original four feeders were again used.
Time of starting of test, 10.15 a.m.; time of stopping, 4.15 p.m.
Speed at beginning of test, 1,000 revs. per min.; at end of test, 875 revs. per min.
Average load on section, 226 amperes.
Total supply to section, 740 units; delivered to feeders, 624 units.
Efficiency, 84·3 per cent.

Digitized by Google

Date, August 27, 1907.

Two feeders, *T* and *NH*. These are the two heaviest feeders on the system, and the peaks were really too heavy for the set.

Time of starting, 11.15 a.m. ; time stopping, 5.15 p.m.

Speed at beginning of test, 950 revs. per min. ; at end of test, 847 revs. per min.

Average load on section, 270 amperes.

Total supply to section, 960 units ; delivered to feeders, 845 units.

Efficiency, 88 per cent.

It may be of interest to note that the energy required to run the set up from rest to 1,000 revs. per min. keeping the current steady at 100 amperes was 7·2 units.

At the end of these short tests the set was left in charge of the switchboard hands, and was started daily at about 7 a.m. and run till 11 p.m., the meters being left in circuit, and the set looking after itself and the load of the four feeders which it was found it dealt with best. A great number of the records of this run, which extended over 14 weeks have unfortunately been lost in a series of removals spread over the past 10 years, but the final results are available as showing that the overall efficiency of the set used in this way over this long period came out to just over 84 per cent.

The use of the machine was finally discontinued, owing to circumstances connected with the Ilgner and other patents, which were at that time held to cover almost any form of flywheel equaliser. It is probable that had the other people with whom the writer was associated at that time been in a financial position to push the matter without fear of the firms which were backing the Ilgner system, more might have been done ; but when the borough engineer, through whose courtesy we had been able to carry on the experiments, required the space occupied, for the purpose of putting down converters, the set had to be dismantled, and though the flywheel itself is almost certainly still in existence, the machine itself or its parts have probably been used for other purposes long ago.

It may be remembered that about this time the Lancashire Dynamo Co. were also offering a flywheel set controlled also on a pure shunt connection, but the speed variation suggested for this and the maximum speeds were far below what we obtained in useful practice, and it seems unfortunate that something cannot be done in this direction to replace batteries for levelling off tramway peaks on outlying feeders by sets of this nature.

The efficiency is far higher than with batteries and the maintenance is a mere fraction ; and with the very large reduction in capital cost which can be made, to say nothing of the small space occupied, there should surely in these days be a movement towards adopting flywheels for this purpose now that their capacities are more generally recognised. The writer has met, almost incredulity, when he has spoken of speeds in the nature of 1,200 revolutions, even for plate wheels, and still more incredulity as to the output obtainable from a small wheel of the dimensions of the one on which these tests were made.

The details of tests given above are merely taken from a very large number spreading over nearly four months, and there were also taken at the same time many miles of record charts from the recording ammeter, showing both the regularity of the average load maintained and also the load peaks above and below the normal, all these records being taken at a speed of about 3 in. to the minute on an Elliot recorder.

THE PROSPECTS OF THE ACCUMULATOR.*

BY DR. LUDWIG STRASSER.

Little importance attaches to the weight of accumulators which are intended to be used in some fixed spot. The length of life, the efficiency, low cost and convenience in attendance are considered of more importance. The output of such an accumulator depends on the rate of discharge. As a rough rule it may be said that a lead accumulator, if discharged in 10 hours, will give double the output in ampere-hours that it would do if discharged in one hour. A reservoir, containing water and used as a source of motive power, gives a definite number of cubic feet of water, independent of the rate of outflow ; so if comparison is to be instituted some basis is necessary, and it is perhaps well to rate the accumulator on what may be called its mean output, which may be taken as its output over a total period of five hours. This five-hour rating will be taken as the basis of our discussion. Let us take a typical make, which gives 3,000 ampere-hours in a five-hour discharge. It weighs without acid 507 kg. ; it would contain 177 litres of dilute sulphuric acid, of specific gravity 1·18, weighing in all 210 kg. ; thus, the total weight is 717 kg. We must add something for the wood framework, on which it stands, and for the insulator sets ; we arrive thus at an approximate weight of 750 kg. The mean voltage of discharge is about 1·9 volts, and the output is, therefore, 5,700 watt-hours. Thus 130 kg. is the weight corresponding to 1 kw.-hour.

On the other hand, there are cases where the weight of the accumulator is of great importance, specially when it is used as the motive power for any kind of vehicle, and is carried by the vehicle itself. At the expense of life and cost, it is possible to make a diminution in the weight of the cell ; in such a case, it becomes a kind of compromise. For use on shunting locomotives, accumulators of the usual standard construction are used, differing only in the style of containing vessel, which is then made of substantial vulcanite. The weight for the kilowatt-hour would then be between 85 kg. and 100 kg. For omnibuses, fire engines and such like, the weight can be still further reduced till it reaches about 50 kg. per kilowatt-hour on the five-hours basis. For motor-cars, a special type is made, contained in thin vulcanite boxes ; the plates are only a few millimetres thick, and consist of thin grids of hard lead, filled with the usual paste. Everything is made as compact as possible ; the specific gravity of the sulphuric acid is generally rather high, and reaches 1·25 in the charged state. For cabs, a cell is used which weighs with acid and connections about 16 kg., and has an output of 50 amperes for five hours. In consequence of the higher specific gravity the mean voltage is also rather high, and reaches about 2 volts ; thus the output is about 500 watt-hours. The weight for 1 kw.-hour is thus about 32 kg., which is little more than a quarter of the type used for central station work.

Let us consider on theoretical grounds how far any further progress is likely to be possible. From the chemical equation, governing the reaction, and the electro-chemical equivalents, we can deduce the minimum amount of material corresponding to an output of 1 ampere-hour. Thus, 3·58 grammes of lead, 4·46 grammes of lead peroxide, 3·66 grammes of sulphuric acid result in the production of 11·3 grammes of lead sulphate and 0·67 grammes of water. Taking the mean voltage as 2, we find that 12 grammes of reacting material are necessary for an output of 2 watt-hours. This is very different from the practical figure. If there is to be a certain mechanical stability the material must be packed so tightly that the electrolyte penetrates with difficulty ; the chemical reaction is therefore slow and incomplete. Moreover, the particles are necessarily coarse, and are superficially covered with lead sulphate, which is, moreover, a non-conductor. The conductivity of the cell can only be maintained by an excess of metallic lead and peroxide. Therefore, about three times the theoretical amount of raw material is needed in practice to maintain the conductivity and to complete the reaction. The same is true of the sulphuric acid, which, for electro-chemical reasons (not here discussed), cannot exceed a certain specific gravity, which is about 35 per cent. of the concentrated acid. Therefore, we require at least three times the weight of the theoretical quantity of acid. But even this is insufficient ; otherwise, as the equation shows, at the end of the reaction, all the acid would be converted into water, which is a non-conductor. Thus, we require at least four times the amount of dilute acid. The weight then becomes about 39 grammes for 2 kw.-hours. Further, taking into account grids, connections, separators containing vessels, &c., we should reach, for the complete cell, a weight of about 26 kg. per kilowatt-hour. This figure represents probably the extreme limit of any practical lead accumulator, unless some new principle should be discovered. The inventions which have been made since the days of Faure have mostly a negative value, and it is useless to enter into a discussion of them. If very porous materials are used, some reduction of weight is possible, but only at the expense of mechanical stability and, therefore, of the life of the cell. (The author gives a brief account of certain suggested improvements, which have been found none the less, to have little practical value). An acid of specific gravity 1·3 has been used on electric cars, but it

*Abstract of an article in the "Elektrotechnische Zeitschrift," Heft 25, 1916. An address delivered before the Elektrotechnische Verein.

Digitized by Google

shortens the life and decreases the efficiency. Taking advantage of every possible means, it is impossible to lower the weight below 20 kg. per kilowatt-hour, which may be taken as the theoretical limit of the lead accumulator. Zinc has been used for the negative plate with lead peroxide in the positive; the zinc is gradually dissolved during the discharge, and must then be replaced as it cannot be effectively recovered from the electrolyte, which also needs to be renewed from time to time. This type of cell is certainly lighter, but it is costly and inconvenient.

Of late years, the alkaline accumulator, due to Edison, has been introduced, the electrolyte being a solution containing 21 per cent. of caustic potash. The cell weighs from 28 kg. to 33 kg. per kilowatt-hour. This is not much better than the lead accumulator as used on cabs. But it has certain advantages, insamuch as it has a longer life, and requires less careful handling. But there are disadvantages notwithstanding. It is much more expensive, takes up more space and has a lower efficiency. If the matter is theoretically considered there are notable differences between the Edison and the lead accumulators. In the case of the Edison cell the electrolyte itself takes no part in the chemical reactions, and is merely present for the purpose of forming a conducting passage between the electrodes. The reaction consists essentially in the transference of hydroxyl groups to the iron electrode; the various hydroxides of iron and nickel are not altogether stable under the different conditions of charge and discharge; consequently one of the effects is that the concentration of the electrolyte changes slightly. The chemical equation governing the main reaction shows that theoretically 1 gramme of iron and 4 grammes of nickel hydroxide are needed for an output of 1 ampere-hour. The mean voltage of discharge is 1·2; therefore, for 1 kw.-hour, 4 kg. of active material would be needed as compared with 6 kg. in the lead accumulator. Further, it ought to be possible to add other conductive substances, so as more effectively to utilise the nickel oxide and iron. But it must be said this has not yet been done; the iron, more especially, is present in great excess in the existing cells. Still, if the problem were sufficiently studied in the light of physical chemistry, it would seem that the conductivity of the cell could be increased. The weight of steel, which is used as framing and pockets, and which is quite considerable in comparison with the weight of the active materials, ought to be able to be reduced; the distance between the plates might be lessened, and therewith the volume of the electrolyte, if more effective separators for the avoidance of short-circuits could be employed. It does not seem theoretically impossible to hope for considerable practical improvement along these lines; we might perhaps reach a weight of 14 kg. per kilowatt-hour, and this might even be possible without unreasonable reduction in the life of the cell.

Many suggestions have been made for the improvement of the Edison cell, which have none the less been quite ineffective. Cadmium has been suggested in place of iron. This idea has been proposed with a view to evading the Edison patent, and is not based on chemical or technical grounds. Networks of thin wire and fine perforated plates may be smeared with active material; such plates could be folded, or rolled or pressed. A specially conductive material was expected to be produced in this way. But it has not yet been shown that any effective result has been produced. In any case it is certain these improvements, even if it is admitted that they are of the nature of improvements, would result in a higher cost of production, and this is already high enough in the case of the Edison cell.

If these results are compared with those given by other sources of power in the form of reservoirs, we find that a waterfall, 10 metres high, would require about 36 tons of water to produce 1 kw.-hour; this is about 300 times the weight of a station accumulator. Take the case of compressed air. The cylinders are undoubtedly heavy; if filled at a pressure of 100 or 200 atmospheres the cylinders weigh from 6 kg. to 10 kg. per kilowatt-hour. If coal is regarded as a source of stored power, it weighs about 2 kg. per kilowatt-hour. But the weight of the water and boiler ought to be included in this connection. With a steam locomotive the weight of coal and water is 16 kg., and of boiler 19 kg. per kilowatt-hour, reckoning the output to be given in one hour. Thus, this gives a total of 35 kg. per kilowatt-hour over one hour, or about 20 kg. per kilowatt-hour, if the output is spread over five hours.

When compared with petrol, the electric accumulator appears in an unfavourable light. Petrol weighs 0·25 kg. per kilowatt-hour; the containing vessel also weighs little, probably 0·5 kg. per kilowatt-hour would include both. The petrol motor can be made far lighter than the best conceivable type of electric motor; therefore, there can be no comparison in this case for the purposes of the flying machine. But for heavy lorry work there is no great difference; the weight of the two types is about the same, and the accumulator-lorry can make a journey of about 80 kilometres before it requires to be re-charged. This distance is sufficient for most practical purposes.

RESEARCH WORK IN THE U.S.A.

The "Electrical World" reports that the National Research Council, formed by the National Academy of Sciences, at the request of the President, is collecting information concerning research men and facilities available in the United States. The information will be used to stimulate investigational activity and co-operation along technical lines, and to aid in the solution of the scientific and technical problems of the Government. While under normal conditions the Research Council will direct its efforts toward the development of research in all its aspects, present conditions demand that special attention be given to the problems of national defence.

An important preliminary step in the work of the Research Council is the preparation of a national census of research, showing the research men and facilities in co-operating Government bureaus, educational institutions, research foundations and industrial research laboratories. To secure information for this census three kinds of blanks have been sent out: (*a*) For educational institutions, (*b*) for industrial laboratories, and (*c*) for institutions other than educational and industrial.

In the blanks sent to educational institutions it is suggested that a research committee be formed in each institution consisting of faculty members, trustees and alumni. Information is asked regarding the available research funds and scholarships, their purpose and limitations as to use. The Council also desires a detailed statement as to the ways and the extent to which the personnel and the facilities of the institution might be available for problems relating to national defence. Questions are also asked regarding the extent to which the members are co-operating with each other or with outside investigators, institutions or manufacturers.

Each department is also encouraged to state problems upon which co-operation is desired and the greatest research needs of the staff, such as time for research, funds for special apparatus or materials, library facilities, contact with other investigators, financial aid for attending scientific meetings, leave of absence to pursue research, &c.

The blanks which were sent to industrial establishments ask for the names and titles of persons who direct research work, the organisation of laboratory staff and problems which they are especially fitted to undertake by reason of unusual equipment and trained personnel. In addition, the Council asks to what extent the particular laboratory is co-operating with other establishments, and whether or not the Council may be of service to it in connection with military problems. Among subjects that the Council is investigating and on which it desires information are the following:—

Physics (Dr. R. A. Millikan, chairman).—Exhaustive study of devices for detecting completely submerged submarines and mines; range finders of various types; devices for detecting invisible aircraft and sapping parties; improvements in wireless apparatus and other instruments used with aircraft; military photography.

Chemistry (Dr. Marston T. Bogert, chairman).—Generation, detection and absorption of hydrogen, and problems incidental thereto; absorption of other gases, particularly noxious ones; fire extinguishers; prevention of corrosion and electrolytic action on the hulls of vessels; non-corrosive metals and alloys for a great variety of uses; balloon fabrics; new explosives; new sources of important products; utilisation of wastes and by-products.

Engineering (Gano Dunn, chairman).—This committee, which will organise research in the various branches of engineering, has just been formed with the co-operation of the engineering societies.

Nitrate Supply (Dr. Arthur A. Noyes, chairman).—This committee, which was appointed at the request of the Secretary of War to consider the process to be used by the Government in its plant for producing nitrates for explosives and fertilisers, has submitted a report.

The sub-committee on research of the National Electric Light Association has made an investigation of the possibilities of co-operative research between utilities and institutions having research facilities. As a result of correspondence and conference a large number of problems were suggested, the solution of which is of utmost importance.

A few of the more important subjects are as follows: (1) Fuel economies; (2) characteristics of steel conductors; (3) increasing of load factors by nitrate plants; (4) determination of all combinations of transformer loading, and publication of tables showing their effect on apparatus, both transformer and motor; (5) incipient faults in insulators; (6) sludging of transformer oils and determination of their relative values; (7) causes and suppression of surges on long lightly loaded lines; (8) overhead line and underground cable insulation for high voltages; (9) protection of lines and equipment against high voltage, high frequency and high power, low-frequency disturbances; (10) perfection of high-voltage insulators; (11) depths and bearing surfaces of guy anchors in various oils; and (12) inductive interference.

Digitized by Google

ELECTRIC VEHICLES IN MUNICIPAL SERVICE.

A report on the results obtained from a one-ton Edison lorry by the Manchester Corporation electricity department has been issued. The report was prepared by the city electrical engineer (Mr. S. L. Pearce) from information compiled by Mr. H. A. Ratcliff.

The total number of miles run was 10,486 (10,376 on weekdays and 110 on Sundays); the number of hours in commission was 3,036·5 and of days in commission 312 (including seven Sundays).

The total costs for the year (exclusive of tyres and current) were: wages, £115. 14s. 11d,; material, £24. 16s 3d.; and capital charges, £124. 9s.; a total of £265. 0s. 2d. The first charge includes (in addition to drivers' wages) the cost of the labour spent on maintenance and repairs. The cost of material appears to be rather high, but it includes an item of £6. 10s. for a duplicate set of chains, which should strictly be a capital charge; chain renewals would, of course, be charged to running costs. Other outstanding items are: Lubricants £6. 7s. 11d., paraffin £1. 3s., rags £1. 5s. 11d., "Ferodo" brake lining £2. 13s. 2d., and distilled water £1. 7s. 11d.

Average miles per hour maintained during the year, based on the total hours in commission, and including all loading and unloading time, in addition to the actual hours on the road = 10,486/3,036·5 = 3·45 miles per hour.

ANALYSIS OF COST.

The total costs as above = £265. 0s. 2d. = 63,602 pence; therefore, cost per mile run = 63,602/10,486 = 6·07d. To this figure has to be added cost of tyres and current. The tyres have now completed the guaranteed "life" of 12,000 miles, and they cost £25 the set. The cost per mile therefore = £25 × 240/12,000 = 0·5d. The current consumption during the winter months was rather higher than the figure given in previous reports on the work of the lorry, but the average for the 12 months (including the motor-generator losses) was only 1·08 units per mile, which at 0·5d. per unit = 0·54d. per mile. The total costs per mile run are therefore:—

Wages and capital charges, &c.	6·07d.
Current	0·54d.
Tyres	0·50d.
	7·11d.

And the total costs for the year are:—

Capital charges, insurance, &c.	£124 9 0
Wages	115 14 11
Material	24 16 3
Current—10,486 miles at 0·54d.	23 11 10
Tyres—10,486 miles at 0·50d.	21 16 11
	£310 8 11

The total cost of 7·11d. per mile run may now be analysed in rather more detail. For the period in question the average rate of pay to the drivers may be taken as approximately 7¼d. per hour. Then since the average speed over the whole year was 3·45 miles per hour, the cost of driving = 7·5/3·45 = 2·17d. per mile; the capital charges = £124. 9s. = 29·868d.; and therefore the proportion per mile = 29,868/10,486 = 2·85d.

The sum of these two items, together with the cost of tyres and current = 6·06d.; therefore, the difference between this amount and 7·11d. obviously represents the cost of maintenance.

The complete analysis of the cost per mile then becomes:—

Capital charges, insurance and drivers' licences	2·85d.
Drivers' wages	2·17d.
Maintenance of vehicle and battery, including lubricants (material 0·57d., labour 0·48d.)	1·05d.
Current	0·54d.
Tyres	0·50d.
	7·11d.

These figures are based on interest at 4½ per cent. and 0·5d. per unit for current; but, in order to provide a better comparison with results obtained elsewhere and with present-day conditions, a set of alternative costs have been prepared, based on 5 per cent. interest and 1d. per unit:—

Capital charges, &c.	2·93d.
Drivers' wages	2·17d.
Maintenance (material 0·57d., labour 0·48d.)	1·05d.
Current	1·08d.
Tyres	0·50d.
	7·73d.

This figure of 7·73d. per mile compares very favourably with the cost of petrol vehicles. It is, moreover, based on annual capital charges amounting to £127. 16s. 7d., or approximately 18·9 per cent. of the original cost of the vehicle. The £127. 16s. 7d. includes £10 for insurance and 10s. for drivers' licences. The total amount of the interest and repayment charges is, therefore, £117. 6s. 7d., or 17·4 per cent. of the cost of the vehicle. At 4½ per cent. interest the corresponding amounts are: Total charges £113. 19s., and percentage of purchase price 16·86.

The estimated cost of maintenance was 1d. per mile, and there is no doubt that this figure would not have been exceeded had it not been for the trouble experienced with the defective chains and sprockets. The high cost of lubricants is also to a large extent due to the same cause. All cleaning, overhauling and repairing has been done, as a rule on Saturday afternoons, and occasionally at night and on Sundays. The consequent overtime naturally increased the maintenance costs; but had the vehicle been out of commission during normal working hours the resulting loss and disorganisation would have been a more serious matter. As the public holidays were the only days (other than Sundays) on which the vehicle was not actively employed, the full year has been taken as the equivalent of 51 weeks. The normal working week has been taken as 5·5 days.

Neglecting Sunday work, the average miles run per week	= 10,376/51 = 203·4
And the average miles per day	= 203·4/5·5 = 37
The average hours per week the vehicle was in commission, again neglecting Sunday	= 2,988/51 = 58·6

or 5·6 hours more than the normal working week of 53 hours. The average of 3·45 miles per hour includes all standing time whilst in commission. The actual speed on the road has averaged almost exactly eight miles per hour, being slightly more during the summer and slightly less during the winter months. The greater portion of the mileage is run within the city area, and consequently a much higher speed would not be permissible, even if possible. Despite the exceptionally severe winter, the vehicle has never been kept off the road on account of weather conditions, and it has actually gone out after heavy snowfalls when horses were unable to make headway. This and the total number of days in commission are a sufficient indication of the reliability factor. The average load on "outward" journeys was 13·3 cwt., and on "inward" journeys 6·1 cwt., an average of 9·7 cwt. for "outward" and "inward" journeys. This figure, however, takes no account of loads carried between intermediate points:—

The total average ton miles per week	= 9·7/20 × 203·4 = 98·65
And the average cost per ton mile ...	= 7·11 × 20/9·7 = 14·66d.

COMPARISON OF ELECTRIC AND HORSE COSTS.

Up to January last the charge for a light one-horse lorry and driver was 1s. 6d. per hour, but since then it has been increased to 1s. 8d. per hour. The lower value has, however, been taken for the purpose of the following comparison. Previous estimates assumed an average speed of two miles per hour for the horse lorries. On a mileage basis alone, therefore, the electric has been the equivalent of 3·45/2 = 1·73 horse lorries; but in addition there is the further saving resulting from the organisation possible with a centrally-controlled electric vehicle. This is represented by the "Organisation Factor," the average value of which for the year has been 1·58—*i.e.*, 1·58 departments have been represented on every journey the vehicle has undertaken. The electric should, therefore, be the equivalent of 1·73 + 1·58 = 2·73 horse lorries; but as the several departments concerned may not have been represented on the whole of the miles run per journey, and admitting the possibility of a slight amount of organisation with the horse vehicles, this ratio has, in order to be on the safe side, been reduced to 2·5. This is the comparative figure given in the previous report of June 21, 1916, and in the opinion of those competent to judge, it is a very reasonable estimate of the relative values of the electric and horse vehicles. The cost of the electric per hour = 3·45 + 7·11 = 24·5d., and on the above basis the relative costs per week are therefore:—

Horse, 58·6 × 2·5 × 18d.	= £10 19 10
Electric, 58·6 × 24·5d.	= 5 19 7
Saving due to electric	£5 0 3

For a working year of 51 weeks the saving due to the electric therefore = 51 + 5 = £255.

The first cost of the electric vehicle was £675. 15s. There is no doubt that this saving has actually been effected, and further confirmation of it may be obtained from the following figures: The cost of the equivalent horse lorries has been shown to be equal to £11 per week which for a working year of 51 weeks gives a total of £561, and this amount should equal the reduction on the carting account as compared with the previous year, other conditions, of course, being equal. The total amount of carting contractors' accounts for year March, 1916, was £1,715. 17s. 10d., and for the year ended March, 1917, £1,185. 1s. 11d., a reduction of £530. 15s. 11d., or, roughly, £531, which is in very close agreement with the above estimate. It may possibly be argued that there was not as much carting work during the second year as during the first, but such does not appear to have been the case to any great extent, and any decrease in the ordinary carting has been partly counterbalanced by the increased amount of carting to and from the railway stations necessitated by the inability of the railway companies to handle material, and possibly more than counterbalanced by the fact that the contract price for the year ended March, 1917, was 2d. per hour more than during the year ended March, 1916, and consequently the actual reduction of £531 is less than it otherwise would have been. It may also be observed, as a matter of interest, that when in commission the "standing" cost of the electric has been less than that of the horse lorries. The actual costs being: Horse lorry and driver = 18d. per hour, electric lorry and driver (2·85 + 2·17) × 3·45 = 17·32d. per hour.

In conclusion, it is obvious from the total hours worked and miles run that the vehicle has been actively employed, with the result that our carting methods have been revolutionised. Much more, however, still remains to be done, and no doubt the five-ton wagon now on order will enable further economies to be effected, but there are opportunities in other directions.

Digitized by Google

STANDARD METHODS OF TESTING MOULDED INSULATION.

The following is an abstract of the Standards Committee Bulletin No. 1, issued by the Associated Manufacturers of Electrical Supplies in New York. The committee consists of representatives of the Westinghouse Electric & Mfg. Co., the Cutler-Hammer Mfg. Co., Boonton Rubber Mfg. Co., the General Electric Co., the B. F. Goodrich Co., and Johns-Pratt Co.

A classification is given of the more important properties of moulded insulation, and it is pointed out that the committee has begun its work by selecting from this list only those items for st n-dard tests which have the best standing at the present time.

(A) ELECTRICAL.

DIELECTRIC STRENGTH, OR HIGH-POTENTIAL BREAKDOWN TESTS.

Standard Test Piece No. 1.—The Standard test piece is of the form and dimensions shown in Fig. 1, and is made in a mould which is hardened and ground to these dimensions.

Apparatus.—The alternating current should be of sine wave form as far as possible. The transformer and source of energy should be ample, in any case not less than 5 k.v.a. The frequency should not exceed 100 periods per second. Any method of regulating the voltage satisfactorily may be used, provided that it does not distort the wave more than 10 per cent. When the puncture occurs it is desirable to have as much energy available as possible. It is recommended to include choke coils in the circuit, so as to limit the high-tension current to double the normal rating of the transformer.

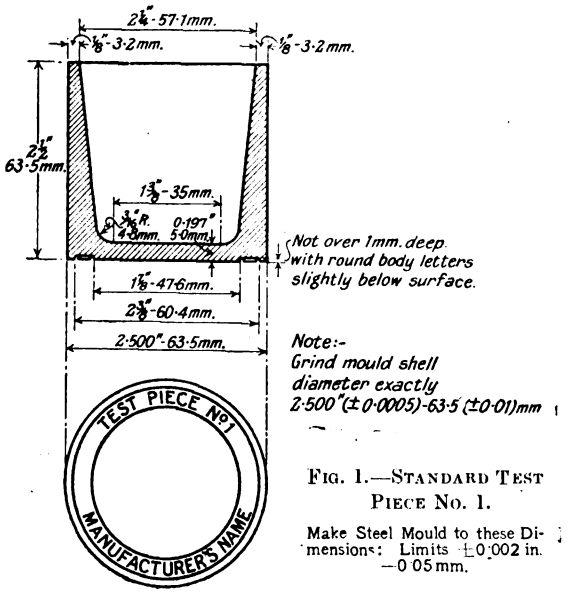


FIG. 1.—STANDARD TEST PIECE No. 1.

Make Steel Mould to these Dimensions: Limits ±0·002 in. —0·05 mm.

Method of Making the Test.—The test cup is floated on mercury with about 3 mm. (⅛ in.) of mercury inside. If it is impossible to puncture the cup in air without arcing over the edge, the cup is deeply immersed in high-grade transformer oil. On test pieces which require a very high voltage to puncture it is often necessary to put a glass tube or shield over the wire leading to the inside of the cup, in order to prevent breakdown over the surface of the oil between terminals. The testing voltage should be raised from zero at a constant rate of approximately 1,000 volts per second until puncture occurs.

Ten cups should be punctured in the condition received, and at normal room temperature of about 21°C. (70°F.) in order to determine the uniformity of the moulded material. Five cups should be punctured after heating for one hour in an oven heated to 10 deg. below the softening point of the material, as determined by Standard Test C. Puncture tests should be made at this temperature with an allowed variation of plus or minus 5 per cent. This test is intended to cover all moulded materials which do not stand working temperatures above 125°C. (257°F.). Tests on materials which resist very high temperatures may be made above 125°C. when necessary.

Five cups should be punctured after they have been entirely immersed in distilled water for 48 hours at normal room temperature of about 21°C. (70°F.). The surface of the cup should be wiped with a dry cloth to remove all trace of excessive surface moisture, and the puncture test made in oil when necessary and at normal room temperature.

In reporting the test, the thickness of the cup is measured in a direction perpendicular to the bottom surface regardless of the path taken by the discharge. The puncture voltage is to be given; also the average volts per mil and per millimetre. If puncture occurs at the side, the voltage per unit of thickness withstood by the bottom section is to be stated.

(B) MECHANICAL.

1. TENSILE STRENGTH TESTS.

Standard Test Piece No. 2.—To be moulded from a hardened and ground steel mould to the dimensions given in Fig. 2.

Clip Detail for Test Piece No. 2. Two Required if Hardened Steel.

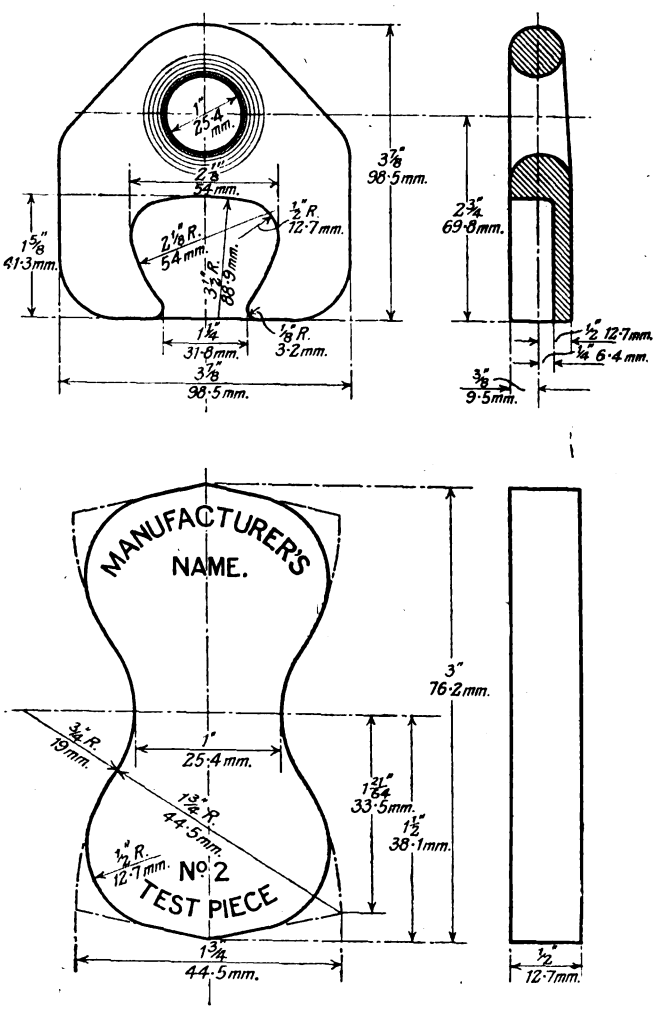


FIG. 2.—STANDARD TEST PIECE No. 2.

Make Steel Mould to these Dimensions: Limits ±0·002 in.—0·05 mm.

Method of Making the Test.—For the test any standard testing machine is used, transverse strain being avoided. The test piece is to be pulled apart at a speed of from 3 mm. to 6 mm. per minute at a normal temperature of 21°C. Six standard test pieces are to be tested in the condition in which they are received. Three standard test pieces are to be tested after heating in an oven for one hour at a temperature which is 10° below the softening point of the material as determined by standard test C. The test is to be made while the pieces are hot, with an allowed variation of plus or minus 5 per cent. from the temperature taken. Three standard test pieces are also tested after being entirely immersed in distilled water for 48 hours at normal room temperature. The excess water is removed by wiping with a dry cloth. In reporting the test, measurements should be included on test pieces before and after heating and before and after immersion in water.

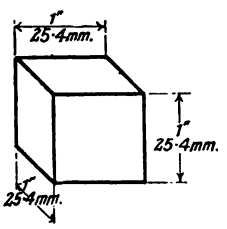


FIG. 3.—STANDARD TEST PIECE No. 3.

Manufacturer's Name and Test Piece No. 3 moulded near Top in small, round body-raised letters.

2. COMPRESSIVE STRENGTH TEST.

Standard Test Piece No. 3.—To be moulded in the form of a cube from a hardened steel mould to the dimensions shown in Fig. 3.

Digitized by Google

Method of Making the Test.—The load is to be applied at a constant rate, not over 3 mm. per minute from zero until the test piece is crushed. Six standard test pieces to be crushed in the condition in which they are received. Three standard test pieces to be crushed after heating for one hour in an oven heated 10 deg. below the softening point of the material as determined by standard test C. This test to be made while the pieces are hot with an allowed variation of plus or minus 5 per cent. from the temperature taken. Three standard test pieces to be crushed after immersion in distilled water for 48 hours, the excess water being wiped off with a dry cloth. The compressive strength tests to be made at normal room temperature of 21°. Tests on materials which resist very high temperatures may be made above 125°C., but the hot test given above is only intended to cover moulded materials which do not stand working temperatures above 125°C.

3. TRANSVERSE STRENGTH TEST.

Standard Test Piece No. 4.—To be moulded from a hardened steel mould ground to the dimensions shown in Fig. 4.

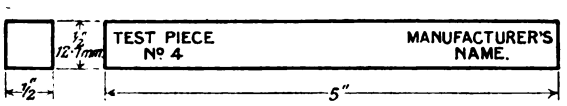


FIG. 4.—STANDARD TEST PIECE NO. 4.

Make steel mould to these dimensions: Limits ±0·002 in. - 0·05 mm.

Method of Making the Test.—Any standard testing machine may be used. The test piece is supported on two steel blocks, with corners rounded 1½ mm. (1/16 in.) radius. These supports are to be 100 mm. (4 in.) apart. The load is applied on top of the test piece by means of a wedge-shaped pressure piece, the edge of which is rounded to a 3 mm. (⅛ in.) radius, extending across the test piece with the edge parallel to the edges of the two supports. The angle of the wedge is approximately 45 deg., and the load is applied at right angles to the test piece, midway between the supports. The test piece is laid flat upon the supports at equal distances from the edges at each end.

Six standard test pieces are to be broken in the condition in which they are received. Three standard test pieces to be broken after immersion in distilled water, at ordinary room temperature, for 48

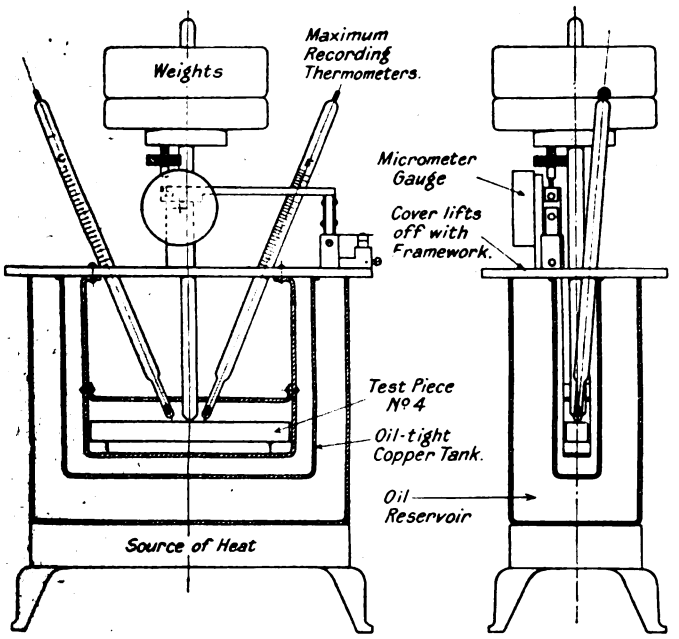


FIG. 5.—MACHINE FOR TEMPERATURE TESTS.

hours, the excess water being wiped off with a dry cloth. All tests to be at room temperature of about 21°C. The load to be applied at the rate of approximately 3 mm. per minute from no-load until the first sign of failure.

In reporting the test, the average fibre strains to be given in kilogrammes per square cm. or in pounds per square inch, calculated from the formula :—

$$S=3PL/2BD^2,$$

in which S=fibre stress, P=load applied, L=distance between the supports, B=width of test piece and D=depth of test piece.

(C) TEMPERATURE.

DISTORTION UNDER HEAT.

Standard Test Piece No. 4.—To be the same as shown in Fig. 4.

Method of Making the Test.—A special apparatus is to be used for this test. The test piece is supported on steel supports 100 mm. (4 in.) apart, with the load applied on top of the test piece vertically and midway between the supports, the same as for the transverse test. The machine is arranged to apply three different loads, 2½ kilos (5½ lb.), 5 kilos (11 lb.), and 10 kilos (22 lb.). The test piece is placed in an air bath, surrounded by an oil bath, which is so arranged that its temperature may be raised gradually. The machine is so arranged that the deflection of the test piece at its centre between the supports can be measured on a scale in millimetres or mils, and is equipped with a thermometer, so that the temperature of the test piece can be recorded at any time. The machine may be arranged to shut off the heat automatically as soon as a given deflection is reached.

Three standard test pieces to be tested as received, starting at normal room temperature of 21°C., increasing the temperature at the rate of approximately 1°C. every two minutes. The distorting point it taken to be the temperature at which the test piece has deflected

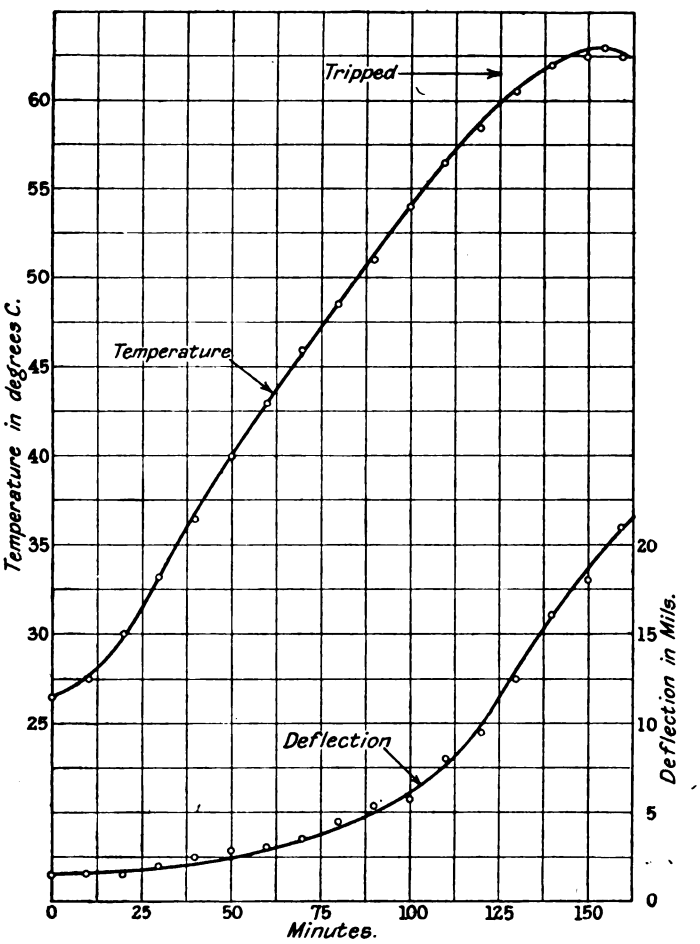


FIG. 6.—CURVES FROM TEMPERATURE TEST C. TEST PIECE NO. 4.

0·3 mm. (10 mils) at the centre between the supports. The test is reported by giving the distorting point, the length of time required, and by plotting a curve for each test piece as shown in Fig. 6.

(D) CHEMICAL.

ABSORPTION OF MOISTURE.

Standard Test Piece No. 1.—The standard test cup to be used as shown in Fig. 1.

Method of Making the Test.—Weigh carefully three test cups in the condition in which they are received. If the material softens readily at moderate temperatures, the test pieces may be placed in a desiccator, or in an oven at a temperature of 50°C. (122°F.) for 48 hours. For materials which do not soften readily the test pieces are placed in an oven heated to 100°C. (212°F.) for 48 hours. After drying, the test piece is weighed again at normal room temperature. Remove the test pieces at the end of 12, 24, 36 and 48 hours, wipe off all excess surface water with a dry cloth and weigh carefully.

In reporting the test, state the percentage of moisture contained in each test cup as received, and the percentage of moisture absorbed during each interval, taking the dry weight as 100 per cent.

Digitized by Google

The Electrician.

FRIDAY, JULY 20th, 1917.

Editorial and Publishing Offices:—

8, BOUVERIE STREET, LONDON, E.C. 4.

Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

THE RIGHT MAN IN THE RIGHT PLACE.

We believe it was Mr. JOSEPH CHAMBERLAIN who, during the dark days of the South African war, said he had no doubt that the country would be able to "muddle through to victory."

Within a stone's throw of Westminster there are probably a hundred middle-aged consulting engineers who would welcome an opportunity of helping to win the war by engaging on work for which they have been trained. Within the Empire there are some thousands of such men. Of the number, perhaps not more than half a dozen enrolled under the National Service scheme. Being a consulting engineer in Westminster, whatever else it means, certainly does mean that the consultant is a man of average intelligence. Parenthetically we would observe, and we think that most of our readers will agree, that it requires at least average intelligence for an individual to earn a living wage when his competitors—the manufacturers—are in a position to employ, as whole-time servants, specialists on every subject with which they have to deal.

We say that these men did not enrol under the National Service scheme because they knew that to do so would really be doing a disservice to the country by perpetuating conditions known to be bad. Platform and pulpit oratory notwithstanding, the scheme has so far proved to be of little value, and the cost is said to have been close upon a quarter of a million sterling.

The official way of enrolling the engineering talent of the country is to grant commissions to young persons of robust health, and of little or no engineering experience; to provide the commissioned with wearing apparel (which it would take them a year to earn), and to turn them loose into the workshops of harassed contractors as Inspectors of Materials at a salary of 22s. 6d. per day. This, when multiplied by 365, amounts to £410 odd per official per year, which is practically on a par with the salary paid to a Member of Parliament. Knowing this to be the truth we know why we are paying close upon eight millions a day on the war. An outside estimate of the real value of the services of the men actually appointed to fill such important positions is from 12 to 15 shillings per week as juniors on the bottom rung of the engineering ladder. When peace is proclaimed these self-same "inspectors" will be lucky to find employment in the works, in order to learn engineering, and to be paid 15 shillings a week while they are being taught by those whose work they now have the presumption or impudence to criticise.

It is, or it should be, within the powers of Parliament to call for a return showing the pre-war experience and training of the pseudo inspectors, engineers and the like employed in large numbers by the various buying departments of the State. Should such a return be insisted upon we urge Parliament to appoint a committee consisting of the Presidents of the Engineering Institutions for the purpose of properly classifying the returns and of reporting upon them. It would be impossible to find a more highly qualified body of men for the task. We venture to think that the work would be quickly and efficiently carried out, and that it would be willingly undertaken. Such a report should be confidential.

Faced with a task without parallel in history it is natural that mistakes without parallel in history should be made. Lack of experience and absence of data, which experience alone can furnish, account for most of the mistakes that are made in every sphere of human activity.

Without entering into details, and surely the details will be fresh in the memories of many people when the present century is drawing to a close, it is patent that the amateur, be he never so enthusiastic, is a positive danger to the country when it comes to issuing commands on which human lives depend. The debt we owe to those who have fallen is that henceforth we will strive unceasingly towards efficiency. To become efficient it is necessary, above all things, to try and put the right man in the right place. As yet this has not been seriously attempted. The present system of giving high-salaried appointments to those who are little more than boys, apart from the truly awful waste of so doing, is likely to do incalculable harm in the future when these young men find, as they will find, that their time value in the labour market is a few shillings per week.

As a beginning we would have Parliament make it illegal for any man of military age and fit for general service to hold, except with good and sufficient reasons, an appointment as a non-combatant in a Government department. Under no conditions whatsoever would we allow a man of military age and without previous training to hold an engineering appointment under the Government. And we would call upon the engineering institutions to supply the men to fill such appointments. Under present conditions the people of the country are asked to pay and at the same time to be silent. Does not the reader feel that there may come a time when the people will do neither unless proofs are forthcoming that they are getting value for money? The only way of getting value for money is to put the right man in the right place; or, in other words, to do as the engineer does, namely, to use materials, all more or less unsuitable, to the best advantage for the work in hand.

REVIEWS.

Lecons sur le Fonctionnement des Groupes Electrogènes en Régime Troublé. By L. BARBILLION. (Paris: Gauthier-Villars et Cie.) Pp. 306. 11 fr.

The volume under notice constitutes the subject matter of a course of lessons given by Prof. Barbillion, at the University of Grenoble, during the academic year 1912-13. The author has made a special study of problems connected with the speed control of electric generating sets, and has previously contributed to the literature of the subject in "L'Encyclopédie Électrotechnique" (Geisler, Parts 38 and 39). In the present volume, however, Prof. Barbillion has employed, to a much greater extent than heretofore, graphical methods of representing the phenomena concerned, and of explaining the action of the various governing devices met with in modern practice.

Nevertheless, the subject is such that a certain mathematical knowledge is essential to its complete understanding, and, in spite of the large use of graphical methods, there is a considerable amount of mathematics for the reader to digest in the present volume. So much is this the case, that one is forced to the conclusion that the students to whom these lessons were given were expected to possess mathematical knowledge of a

Digitized by Google

higher order than would be customary in this country, even in advanced courses. Other Continental text-books also tend to give the impression that a higher mathematical attainment is expected of the student of electrical engineering abroad than at home. Now, it is of prime importance that students should obtain a thorough grasp of physical facts, and, no doubt, to the average student an abundance of mathematics obscures rather than illuminates such facts. But, in order to deal fully with the complex problems which arise in modern electrical engineering practice, a first-rate mathematical knowledge is essential, and it is for our universities to see that not only is the average student catered for, but that, in addition, full scope is given to engineering students of marked mathematical ability.

It is not necessary to give here a catalogue of the subjects covered in these lessons. Suffice to say that the whole theory of the governing of electric generating sets, the oscillations set up and the methods of damping them out, and the various systems, direct and indirect, of speed control, are dealt with in a very complete and thorough manner. The treatment throughout is uniform and balanced, and the diagrams are excellent. So far as we have noticed, the misprints—which are to be expected in a first edition—are remarkably few, and the book is produced in a manner well in keeping with the high standard customary with Gauthier-Villars' productions.

The work is a valuable contribution to the literature of the subject, and should be studied by all those who have to deal with problems connected with the governing of electric generating sets. It is of no use to those who wish to obtain mechanical details of the various governing devices in present use.

A. E. CLAYTON.

Wiring of Finished Buildings. By TERRELL CROFT. (London: The Hill Publishing Co.) Pp. xi.+275. 8s. 4d.

Although the central station engineer and the wiring contractor may find some points of considerable interest in this volume, it applies essentially to American conditions. The author refers in the first instance to methods of publicity and the running of campaigns solely to secure business for the central station by means of wiring. Five chapters are occupied with this part of the subject, and a chapter is also devoted to approximate costs to enable estimates to be made rapidly. The remainder of the book deals with purely technical matters, namely, various methods of wiring, planning of installations and the tools required for carrying out the work. The use of flexible metallic tubing is noticeable in combination with ordinary conduit, and no doubt leads to a considerable saving in labour. This method has not found favour in Great Britain, possibly due to the fact that our buildings are more solid than those which would be found in the average American town. Some description is given of the knob and tube methods and of ordinary wood casing. In the brief account of European methods we notice the statement that a very large proportion, possibly 50 per cent., of wiring in England is on the slip joint tube method. The author is evidently unaware of the fact that this method is no longer recognised by the Institution of Electrical Engineers. In chapter 9 various tools and dodges are described, but these chiefly have reference to the character of work required in wooden buildings. They involve such devices as the "snake" and "mouse," and we can imagine they would give rise to much undesirable work if not kept under close supervision.

ELECTRIC VEHICLES AND THEIR USE ON CLEANSING WORK IN SHEFFIELD.*

BY J. A. PRIESTLEY.

Briefly, the advantages of the electric vehicle for cleansing purposes are: (*a*) That its motive power is ready to hand, particularly in those departments possessing a destructor; (*b*) the economy of motive power whilst standing; (*c*) the ease of starting; (*d*) the noiselessness; (*e*) the fewness of its working parts; and (*f*) the ease with which an unskilled man can learn to handle the machine. With petrol prices and restrictions so much in evidence, and coal and coke so difficult to obtain, (*a*) requires no elaboration. In work which is made up of stoppages every few yards for loading, (*b*) and (*c*) are self-evident advantages; (*d*) is of considerable importance where night work is carried out; whilst (*e*) and (*f*) require no argument with any cleansing superintendent who looks upon the havoc war has played with his staff.

As a result of extensive inquiries and examination of various makes of vehicles, my Council appointed a committee, which unanimously recommended the purchase of an Edison battery vehicle of 2 tons capacity, and this was delivered and commenced work in September, 1915, and has been at work continuously ever since. A few weeks' trial of the first vehicle proved so satisfactory that a second was ordered and delivered in January, 1916, a third was delivered in May, 1916, a fourth in November, 1916, and a fifth in December, 1916. Five further vehicles were then ordered, and three of these are now at work, and a total fleet of 10 vehicles will probably be operating before this Paper is read. These facts indicate, without any comment, what Sheffield thinks about "electrics."

So far as I am familiar with conditions in other districts, I know of no place where those relating to bin refuse collection are less favourable to the use of motors than in Sheffield. With horse wagons there are two men—a driver and labourer—and both help to load. With "electrics" there are three labourers, and a driver who only loads occasionally. In each case the labourers accompany the vehicle to tip. The costs given hereafter for bin refuse, both in the case of horse and "electric," include all labour in collecting. Ashpits, both wet and dry, are emptied by "getters-out," who are paid at piece rates. The costs given in the case of ashpit refuse do not include getting out, but represent the cost of loading and removal only. The weekly wages at present paid for each class of workmen, including bonuses, is electric vehicle drivers 46s.; electric vehicle labourers, 43s.; horsemen, 41s.; and horse wagon labourers, 38s. In calculating the cost of horse labour, I have taken 13s. 6d. per day as the value of horse, carter and wagon, a figure which cannot be challenged as inflated, I am sure, and to this is added the actual wages paid for labourers.

The working costs of the "electrics" include (1) wages, (2) vehicle costs, (3) tyres and (4) electricity. The first item is the actual amount paid during the period under review. The second includes (*a*) interest and depreciation based on 10 years' life, (*b*) insurance, (*c*) garage, watering, cleaning and charging; (*d*) waste, oil, grease &c., and (*e*) repairs and renewals. The third is the actual cost under a maintenance contract, and the fourth is the amount charged against the vehicles for the current supplied from the destructors, and represents an interdepartmental profit.

The details of the vehicle costs are:—

(*a*) Interest and depreciation—10 years' life	£123	5	10
(*b*) Insurance	8	10	0
(*c*) Garage, cleaning, charging and watering	25	2	8
(*d*) Waste, oil, grease, &c.	6	10	0
(*e*) Repairs and renewals.....	43	2	0
	£206	10	6

or £3. 19s. 6d. per week divided equally between day and night work.

Taking these items seriatim:—

(*a*) The basis of 10 years' life may be challenged as too optimistic, especially by those familiar only with the life of petrol wagons. So far from this being the case, I think the estimate is fully justified for the following reasons:—

1. One-half the cost of the vehicle is represented by the battery, and this is guaranteed to give 100 per cent. of its original efficiency after eight years' constant service, and any defects not due to misuse are made good by the makers during such period. If a battery will do this at the end of eight years' service, it is not unreasonable to expect a further two years' working life, and in America, where the battery vehicle has been much more extensively used than in this country, there are batteries in use after even longer periods of service.

2. The electric vehicle cannot be compared with steam or petrol vehicles, as there are less working parts. There are no boilers, cylinders, valves, cranks, pistons, clutches or gears, all of which are liable to quick wear. The life of a vehicle with less parts to wear must necessarily be longer.

* Abstract of a Paper read before the Institute of Cleansing Superintendents, July 10, 1917.

Digitized by Google

3. The electrical drive subjects the vehicle to very much less strain and shock in starting or speed changing.

4. The provision for repairs and renewals represents about 10 per cent. on the cost of chassis, less battery and tyres, and allows, therefore, for complete renewal of the entire machine, less these items, in the 10 years' period.

5. Although the vehicles are used for both day and night service, the total mileage per week is very low, and nearly one-half of this mileage is run without load. On this basis, therefore, 10 years' life does not represent hard service.

(*b*) Is the actual cost.

(*c*) (*d*) are the costs per vehicle year based on present experience.

(*e*) Is based on our experience with the first vehicle, and is more liberal than appears necessary with later vehicles. It is retained, however, for reason 4 given above. A number of weaknesses found in the first machine have been corrected in later models.

I have not taken into account the whole performance of each vehicle since it was put into service, but have confined myself principally to the period March 26, 1916, to March 25, 1917, during which five "electrics" were in service for periods varying from one year to three months. In this year 51,498 tons, 15 cwt. 1 qr. of bin refuse were collected by horses at a cost of 5s. 5·4d. per ton, and 7,040 tons, 11 cwt. by "electrics" at a cost of 4s. 9·8d. per ton. Of ashpit refuse, 27,877 tons, 12 cwt. were collected by horses at a cost of 3s. 8·5d. per ton, and 10,670 tons, 3 cwt., 3 qrs. by "electrics" at a cost of 2s. 2·3d. per ton.

The detailed figures are given in Tables I. and II.

Table I.—*Horse Costs for Bin Refuse.*

Depot.	Weight collected.	Cost per ton.
	T. c. q.	s. d.
Heeley	16,155 16 3	5 6·8
Penistone-road	19,079 9 3	5 2·4
Worthing-road	16,263 8 3	5 7·6
Total	51,498 15 1	5 5·4
Electric	7,040 11 0	4 9·8

Bin Refuse—Electric Costs.

Vehicle costs about 3½ years	£331 1 11
Drivers' and labourers' wages	1,230 9 8
Tyres—12,640 miles at 1d. per mile	52 13 4
Electricity—19,639 units at 1d. per unit	81 16 7
	£1,696 1 6

Refuse collected 7,040 tons, 11 cwt.—4s. 9·8d. per ton.

Table II.—*Ashpit Refuse—Horse Costs.*

Depot.	Weight removed.	Cost per ton.
	T. c. q.	s. d.
Heeley	12,853 10 2	4 2·9
Penistone-road	10,260 5 0	3 3·3
Worthing-road	4,763 16 2	3 2·3
Total	27,877 12 0	3 8·5
Electric	10,670 3 3	2 2·3

Ashpit Refuse—Electric Costs.

Vehicle costs about 3½ years	£362 16 0
Drivers' and labourers' wages	641 5 11
Tyres—15,313 miles at 1d. per mile	63 16 1
Electricity—24,716 units at 1d. per unit	102 19 8
	£1,170 17 8

Refuse removed 10,670 tons, 3 cwt. 3 qrs.—2s. 2·3d. per ton.

It should be pointed out that in these tables the comparison of cost is between horse labour and "electrics" over the whole city, but inasmuch as the "electrics" with one exception were working on the longest distances this basis is not strictly fair to the "electrics." As additional motors were put in service these replaced horses on long distances, with the result that the horse costs over the city area have decreased, whilst "electric" costs remain at a maximum. The following figures illustrate this. In three bin districts now worked by motors the cost of collection by horses would have been 8s. 3·2d., 6s. 11·9d. and 6s. 10d. per ton respectively, whilst in one ashpit district horses and an "electric" were worked side by side, with the result that over a period of 23 weeks the average cost was: Horses, 5s. 6·2d. per ton; and electrics, 2s. 10·2d. per ton.

In addition to the collection and removal of house refuse, I have made use of electric vehicles for the removal of clinker residue from the destructor works to tips, and figures as to the cost on this work, as compared with horse labour, are summarised in Table III.

Table III.

	T.	c.	q.		T.	c.	q.		T.	c.	q.
Clinker removed	333	1	3	...	331	4	2	...	1,423	2	2
Cost per ton	1s.	9·9d.		...	1s.	6·6d.		...	1s.	7·3d.	
Cost per ton miles	1s.	4·4d.		...	1s.	6·1d.		...	0s.	11·7d.	
Cost of horse labour on same work, per ton	2s.	2·0d.		...	1s.	9·6d.		...	2s.	2·0d.	

The result of 12 months' working of electric vehicles in Sheffield, considered on a financial basis alone, is eminently satisfactory. As previously stated, five vehicles have been at work for varying periods amounting in the aggregate to the work of practically 3½ vehicles for one year. The saving in the work done by them as compared with horse costs over the whole city amounts to £1,050. 12s. 6d., capital has been written off to the amount of £292. 12s. 6d., and electricity supplied from the destructors represents a further sum of £191. 14s. 8d., making a total of £1,534. 19s. 8d. Put in another way, 3½ vehicles working for one year have cleared off more than the entire initial cost of 1½ vehicles. This result, be it noted, is in comparison with horse costs for the whole city, which for reasons already stated does not represent the full facts. If the comparison was made only with horse costs for the districts now served by the "electrics," the saving shown would be materially increased and the total figure would be well over £2,000.

Questions will probably suggest themselves to many of my hearers, such as What of the cases where work is available only for one shift? Can electrics be profitably employed under those circumstances? The answer I think can now be supplied by many local authorities who are making a success of them under such circumstances. So far as Sheffield is concerned, I believe that "electrics" would be profitable on single shifts only—very much so on ashpit refuse work, and to a lesser degree on ashbins. If the entire vehicle costs were charged against ashpit work, the comparative figures would be: Horses, 3s. 8·5d.; electrics, 2s. 10·4d. If charged entirely against ashbin refuse, the figures would be: Horses, 5s. 5·4d.; electrics, 5s. 9·1d.; but taking the horse costs in this case on the districts now worked by "electrics," the comparison is: Horses, 6s. 8·4d.; electrics, 5s. 9·1d. It must also be further noted that with vehicles working only one-half their present mileage and tonnage, the depreciation and repairs items would both admit of substantial reductions.

For those concerned in the horse value of "electrics" the following table may be interesting:—

	Bin refuse.		Ashpit refuse.		
Average tons per day—horses	3·42	...	3·63		
,, ,, electrics	7·67	...	10·58	...	Total
Value of each electric in horses	2·24	...	2·91	...	5·15

These figures again relate to the whole city, but the number of horses actually replaced by each vehicle is a fraction under six.

In conclusion, there are two suggestions I would throw out for the consideration of electric vehicle manufacturers. My first is that the manufacturer who best studies those conditions, and is prepared to show by demonstration vehicles what he can do under the special circumstances of each case, is the man who will get the business. It is no use telling Yorkshire towns what is being done in London or in Glasgow, where conditions are entirely different. Send down a vehicle for a week or a month, and demonstrate what can be done in the particular town concerned.

My second suggestion is that it should not be assumed that any vehicle or any battery represents the last word in efficiency. Personally I am looking eagerly for that battery which will absorb sufficient power in one hour to run a vehicle for 23 hours without either boosts or warming up, and so save that extra six hours now required to give a "normal" charge.

DISCUSSION.

The President (Dr. S. BARWISE) said that Nottingham corresponded almost exactly with Sheffield in its local conditions, and the figures came out nearly the same. In their experience there had been a considerable saving in favour of electrics.

Ald. ROBERTS (Liverpool) asked it Mr. Priestley had taken breakdowns into consideration. It was necessary to keep mechanical vehicles always working in order to make them pay. For short journeys horses were preferable to petrol or electric vehicles.

Mr. W. GREIG (Glasgow) said that, notwithstanding the drawbacks of electric vehicles, the cost for collection and haulage worked out at 3s. 10d. per ton at Glasgow, compared with 4s. 2d. for horses.

Councillor Thwaites (Newcastle) said that for certain forms of work the electric vehicle was unapproachable. Down to three miles the petrol vehicle had its advantages, and the electric had its value for intermittent work.

Mr. R. DIGGLE (Accrington) said that they had had an electric vehicle for two months operating within a radius of two miles. In his town the electric had come to stay, and if they could get another one they would do so next week. The vehicle did on an average nine loads a day, and dealt with about 20 tons. As compared with horses, the cost had been re-

Digitized by Google

duced by a shilling per ton, and since they had had the electric more work had been got out of the horses. Their experience had taught them that for short distances the electric would compare very favourably with horses.

Mr. C. W. LASKEY (Eccles) w ndered whether the adoption of motor traction of any kind would be advantageous to a small town like his, which had an area of about 2,050 acres, and was about 2 miles long and 1¼ miles broad.

Councillor KAYE (Sheffield) said there was no doubt as to the accuracy of the figures in the Paper. His committee was perfectly satisfied that they had beaten horses off the face of the earth so far as the collection of refuse was concerned.

A vote of thanks to Mr. Priestley for his Paper was moved by Ald. Elliott (Newcastle) and seconded by Councillor GIBSON (Nelson), and unanimously carried.

In reply, Mr. PRIESTLEY said that his experience showed that when a load could be got rapidly the electric could beat the horse on any distance. Everything depended upon the class of work and the time taken in the loading.

CORRESPONDENCE.

A REVELATION CONCERNING THE WAYS OF REVIEWERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In a recent review of a book in an electrical journal that shall be nameless the reviewer apologises for the tardiness thereof, with the plea that "*he got interested in it, so that instead of reading merely the introduction and contents pages and basing his review on these, he read it through, and forgot he was a mere reviewer.*"

These remarks, quite obviously made in all seriousness, will be received with mixed feelings by those whose misfortune it is to be authors, by publishers, and by a large body of readers who look for enlightenment and guidance in reviews.

Comment seems hopeless, unless other people will take up the cudgels.—I am, &c.,

London, July 14. W. PERREN MAYCOCK.

UNIVERSITY TRAINING FOR WORKSHOP MANAGERS.

Under the auspices of the Lancashire Section of the Textile Institute a conference on "Management" was held in Manchester on the 10th inst.

In the discussion which ensued Mr. H. T. Hildage said it seemed hard to understand why there should not be a real partnership between employers and workers to the advantage of both, and to the nation as a whole. A good way of reducing the cost of production, of paying higher wages for shorter hours and of introducing better conditions of employment was to increase the output. The best way to increase the output was to improve the management, which could be effected in several ways. In the first place the manager should be able to win the sympathy and confidence of the people, which he could not do if he took the side of one of two hostile parties; he must be the link between the employer and the workers he employed; the managers must be men of broad outlook and wide experience, and have better training for the important duties they would have to discharge. It did not follow that the present race of managers must be discarded and a new supply created. These men would prove fully adequate for the high work they would be called upon to do if they were given proper opportunities to broaden their outlook and extend their scope. That was one of the matters in which the university could give valuable assistance. The manager's duty was to direct the energies, skill and ability of his people, so that the results of their labours might be the utmost possible. He must be able to induce their willing and hearty co-operation, and in order to do that he would have to study more carefully certain of his functions, for example, the selection of employees, and a careful study of their abilities and peculiarities must be undertaken with a view to seeing that the people employed were the best that were obtainable; that they were given conditions of employment for which they were best fitted; that their progress as well as their health and welfare should be noted and followed. A steady supply of carefully selected employees, qualified to undertake higher positions in the factory, must be secured and trained. Mr. Hildage concluded by moving a resolution for the formation of a special committee to approach the university authorities with a view to arranging for instruction in management both for students in their graduate course and for those who are already occupying or who are likely to occupy managerial positions.

Mr. A. P. M. Fleming, of the British Westinghouse Electric and Mfg. Co., Principal Garnett, Capt. Mather and other speakers took part; and the resolution was carried unanimously. A committee, consisting of Messrs. Hildage, Fleming and Greenwood was appointed with power to add to their number.

SYMBOLS RECOMMENDED BY THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.

The following table of Symbols and Abbreviations have been recommended by the Standardisation Committee and were adopted by the Institution at the Autumnal General Meeting, October 10, 1916:—

Notation.	Signification.
θ	"Therm." A synonym for the "British Thermal Unit." The Therm may be defined as the amount of heat absorbed by 1 lb. of water for a rise in temperature of 1 degree Fahr., the slight variation at normal temperatures being ignored for practical purposes under this term.
/	"Per." Ex:—5000θ/hr. (5000 therms per hour).
ft^2 or □	Square foot.
in^2 or □	Square inch.
ft^3 or ℄	Cubic foot.
in^3 or ℄	Cubic inch.
°d	Degree difference.
T	Absolute Temperatures. Context indicating which scale.
t	Ordinary Temperatures. Context indicating which scale.
t_1 t_2	Initial and final temperatures.
ρ	Coefficient of friction for flow of fluids through conduits.
ζ	Coefficient of loss of energy in fluid streams due to passing single resistances.

THE WILD-BARFIELD PROCESS FOR HARDENING STEEL.

An opportunity was recently afforded for the inspection of the Wild-Barfield process for hardening steel at the Westminster Electrical Testing Laboratory. The chief points in the system are the use of a special solution for quenching and the control of the temperature, to which the object to be hardened is heated, by electromagnetic means. The former is presumably the result of patient research on fairly obvious lines, and the latter appears to be a happy inspiration, involving the utilisation of an effect which has long been known, but apparently has not previously been applied for this particular purpose.

At the present time the process is being applied mainly to the hardening of standard screw gauges, though it has other applications. Such gauges are tested accurately at the National Physical Laboratory, subjected to hardening, and then again tested. It was found that the hardening process, unless very carefully done, gave rise to various irregularities. The diameter of the gauge was apt to be changed during the process of hardening, and the pitch of the screw was also sometimes affected. If the distortion is not too great it may be possible to correct such irregularities, but this is a tedious process requiring great skill and patience. It is naturally far better to eliminate distortion of this kind, and it is claimed that by the Wild-Barfield method of hardening this is successfully accomplished.

The gauge to be hardened is placed in an electrically-heated furnace. The heating agent consists of a tube containing a special salt mixture, which has a high vaporising point and is conducive to very even temperature. The tube is raised to the desired temperature by means of a coil of wire wound round its exterior, through which an appropriate current is passed. An electrical pyrometer is inserted into the liquid, and gives an approximate indication of its temperature, but this is not utilised as an indication of the temperature of the immersed gauge. It is merely a supplementary check.

The essential control is electro-magnetic. It is recognised that it is desirable not to exceed the temperature at which decalescence of the steel occurs. It is also known that at the decalescence point the steel becomes practically non-magnetic. The recognition of

Digitized by Google

this point where the magnetism ceases therefore affords a useful indication that the correct temperature has been attained. The gauge is continuously magnetised by the heating solenoid surrounding the tube in which it is immersed. A second solenoid of fine wire is wound round the exterior of the furnace and connected to a mirror galvanometer. While the gauge is being heated up its magnetism remains practically constant, so that there is no induced current in this outer coil. But when the recalescence point is reached the diminution in magnetic effect induces an E.M.F. in the coil, which is proportional to the rate of change of the magnetic flux. This E.M.F. rises to a maximum and then dies away when the non-magnetic state has been reached, and there is no further change in the lines of force. Accordingly the spot of light from the mirror-galvanometer is seen to deflect to a certain value, and then return to zero. When this is observed the gauge is withdrawn from the furnace and quenches in another special salt mixture, maintained at an appropriate temperature, and then subsequently dipped in water and dried. The whole process only takes two minutes, and it is stated that by this method there is no appreciable deformation of the gauge.

Distortion or inefficient hardening appear to be due to two chief causes—namely, incorrect temperature in the initial heating, and uneven temperature either in the preliminary heating or in the process of quenching. The electromagnetic device ensures the correct temperature being maintained, and the high vaporising points of the mixtures employed, both in heating and quenching, are conducive to even distribution of heat.

B.T.-H. IRONCLAD DRAW-OUT OIL-BREAK SWITCHGEAR.

A descriptive list (No. 4,160-A) has recently been issued by the British Thomson-Houston Co. (Ltd.), referring to switchgear of the above type. This three-phase gear is designed on the "draw-out" principle, with interlocking devices to prevent accidental contact with live metal and ensure that the gear is isolated from the line before it can be opened up for inspection. This type of switchgear has been developed specially for mining and industrial service where compact, totally enclosed, dust-proof and drip-proof gear is needed.

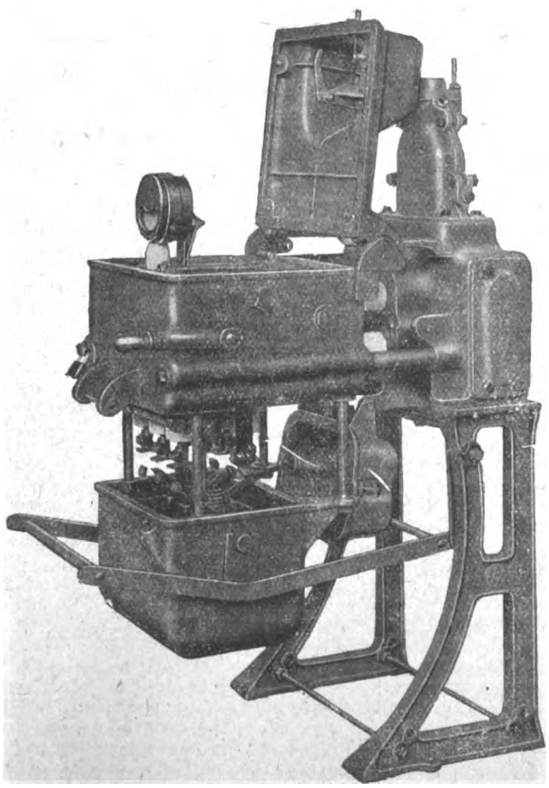


FIG. 1.—B.T.-H. IRONCLAD DRAW-OUT SWITCHGEAR.

In the list a variety of types is illustrated, and the elements in design ensuring accessibility, mechanical interlocking, &c., are described. Special combinations can be made up, and the automatic features include overload trips, low voltage release and, if desired, a time-element device delaying the action of the overload trips, so that the switch will not be affected by a momentary overload.

The list is completed by a series of connection diagrams with outline sketches of typical gear.

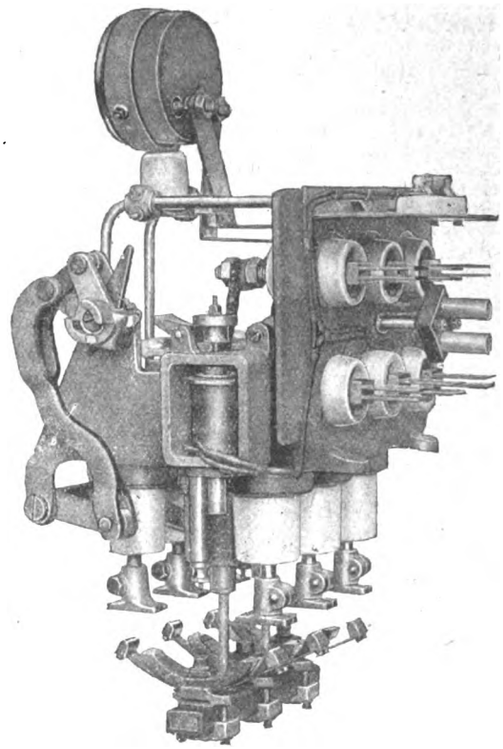


FIG. 2.—SWITCH MECHANISM OF THE SWITCHGEAR SHOWN IN FIG. 1.

Fig. 1 shows an OJ2 switch with ammeter hood, the switch carriage being withdrawn and cover open and tank lowered, whilst Fig. 2 shows the switch mechanism.

LEGAL INTELLIGENCE.

Alleged Preferential Charges.

On Tuesday Mr. Justice Astbury began the trial of an action by the Attorney-General at the relation of the Gas Light & Coke Co. against the Mayor and Corporation of Hackney for a declaration that the system of charging for electricity supply adopted by the Council was in breach of certain sections of the Electric Lighting Act of 1882; and plaintiffs also asked for an injunction.

Mr. F. Russell, K.C., Mr. Colefax, K.C., and Mr. Percy Wheeler appeared for plaintiffs; and Mr. A. J. Walter, K.C., and Mr. Spence for defendants.

Mr. RUSSELL said plaintiffs supplied gas for lighting and power and other purposes within a certain area, and the Borough Council of Hackney supplied electrical energy for lighting and power within a certain area which was within plaintiffs' district, and they did that under the provisions of the Hackney Electric Lighting Order of 1893. Plaintiffs said what defendants were doing violated secs. 19 and 20 of the Electric Lighting Act of 1882, which provided that where a supply of electricity was given in any part of an area for private purposes, except in so far as otherwise provided by licence or special act authorising such supply, every company or person within that part of the area should on application be entitled to a supply on the same terms on which any other company or person in such part of the area was entitled under similar circumstances to a corresponding supply; and the undertakers should not in making any agreement for the supply of electricity show any undue preference to any local authority, company or person, but might make such charges not exceeding the limits of the price imposed by the licence or special Act. The Council were the successors in title of the Board of Works of the Hackney District, who were the authority authorised under the Provisional Order. The matter in respect of which plaintiffs were suing was the scale of prices published by defendants in July, 1914. The scale was: For lighting and for any quantity of electrical energy used each quarter, not exceeding the equivalent of one hour's supply per day of the maximum demand at 6d. per unit; for any further quantity of electrical energy in each quarter, 1d. per unit; or, alternatively, a flat rate. For power (this was what plaintiffs complained of): A fixed charge of £1 per quarter per kilowatt of maximum power demanded, and a charge for electrical energy used of ½d. per unit; consumers paying under this scale are allowed to use 20 per cent. of the energy consumed for lighting. The effect of that was that persons who were consumers of energy for light only were charged more for their light than the consumers of energy for power who also used the energy supplied for power for light.

Digitized by Google

Put the other way round, consumers of energy for power were supplied with energy for light at a lower rate than the persons who were consumers for light only. That would work out, for instance, as follows: A lighting consumer who in a quarter purchased 300 units per kilowatt demand paid for 91 of these units at the rate of 6d.; that was one hour per day per quarter, taking 91 days to the quarter. That came to 546d., and he paid for the remaining 209 units at 1d., which made 755d. altogether, and that worked out at 2·5d. per unit. In the case of the power man who purchased 300 units, he paid a fixed rate of £1 per quarter and ¼d. per unit = 150d., which made 390d., and that worked out at 1·3d. per unit, so he was getting his lighting at roughly half the rate of the other man. Counsel argued that a light consumer was entitled to be supplied with his light on the same terms as another person, and to give favourable terms to a power consumer in respect of his lighting was to induce him to become a customer.

Sir JOHN SNELL, vice-president of the Institution of Electrical Engineers, said he had had before him the Statutory Acts of the Borough of Hackney, together with facts and figures which had been disclosed; and he had investigated the question whether or not defendants had been supplying electricity at a profit or loss, having regard to the charges that were made. He had come to the conclusion that the borough had made a profit on lighting and a loss on the supply of power.

The case had not concluded when we went to press.

Supply Companies' Agreement.

On Friday last Mr. James Swinburne concluded the hearing of a claim by the Kensington & Knightsbridge Electric Lighting Co. (Ltd.) for damages against the Notting Hill Electric Lighting Co. (Ltd.) for an alleged breach of an agreement.

Mr. Vesey Knox, K.C., and Mr. H. B. Marriott for claimants and Mr. Honoratus Lloyd, K.C., and Mr. Bruce Thomas for respondents.

In opening, Mr. VESEY KNOX said the question was whether the taking of a supply of electrical energy in bulk from the Metropolitan Electric Supply Co. and Hammersmith Borough Council by the Notting Hill Electric Light Co. was a breach of an agreement made in 1900 with the Kensington Company.

Mr. HONORATUS LLOYD: I do not accept that. The point I venture to think we have to discuss is in relation to Kensal Town, and not Hammersmith. Kensal Town is the one we referred to the Arbitrator. Hammersmith has cropped up afterwards.

Mr. VESEY KNOX said he thought he should be able to satisfy the Arbitrator that the question of the Hammersmith supply should be included. In July, 1899, the claimants and respondents (both of whom had statutory powers to supply electrical energy in Kensington) agreed to continue jointly to promote a Bill in Parliament for enabling them to acquire lands near Wood-lane, Hammersmith, and erect a generating station thereon. It was agreed that the joint station should be constructed with a generating plant of a total power of 1,800,000 watts continuously, and that this output might be used by the parties as they might require, but the claimants were not to be entitled to use more than 1,200,000 watts, and respondents not more than 600,000 watts, without the consent in writing of the other, and any lesser output was to be available in accordance with the proportions above mentioned. Another clause of the agreement provided that the parties should bear the expense of working, maintaining and repairing the joint station, and of outgoings and interest on the joint loan, by means of a sinking fund, or otherwise rateably in proportion to the amounts of electrical energy taken by the parties respectively from the joint station. The Bill was passed, and by an agreement dated October 25, 1900, it was agreed that the station should be constructed and equipped by the two companies by means of an issue of debenture stock of a nominal amount not exceeding £200,000, to be secured by a trust deed. Another clause (the one under which the Kensington Company now claimed) provided "that so long as any of the said stock shall be outstanding the two companies shall from time to time take from the joint station all such electrical energy as each company, having regard to its other sources of supply, may require for the purposes of its business, in accordance with the provisions of the agreement of 1899, or such other provisions as may from time to time be agreed upon between the two companies, or settled unanimously by the Committee of Management." The trustees for the debenture holders were not satisfied to lend their money unless the principal agreement was strengthened in that manner. It was further provided that the property, after the redemption of the stock, should belong to the claimants and the respondents in the proportions to which they should be entitled as tenants in common, in such shares as should be in proportion to the amounts of their respective contributions. The espondents had in 1909 and since taken a supply of electrical energy in bulk from the Metropolitan Electric Supply Co., and they had also taken a supply from the Hammersmith Borough Council. Claimants submitted that the Notting Hill Company had thus committed a breach of their agreement. As a consequence, the expenses of the joint station to be paid by the claimants were increased to the extent of £1,650 from 1909 to the end of 1915. The figures for 1916 had yet to be supplied by the respondents. The Kensington & Knightsbridge Company accordingly claimed damages, and a declaration that the respondents were bound to take electrical energy in accordance with the agreement. The respondents in their defence denied any breach of the agreement, and declared that the claimants expressly or impliedly requested them to take, or so agreed to them taking, the supply from the Metropolitan Company and to waive such breach, if any. Respondents further stated that they relied upon the following circumstances: "In 1907 certain parties in the Borough of Kensington, outside the areas of supply of both the claimants and respondents, being anxious to obtain a supply of electricity, representatives of the two companies met and discussed the question of such supply being given by the respondents. The parties in question were Messrs. W. N. Davis & Son, of Kensal Dye Works, South-row, Upper Westbourne Park, W. As a result of the discussions it was determined that the respondents, not being able to give he supply themselves, should arrange for it to be provided by the Metropolitan Supply Co. The respondents accordingly made such arrangements, and obtained authority from the Board of Trade to give the supply. The decisions referred to were made at one of the weekly meetings which took place during July, 1907, at which the claimants were represented by their then secretary (Mr. Erskine), and the respondents by their secretary (Mr. Rawkins) and their chief engineer and manager (Mr. G. Schultz), and had been acted upon ever since with the full knowledge of the claimants. Since Messrs. Davis & Son were first given a supply of electricity, other parties outside the respondents' area of supply had been supplied in the same manner, and the claimants had been at all times aware of it and had acquiesced therein. In the further alternative, if the supply in question was a breach of the agreement, the respondents contended that it was authorised by the London Electric Supply Act, 1908. They further submitted that they had at all times taken such a proportion of the output of the joint station as was reasonable; and, in the alternative, if the supply was not in compliance with the agreement, that the claimants were not entitled to any payment or to claim any damage in respect of any period prior to the date when the claimants first represented to the Committee of Management that the respondents were not taking such a proportion of the output of the joint station as was reasonable." Counsel said it was not till 1916 that the directors of the Kensington Company had any knowledge of any supply being taken by the respondents from the Metropolitan Company. They immediately made a complaint, and as it had not been met they brought the matter before the Arbitrator. Counsel said it was apparent on the score of cost that the respondents had a strong motive for taking the supply from the Metropolitan Company and not from the joint station.

Mr. HONORATUS LLOYD observed that the Metropolitan Company laid the mains and the Notting Hill Company paid for them

The ARBITRATOR inquired when the Hammersmith supply began.

Mr. LLOYD: In 1906. It has always been trifling. It would affect the Wood-lane account in respect of your supply not more than £5 a year.

Mr. VESEY KNOX, continuing, submitted that it was clear that the supplying of various customers under the "fringe" orders by the Notting Hill Company was part of their business. It was true that the annual accounts of the respondent company were sent to the claimants because it was the custom of the London electric light companies to exchange accounts; but the directors did not notice that those accounts contained year by year an item of "Electricity purchased from other sources."

Mr. HERBERT WOODFIELD MILLER, managing director of the Kensington Company since April, 1914, and prior to that for some 20 years chief engineer, in giving evidence said Mr. Erskine was the secretary of the company until June, 1913, when he died. During that time witness was practically in daily communication with Mr. Erskine, who never mentioned a word about any such arrangement as that alleged by respondents. Witness had searched through Mr. Erskine's papers, and had not been able to find a single document or note relating to the alleged arrangement. Towards the end of 1914 Mr. Rawkins told him the respondents were going to enter into an arrangement with the omnibus company, that it would be a good stroke of business, and that the supply would be given by the Metropolitan Company. Prior to that he had no knowledge or notice that they were getting a supply from the Metropolitan Company.

Col. R. E. CROMPTON, C.B., a director of claimant company since 1901, and chairman of the board of directors since 1903, said that if Mr. Erskine had mentioned anything to him about respondents being supplied by the Metropolitan Company he should have objected very strongly.

Sir HENRY BLISS, director of the Kensington & Knightsbridge Co., said that until Mr. Miller brought the matter before the board of directors on March 30, 1916, it had never come before the directors in any shape or form.

Mr. G. S. BRITTON, secretary of the Kensington Company, who succeeded Mr. Erskine, also gave evidence.

This concluded claimants' case.

Mr. HONORATUS LLOYD (for respondents) said he began by protesting against the inclusion of the Hammersmith matter, and he adhered to that. The question arose with reference to two groups of consumers, one in Kensal Town and the other in Hammersmith. So far as the Kensal Town customers were concerned they had never been in the area of respondent company, and were not within their area now, and respondents had no right to supply them or lay a main or anything else until after 1910, when they obtained some "fringe" orders. In Hammersmith the customers, originally 14 in number, now numbered four—at any rate, four had now come into the area upon the re-casting of the boundaries. It was admitted that at the time of the agreement respondents had one source of supply which was their own generating station, and that this was sufficient to have supplied both the customers at Kensal Town and Hammersmith. Therefore, he submitted, under the agreement, having a source of supply which was ample, the company was not obliged to take the supply from the joint station. If he was right in that construction of the clause in the agreement, there was an

Digitized by Google

end of the whole case. With reference to Kensal Town, it was not legal for respondents to supply the consumers until the "fringe" orders were obtained. Until the "fringe" orders it was an illegal business, and, as such, certainly could not be business which would come under the agreement. Regarding the position when the business became legalised, counsel quoted from the Act of Parliament sanctioning the erection of the joint station with the object of showing that it was "for the purpose of supply within the respective areas of supply" of the two companies, and to certain specified bodies—the vestry of St. Mary Abbotts, Kensington, and Hammersmith for the White City.

The ARBITRATOR: Do you contend that the joint station is not even now available for supplying under the "fringe" orders?

Mr. LLOYD: I do. Although I submit that the decision of the company has been legalised by the "fringe" orders, it has not enabled the supply to be given from the joint station for that purpose. In 1907, when they had an isolated request from Kensal Town Dye Works, who threatened them with the Board of Trade, they thought at the time those works were in their district, and that occasioned more worry still. Mr. Rawkins had interviews with Mr. Erskine, and the latter agreed that it was the wisest and best thing to give this one customer a supply. As time went on other customers came in, and Mr. Rawkins used to tell Mr. Erskine the price he was getting. The real point was that that was done as a perfectly reasonable thing, having regard to economic considerations. It was admitted that it would have been an uneconomical thing for respondents to have supplied the customers direct from their own generating station because of the distance, and what was done was done with the knowledge and acquiescence of Mr. Erskine.

The ARBITRATOR: The question is, having done it and received benefit, has the other side any right to part of the benefit? That is a legal question. The other question is economy—whether it would have been wise in the circumstances to take it on at all if you had to do it yourselves. I appreciate your argument that the joint station still has no power to supply it. That has nothing to do with the other points.

Mr. LLOYD submitted lastly that, even if he was wrong in law and fact, the claimants had suffered no damage.

Evidence was given by Mr. Rawkins, who said Mr. Erskine agreed that he should go to the Metropolitan Company, and upon the report of Mr. Schultz (who was manager and chief engineer up to 1913, and who since then had been consulting engineer) the directors determined to make arrangements to obtain the supply from the Metropolitan Company. On the report of Mr. Schultz the respondents would not have given a supply had it not been possible to have obtained a supply from the Metropolitan Company.

Mr. Schultz and Mr. Macdouall having been examined, Mr. C. P. Sparks, president of the Institution of Electrical Engineers, then gave evidence as to the economic considerations involved in the supply. It appeared that claimants had based the amount of their claim on figures supplied by respondents of the quantities of electric energy purchased by them from other sources. The figures included a certain quantity supplied by Hammersmith Borough Council. While not agreeing to the inclusion of the Hammersmith matter in the case, Mr. Lloyd consented to the figures being considered, and counsel on both sides agreed that, for the purposes of the case, the damages should be put at £1,900 up to 1916.

Mr. VESEY KNOX remarked that the primary object of the claimants was to get the agreement construed, although they did not know of the supply by Hammersmith until respondents sent them the figures.

The ARBITRATOR intimated he would state his award in the form of a special case; but in view of the Long Vacation there was no immediate hurry.

Prust v. Westminster City Council.

In the Shoreditch County Court last week Judge Cluer and a jury heard this action by a taxicab proprietor for the recovery of £34 damages to a taxicab.

It appeared that at 11 o'clock at night on a dark night one of plaintiff's cabs was being driven along Knightsbridge, when it collided with a hansom cab, causing the damage. The alleged cause of the collision was that the Corporation had negligently allowed the electric light to go out at one standard, so that plaintiff's driver was unable to discern his danger. He saw in front of him two red lights, which he took to be the danger signals put there in connection with an excavation in the roadway. He pulled to the right to avoid it, as he thought, and ran right into a cab which was coming in the opposite direction. As a fact, the red lights were those at the rear of stationary cabs on the rank. Had the arc lamps been alight he would have seen what was happening and avoided any danger. Counsel argued that it was the duty of the Corporation to keep the lamps alight, and that they were responsible for anything that happened if they failed to do so.

For the defence it was stated that the electric light was carried out by the Westminster Electric Supply Corpn., and the company had three men constantly on duty to attend to those light failures. They knew the dangers in view of the darkened streets, and they had had to shade their lights to the required dimness; besides which they were even paying the police to give them information of any failure of light. On the occasion in question they were informed that the light "had gone," and sent as quickly as they possibly could, but unfortunately the accident happened in the meantime.

Ultimately the jury found for defendants, and judgment was entered for them, with costs.

PARLIAMENTARY INTELLIGENCE.

SHEFFIELD CORPORATION BILL.

This Bill has now passed through the committee stage in the House of Commons. Rotherham Corporation were successful in their opposition to the portion of the Bill which would confer powers upon Sheffield Corporation to abstract water from the River Don. Clauses for the protection of the Great Central Railway and the Sheffield & South Yorkshire Navigation Co., and Messrs. Steel, Peach & Tozer were inserted in the Bill.

In the course of the proceedings the report of the Board of Trade upon the scheme was submitted, and showed that, in the view of the Board, as a Committee on Electric Power was sitting the scheme should be postponed until the committee had reported.

Royal Assent.—On July 10 the Royal Assent was read to the following new Acts of Parliament:—

Nottinghamshire & Derbyshire Tramways Act, Lancashire Power Construction (Ltd.) Act.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

May 14, 1917.

6,812 WOOD. Swivelling trolley pulleys of electric vehicles.
6,823 CRAMPTON. Synchronised mechanism under electric control.
6,825 HACKWOOD. Miner's safety lamp burners
6,835 DEAN. X-ray couch permitting of wet surgery and radiscopy.
6,870 STONE & CO. (Walton.) Couplings or connections for electric cables of railway vehicles, &c.
6,871 STONE & CO. & DARKER. Brush and terminal contact mechanism of dynamo-electric machines.
6,889 REEPMAKER D'ORVILLE. Installing and disposition of electric equipment for motor vehicles.
6,894 MURRAY & HOFFER. Electric spot welding. (28/6/16, U.S.).

May 15, 1917.

6,926 HARRIS. Signs, telegraphs and electric advertising devices.
6,927 BASTIAN. Attachment for magnets.
6,932 B.T.-H. CO. (G. E. Co.) Electric motor control systems.
6,936 BRITISH INSULATED & HELSBY CABLES, BAIRSTO & HARRISON. Loading coils for telephone circuits.
6,952 AKT. GES. BROWN BOVERI ET CIE. Electric connections for utilising voltage curve in metal vapour rectifiers fed with polyphase current. (18/5/16, Germany.)

May 16, 1917.

6,993 ETCHELLS & GREAVES. Sealing openings in roof and walls of electric furnace through which electrodes are introduced.
7,001 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Electric resistance elements. (8/6/16, U.S.).
7,004 CABLE ACCESSORIES CO. & REEVES. Electric lamp holders.
7,009 FYFE, WILSON & CO. & STOCKEL. Electric switches.
7,016 WATKINS. Electro-magnetic apparatus for controlling discharged torpedoes.
7,022 B. T.-H. CO. (G. E. Co.) Manufacture of turbine blades.
7,025 HORNE. Auto-luminous switch indicator.
7,034 AKT. GES. BROWN BOVERI ET CIE. Magneto-ignition apparatus for engines. (16/5/16, Germany.)

May 17, 1917.

7,058 RINGROSE. Electric switchboards.
7,080 WALKER. Electric measurement of sound.
7,092 NICHOLLS. Electric fuses.
7,093 SIEMENS & HALSKE, A. G. Automatic selectors for telephone systems. (4/5/16, Germany.)
7,122 DE FOREST & LOGWOOD. Radio-signalling systems. (23/5/16, U.S.)

VOLUNTEER NOTICES.

1st LONDON ENGINEER VOLUNTEERS.

Orders for the Week.

Lieut.-Colonel C. B. CLAY, V.D., Commanding.

Officer for the week.—No. 3 Company.
Next for Duty.—Platoon Commander P. Bowden.
Monday, July 23.—Technical Instruction (Searchlight) for No. 3 Company. Right Half Company, Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' Drill, 6.30.
Tuesday, July 24.—Lecture, 6.30. Physical Drill and Bayonet Fighting, 7.30.
Wednesday, July 25.—Drill and Elementary Bridge Construction, No. 1 Company, Right Half Company.
Thursday, July 26.—Drill and Elementary Bridge Construction, No. 2, Right Half Company. Ambulance Class, 6.30. Signalling Class
Friday, July 27.—Technical Instruction (Searchlight) for No. 3 Company, Left Half Company, at Regent-street. Drill, No. 3 Company, Right Half Company. Recruits' Drill, 6.30.
Saturday, July 28.—Commandant's Parade, 3 p.m., Uniform, for route march. Fall in, Golder's Green Station.
Armlets.—Members are warned that armlets must be worn at plain clothes parades.
Musketry.—For all Companies, see Notice at Headquarters.
Note.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street).

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

Contract Prices. Recently the Association of Chambers of Commerce represented to the War Office that, in the opinion of its members, in cases of Government contracts where wages were raised by direction of a Government Department an appropriate increase in the contract price should follow.

The War Office has now replied that they are prepared to take into consideration cases where the contractor is able to prove that his position has been affected to such a degree as to deprive him of such reasonable profit as otherwise he should, in the opinion of the department have secured. The satisfactory carrying out or otherwise of the contract will be taken into consideration. The department is prepared in making new contracts, to consider the insertion of a provision relieving the contractor of the risk of a wages fluctuation, but the contractor must be prepared to accept a modified price.

* * * *

Excess Profits Duty. Last week a deputation of about 60 M.P.s waited upon the Chancellor of the Exchequer, in order to press upon him the necessity of modifying the excess profits duty in connection with the valuation of manufacturing stocks and the depreciation of plant and machinery.

In reply, the Chancellor of the Exchequer promised to give the whole subject his most careful consideration before the report stage of the Finance Bill. On Monday this stage of the Bill was concluded, and among the concessions made were (1) the enlargement of the powers of Referees to decide excess profits appeals, and (2) an extension from one to two years of the period for the valuation of stocks.

Mr. GEORGE TERRELL, who moved a new clause enabling the Commissioners of Inland Revenue in making assessments of business premises to make deductions for wear and tear, depreciation and obsolescence of all assets, building, machinery and plant, said he moved the amendment on behalf of a number of associations and manufacturers. In ordinary times such a clause was not a matter of great moment, but at the present high rate of the tax it was essential that the taxes which were put on profits should be rigidly confined to profits.

The amendment was not accepted, and Sir WM. PEARCE, who deprecated the attitude of the Government, said that if we intended to hold our place in the industrial world we must allow at least 10 per cent. on the value of plant in order to keep it effective and up to date.

On the question of the valuation of stocks a new clause was moved by Sir J. HARMOOD BANNER, the effect of which would be to stereotype the basis of values of stocks during the continuance of the excess profits duty. He proposed that for the purpose of arriving at the excess profits duty the average quantities of stocks in hand during the accounting period should be taken instead of the minimum.

Sir SAMUEL ROBERTS, who seconded the motion, said that many Chamber of Commerce were of opinion that the proposals in the White Paper did not meet the just claims of the business world. The suggestion of a year's grace was no remedy, because the fall would not occur in the first year.

After discussion, Mr. Bonar Law decided to extend the period to two years, and the amendment was then withdrawn.

* * * *

Pig Iron Prices. The Minister of Munitions announces that the general permit as regards dealings in pig iron embodied in the Order of July 7, 1916, is modified by the insertion or substitution in the Schedule thereto of the following prices for the articles specified below :—

Additions to Schedule.—Hematite Pig Iron—Malleable.—Refined—Refined cupola cast, £8 per ton net f.o.t. makers' works ; refined cupola cast to guaranteed analysis, £8. 5s.

Cast direct from blastfurnaces.—Small pig iron—all grades, £7. 10s. ; medium pig iron, white to grey mottled, £7. 5s. ; medium pig iron, all other qualities, £6. 17s. 6d. ; large pig iron, all grades, £6. 17s. 6d.

All the above prices include agents' commission or merchants' profits, which is not to exceed 5s. per ton. Applications for licences to sell special grades of extra quality at special prices will be separately considered by the Director of Steel Production.

Cleveland and South Staffordshire, Shropshire and Worcestershire Pig Iron.—Basic, £4. 17s. 6d.

Substituted Prices.—Cleveland Pig Iron.—No. 1, £4. 16s. 6d. per ton net f.o.t. makers' works ; other grades, £4. 12s. 6d.

South Staffordshire, Shropshire and Worcestershire Pig Iron.—" Part Mine " forge, £5 ; " Part Mine " found ry, £5. 2s. 6d.

Additions to the Schedule take effect from the date of the notice ; substituted prices from April 2, 1917.

It is further notified that in further modification of the general permit, in all districts an extra charge of 1s. per ton may be charged over the fixed maximum price for basic pig iron cast in chills.

Empire's Aluminium Resources. Inquiries made as to the position of aluminium production within the Empire show (according to a report of the British Empire Producers' Organisation) that notwithstanding the fact that some of the best deposits of bauxite are in foreign territory, namely in France and the United States, the British Empire has an important place amongst the world's producers of this metal.

The best British deposits of bauxite are in the county of Antrim, Ireland, whence the ore is sent to the aluminium works at Foyers and Kinlochleven (Scotland), where the output of metal is now well over 10,000 tons a year. Canada also manufactures nearly as much at Shawinigan Falls, in Province Quebec, from bauxite imported from the United States. A lease of some of the bauxite deposits recently proved in British Guiana has been granted to the company owning these Canadian works on condition that within seven years it establishes in British territory refining works capable of producing about 4,000 tons of aluminium per annum. Large deposits of bauxite which could be worked by simple quarrying are awaiting development in the Central Provinces of India. This bauxite could hardly be exported from India at a profit, but it might be treated on the spot for the extraction of alumina for export, and possibly aluminium metal might ultimately be made in India. The production and utilisation of aluminium have increased enormously during the last three years, especially in the United States ; but it is scarcely possible to over-estimate the importance of the demand which is likely to arise after the war in connection with the construction of commercial aircraft. It will be seen that the British Empire already has a good share in the world's production of this metal, and has also large reserves of the raw material upon which we can draw.

* * * *

Electric Power in Tasmania. The Agent-General for Tasmania (Sir John McCall) has issued a statement as to the steps taken to develop Tasmanian industries.

Sir John McCall said Tasmania was in a position to supply electric power at a cheap rate, which would be a distinct advantage to manufacturers. A factory for the manufacture of carbide had been erected at North-West Bay, near Hobart, and only awaited machinery, which it was difficult to get owing to the war. The manufacture of zinc-spelter could now be carried out without first making zinc in ores into oxide of zinc, as it could be deposited electrically from the solution containing the sulphate of zinc. The Government had completed a scheme to supply 10,000 H.P. from water-power, and as soon as war conditions permitted of them getting additional plant they would increase the power available for industries to 40,000 H.P. In addition to that 40,000 H.P., which had been over-applied for, there were a large number of other sources of water-power which were being examined, and some were being surveyed. He was confident the electric power to be generated from those sources would eventually make Tasmania the home of great industrial works. Anything was possible with cheap power in the development of chemical and metallurgical works.

* * * *

Commercial Education. The Education Committee of London County Council last week adopted the recommendation of the Higher Education Sub-committee to establish advisory consultative committees of business men for banking, chemical industry and engineering, of not more than 12 members each, to advise the Council in regard to schemes of education relating to the businesses mentioned.

The engineering sub-committee is composed as follows : Mr. E. Bruce Ball (Messrs. D. Napier & Sons), Dr Dugald Clerk (National Gas Engine Co. and Messrs. Marks & Clerk), Sir John Snell (Messrs. Preece, Cardew, Snell & Rider), Mr. W. Stokes (Messrs. Ransomes & Rapiers), Sir Vincent L. Raven (North Eastern Railway), Mr. Charles P. Sparks (President of the Institution of Electrical Engineers), Sir Charles A. Parsons (Parsons Marine Steam Turbine Co.), and Mr. J. Dewrance (Messrs. Babcock & Wilcox and Dewrance & Co.).

* * * *

Creosote Order. The Minister of Munitions has issued an Order dealing with creosote and oils from coal tar.

For the purposes of the Order, "creosote" means creosote, green oil, sharp oil, and any oil produced from or containing an admixture of oil produced from the distillation of coal tar, or any of them.

No person shall until further notice, except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions, use any creosote for or in connection with the water-proofing, preservation or treatment of timber or wood of any kind or description.

No person shall until further notice, offer to sell, or, except for carrying out an existing contract for the sale of creosote, enter into any transaction or negotiation in relation to the sale of creosote except under a licence.

Applications for licences should be made to the Director-General of Munitions Supply, Whitehall-place, London, S.W. 1.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Bulk Supply Order.—After inquiry the Board of Trade has decided to grant Rotherham Corporation an order to supply electricity in bulk to the Mexborough & Swinton Tramways Co. for the period of the war and 12 months' after.

Burnley.—The Corporation has applied for sanction to a loan of £1,600 for an aditional feeder cable to the Calder Vale district.

Nuneaton.—The Council is recommended to purchase land near Central-avenue, at an estimated cost of £1,200, to serve as a site for an electricity generating station.

GENERAL.

Board of Trade Electric Power Supply Committee.—In the House of Commons last week the President of the Board of Trade stated, in reply to General Croft (who asked whether, in view of the increased representation of local authorities owning electricity undertakings on the above committee, he would consider appointing a member to represent the provincial electric supply companies), that he was of opinion that the Electric Power Supply Committee as now constituted was sufficiently representative of all bodies owning electricity undertakings, and he was not prepared to make any further additions to it.

In reply to Mr. Gilbert, Sir Albert Stanley said that three members of the committee were directors of electric power supply companies. Mr. Harold Dickinson, who was electrical engineer to the Corporation of Liverpool, was nominated by the Association of Municipal Corporations. Mr. Vesey Knox, K.C., had acted as counsel for many urban district councils owning electricity undertakings, and was nominated by the Urban District Councils Association. Mr. W. B. Smith, of Glasgow, was nominated by the Secretary for Scotland, on the recommendation of the Lord Provost of Glasgow.

City of London.—The Corporation has allowed the City of London Electric Lighting Co. to make an increase of 15 per cent. in its schedule prices for public lighting from now until 12 months after the war.

Donaghadee (Ireland).—The Board of Trade have deferred the revocation of the Council's Provisional Order for 12 months from Aug. 18 next.

Greasborough.—The Urban Council has received notice from Rotherham Corporation of intention to apply for a provisional order for this district.

The Council will not assent to the proposal, and has decided to apply for a Provisional Order, but the Clerk has been directed to ask if the Corporation would be prepared to submit terms for supplying electricity in bulk, so as to enable the Council to supply to consumers at rates not higher than those charged within the borough.

Hackney (London).—An arbitration award has increased the salaries and wages of the staff and employees of the electricity undertaking by £3,526 per year.

Halifax.—Yesterday (Thursday) Lady Rhondda performed the ceremony of starting a new turbo-generator at the electricity supply works.

Edinburgh.—It was announced at the meeting of the Corporation last week that there was a deficit of £4,726 on the working of the electric supply department during the past year, due to increased expenditure for coal and to a decrease in revenue from lighting and power amounting to £9,775.

Itchen.—The Council is considering a scheme for the supply of electricity in bulk.

Power Station Engineers' Salaries.—The Electrical Trades' Union has sent the Marylebone Electric Supply Committee working rules for power and sub-station engineers.

The Union informs the Committee that in the event of the Council refusing to agree to the rates of pay and conditions of labour laid down in the rules the Trade Union Committee will name the Council to appear before the Committee of Production to hear the Union's claim in regard to the matter. The Electric Supply Committee has informed the Union that the wages of the employees have recently been increased, that an agreement had been come to with the representatives of the men, and that the committee is not prepared to re-open the question.

Rotherham.—The Council has increased the salary of Mr. J. R. Lilleker, assistant engineer of the electric supply dept., from £200 to £250; and that of Mr. C. H. Jessop, engineering assistant, from £166 to £200; while the salaries of Messrs. Redmayne (mains engineer), Rodgers (station superintendent), and A. T. Ripley (clerk of works) have been advanced to £200.

Sheffield.—Last week the Corporation increased the salaries of the general manager and engineer of the electric supply department (Mr. S. E. Fedden) and of the deputy manager (Mr. H. E. Yerbury).

Councillor G. E. STEMBRIDGE said the Electric Supply Committee's proposals were based on increased work and responsibility. The undertaking commenced to supply electricity in May, 1892, and up to March, 1914, the total plant capacity was 23,225 kw. (including Kelham Island tramway station, since transferred to the electric supply department), the results of 22 years' working. In less than three years since, the capacity of the undertaking had been increased to 68,225 kw., an increase of 45,000 kw. The units sold in 1914 were 26,546,718, and this year they were estimated to be 122,000,000. From those figures it would be easily seen that the work and responsibility of Mr. Fedden and his assistants had very considerably increased. There was no more important department under the control of the Council. At all costs they should maintain Sheffield as the centre of the steel industry of the world, and it was purely a business proposition that they should remunerate their responsible officials and give them their market value.

Ald. HOBSON contended that to change when they were in the midst of an enormous steel trade expansion was about the most costly thing they could do. He doubted if they could get as good a man as Mr. Fedden—particularly from the engineering point of view.

The proposed increases of salary were adopted.

Swansea.—An agreement has been entered into for the supply of electricity in bulk to the British Mannesmann Tube Co.

It has been decided to furnish steel manufacturers in the town and district with an extract of the I.M.E.A. report relating to steel furnaces and the use of electric furnaces, and to appoint a deputation to visit Hereford and investigate the results of experiments being made in that district in electro-culture.

The engineer (Mr. J. W. Burr) has been authorised to arrange with the Cumberland Engineering Co. for the treatment of the condenser tubes by their electrolytic system for the prevention of corrosion.

Willesden.—The British Oxygen Co. will require about 300 H.P. of electrical energy for a new factory, and the Council are recommended to apply for sanction to borrow £1,200 for h.t. cable and £650 for transformers, switchgear, meters and connections; and also to renew the application made in January last for authority to lay a new h.t. cable from the power station to certain premises, at a cost of £4,000, and a new cable from the power station to a sub-station, at a cost of £3,250.

HYDRO-ELECTRIC NOTES.

Canadian Hydro-Electric Power.—The Cedar Rapids Mfg. Power Co. is putting in two additional 10,000 H.P. turbines with three-phase generators at the Cedar Rapids hydro-electric works. The new units are expected to be ready for service in the autumn of 1918, when the company will be able to supply 120,000 H.P.

Hydro-Electric Power in New Zealand.—In a report on proposals to install hydro-electric power plants in the North Island of New Zealand, Mr. Evan Parry, chief electrical engineer to the Public Works Department of the Dominion says the scheme of development recommended is that three sources of water-power should be developed in the first place, namely, Lake Waikaremoana for the Hawke's Bay district; Arapuni Gorge (about eight miles from Horahora), or some other place to be selected, for the Auckland district; and the Mangahao River for the Wellington district.

These three sources in a natural course of extension will be linked up, thereby enhancing the value of each source by adding to the security of supply and enabling a continuous output to be maintained throughout the whole of the North Island. As regards the Wellington scheme, it is proposed to develop the Mangahao River source of supply by tunnelling through the range of mountains from the Mangahao into the Tokomaru Valley, there diverting a part of the Tokomaru River, and then from this valley through into the Valley of Mangaore, with a power station situated within three miles of the railway at Shannon. It is possible that in the course of time the requirements of the Wellington district will necessitate a further development in the Taranaki district, where there is more than one promising source of power. The cost of providing head works, power-station and plant for 25,000 H.P. required for the Wellington scheme would be, at normal prices, £420,000. The area to be supplied from this source is to include the whole of the Wellington Province as far north as Taihaipe and Wanganui, and the southern portion of Hawke's Bay. It is proposed in the first place to run trunk lines to Wellington, Palmerston North, Wanganui and Masterton as chief centres. The cost of providing the trunk lines, distribution-lines, sub-stations and other services to give a supply in bulk to local distributing authorities and to large power users throughout this area would be £580,000, making a total expenditure of £1,000,000.

Digitized by Google

The suggested source of supply for the Auckland district—viz., the Arapuni Gorge—is capable of providing 120,000 H.P., but, as only 30,000 H.P. are required for known purposes, the initial cost of installation of hydraulic works for such a partial development would make it unduly expensive. Further consideration is therefore being given to this project, with a view to ascertaining whether, within a reasonable time, there is likely to be a market for energy which would justify a scheme for developing the entire horse-power of the Gorge. The extent of the initial installation of power plant and equipment proposed for the Auckland district is a power plant of 30,000 H.P., with trunk lines to Auckland on the north and Te Kuiti and Rotorua on the south, with depots at intervals, and a system of primary distribution to serve intermediate towns and surrounding districts. For this £1,200,000 is required.

It is recommended that the development of Lake Waikaremoana should be deferred and made dependent on the construction of the Napier-Gisborne railway, and that the Auckland and Wellington schemes should proceed simultaneously.

The survey work in connection with the Wellington scheme is more advanced than in the case of the Auckland scheme, and, if labour is obtainable which is very doubtful, the headworks for the former could be put in hand at once and prepared in readiness for machinery and pipelines, which, however, could not be obtained during the war.

LIGHTING AND INDUSTRIAL POWER.

Aberdeen Power Contract.—The Council recently approved an agreement for the supply of electricity for power to Messrs. John M. Henderson & Co. for five years as from Jan. 1 last.

The minimum annual consumption is to be 250,000 units, and the Corporation will supply up to a maximum demand of 400 kw. (including both power and lighting), at £4. 10s. per annum per kilowatt, plus a running charge of 0·47d. per unit used, to be increased or decreased 0·01d for every complete 6d. by which the average price of coal is higher or lower than 22s. 6d. per ton. The consumers are to have the option of being charged for ordinary rates for any complete period of six months (commencing either on Jan. 1 or July 1) during which the period the provision as to the guaranteed minimum consumption shall not apply, and the consumers are also to undertake that during the currency of the agreement they will not install electric generating plant beyond dynamos of about 20 kw. capacity at present in use.

Canadian Electric Mining Plant.—The Granby Consolidated Mining Smelting & Power Co. has recently put in an auxiliary steam power plant at Anyox, British Columbia, at a cost of about £100,000. In the power house there are five 550 H.P. water-tube boilers, one 3,000 kw. and one 2,000 kw. Westinghouse turbine-driven generators.

According to the "Electrical News," the boilers are designed for a working pressure of 200 lb. and 150 deg. superheat, and are served by a continuous brick smoke duct, entering the base of a Custodis radial brick chimney 10 ft. in diameter and 150 ft. high. In the boiler room there are a 3,000 H.P. Blake & Knowles open feed water heater, two Worthington oil-burning sets and two De Laval centrifugal steam turbine-driven boiler feed pumps. In the turbine room there are a 3,000 kw. Westinghouse turbine-driven three-phase 60-cycle 2,200-volt alternator, the turbine exhausting to a C. H. Wheeler surface condenser; one 2,000 kw. Westinghouse turbine-driven generator, the turbine exhausting to a Westinghouse Le Blanc jet condenser; one 100 kw. Westinghouse turbine-driven exciter exhausting to a feed water heater. In the turbine room is also installed a 3,500 cubic ft. 100 lb. pressure De Laval centrifugal compressor, consisting of 14 stages, and arranged to be driven at the one end from an 800 H.P. De Laval turbine without reduction gears, and at the opposite end by an 800 H.P. Westinghouse 2,200-volt induction motor operating through De Laval reduction gears. This unit is said to be the first high-pressure centrifugal compressor installed in Western Canada, and is arranged for two forms of drive, one to be used when the steam plant is in operation, and the other when the water power is adequate to furnish current for the electric motor, which will be during the summer months. The 800 H.P. De Laval turbine is arranged to exhaust to a Schutte & Koerting jet condenser. The turbine room floor is served by a 15-ton hand-operated travelling crane. Circulating water for condensing purposes is supplied by two 12 in. De Laval centrifugal pumps, each directly connected to a 125 H.P. Westinghouse motor. Each pump has a capacity of 4,000 gallons per minute against a total head of 70 ft., and either unit is capable of supplying the full requirements of the plant. The high-pressure steam piping has all been designed for a pressure of 230 lb. and 150 deg. superheat, and the main steam header is of cast steel. The plant is intended to serve the operation of the company during the periods of low water, and it is believed will be in operation for about six months of the year. In connection with the plant is a fuel oil storage system, consisting of a steel storage tank 90 ft. in diameter by 30 ft. high, having a capacity of 35,000 barrels. Oil is received at the company's dock and pumped through about 1,400 ft. of 12 in. diameter pipe to this tank. In the tank is installed a heating coil of special design. Adjacent to the tank is a small concrete pump house, in which is installed a vertical boiler, which supplies steam to the heating coil, and an electrically-driven rotary oil pump delivers oil from the tank through about 900 ft. of 6 in. line to an auxiliary tank buried underground at the power house.

Electric Coal Cutters in Australia.—The "Colliery Guardian" quotes from an Australian newspaper (dated May 16) a Sydney despatch to the effect that Judge Fitzhardinge, who was umpire in the recent Bulli Colliery coal-cutting case, decided that the practice of using electrical coal cutters in the Bulli seam of the Bulli Colliery was dangerous, and, in the interests of the miners and of the mine, should be at once discontinued. His Honour directed that the cost of the umpire and arbitrators and of the Arbitration Court shall be paid by the owners of the Bulli Colliery.

Electric Linotype Pots.—The manager of a municipal electricity undertaking writes as follows:—

In your current issue (July 5) there is an interesting article on page 568 dealing with electric linotype pots as made by the Cutler-Hammer Mfg. Co. This is a proposition which has in no small way rather interested us. Two or three local publishers who use linotype machines have experienced very considerable difficulty in keeping the molten lead at the requisite temperature to give the best results. At present they are heating by gas, and the gas is so indifferent in quality and pressure that it is very difficult to maintain the molten lead in the proper consistency. We have considered the question of fitting some electric method for heating the lead, but so far have not hit on anything at all satisfactory which we could put forward to replace the very indifferent gas heating. I should be very much obliged if you could put me in touch with the British agents who factor this equipment, as I feel sure there is a very wide field for its development in this country.

Electricity in Canadian Farmwork.—The "Electrical News" reports that a number of ranchers to the south of Chilliwack, in the Fraser Valley, recently clubbed together and raised $5,000 for the construction of a power line from the municipal electricity station to their district. The line conveys electrical energy supplied by the British Columbia Electric Railway Co., and it is proposed to use it for various farming purposes. The scheme is the outcome of the pioneer work of Mr. Porter, the electrical engineer of the British Columbia Co., who has for the past two or three years been carrying demonstrations among farmers in the district as to how they might lessen the hard work by taking advantage of the company's system of electricity supply. The farmers of the Chilliwack district are 80 miles from the generating station of the British Columbia Co., but electrical energy is also supplied to many farmers around Vancouver, and in the areas contiguous to the transmission line.

ELECTRIC TRACTION.

Belfast.—The Harbour Commissioners have approved the proposals of the Tramways and Electricity Committee to improve the supply of circulating water to the station.

Burnley.—Owing to a dispute between two of the unions of tramway workers, a general strike of tramway employees commenced on Saturday. Except for four cars worked by inspectors, there was no tramways service, but on Sunday six cars were run.

The cause of the strike is stated to be the refusal of a few of the employees belonging to the Enginemen's Union to join the Tramway Vehicle Workers' Association.

At the time of going to press the strike continued, and the service, though improved, remained disorganised. The Tramways Committee has issued an ultimatum to the employees to resume work or to return their uniforms.

Darlington.—The Board of Trade has confirmed the Darlington Light Railways (Amendment) Order, 1917.

Halifax.—At the last meeting of Halifax Corporation Ald. Spencer, chairman of the Tramways Committee, said he was looking forward to the time when the adoption of electric street sweeping machines would be worked in conjunction with the tramways undertaking.

On Sunday an electric tramcar jumped the metals when descending a gradient on the Queensbury route.

Many passengers received slight injuries, and some eight or 10 passengers were treated at the hospitals.

Liverpool.—The new circular tramway route to Everton and Anfield, by way of Oakfield-road and Breck-road from the old Haymarket, was opened for traffic on Thursday last.

London County Council.—On Tuesday the Council approved the revised regulations as to the management of the tramways.

In future transfer tickets will be issued only when there are no direct services, and will be only available for change of cars at specified points. The issue of workmen's tickets on all-night cars on down journeys will begin at 3 a.m. (instead of 3.30 a.m.) from central termini, and return workmen's tickets will be valid for a return journey only over the section of tramway for which the tickets are issued for the first journey.

Mr. F. C. Harrison, C.S.I., has been appointed a member of the Special Committee on London Electricity Supply, in place of the Hon. Gilbert Johnstone, resigned.

Londonderry.—At the next meeting of the Council a resolution will be proposed that in the next Derry Improvement Bill power should be sought to authorise the Corporation to construct and maintain trackless trolley tramways, or, alternatively, power to run motor omnibuses and electric cars.

Southend.—The Corporation has instructed the Borough Surveyor to obtain tenders for the supply of three electric tip wagons.

Weymouth.—The Corporation have decided to purchase an electric tractor, at an estimated cost of £1,150.

Digitized by Google

TELEGRAPHY AND TELEPHONY.

Brazilian Radio-Telegraph Stations.—The Brazilian Government has issued a decree declaring the wireless telegraph and telephone installations in the country to be the exclusive property of the Federal Government.

Telephone Traffic.—From time to time the Post Office issues for the use of its staff instructions dealing with telephone traffic subjects, such as standards of operating loads and service (local and trunk working), operating procedure and switchroom rules, service code markings, switchboard markings and colour schemes, &c.

As these indicate current practice and procedure they should be of interest to British contractors and consulting engineers who specialise in telephone exchange construction, and copies may be had on application to the Secretary, General Post Office, London, E.C.

IMPERIAL NOTES.

British Guiana Bauxite.—It is reported that bauxite in considerable quantities has been discovered in British Guiana.

Prospecting and development work has been carried on for two years with satisfactory results, and a first shipment of 980 tons was made to the United States in March last.

South Africa.—A report on the trade of South Africa for 1915 and 1916, by Mr. W. G. Wickham (H.M. Trade Commissioner in South Africa), has been issued.

Mr. Wickham states that so far the South African has had little opportunity of judging what developments have taken place in manufacturing in the United Kingdom, and that local firms have not been overwhelmingly impressed with the little they have seen. Whatever British manufacturers are going to be able to do in the direction of capturing or recapturing the South African market, they must realise that the campaign is still in front of them. No doubt they are not, and will not be for a while longer, able to deliver their goods or even to show catalogues and prices; but they should keep alive the goodwill of their connections by advertising and by explaining their actual position and temporary difficulties as fully as is permissible. A good agent should be retained, otherwise manufacturers would have no right whatever to expect an agent to come back to them and throw over American and Japanese agencies after the war. To firms who have not yet interested themselves in the South African market, Mr. Wickham suggests that they should make up their minds now. British manufacturers, who had a reputation for refusing to get out of grooves, should make it perfectly clear that they are not in grooves now. Let them (says Mr. Wickham) prove the assertion with samples, illustrated catalogues or statements of facts. If facilities are given for any organised exhibition of goods in South Africa or in the United Kingdom manufacturers should not fail to take advantage of the opportunity. People want some tangible evidence that the whole of our commercial reorganisation is something more than talk. Equally important is the question of price. Organisation and federation in industries to cheapen production by increasing the scale of manufacture are long over due, particularly in certain branches of engineering, and the maturing of a selling policy can only be carried out by the study of experts in the oversea market itself. From the point of view of the British engineer, Mr. Wickham says it would be unwise to wait until works are released for the production of commercial commodities, and the goods are ready for delivery, before beginning to look into the question of how best to market them.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says the national Government has authorised the Direccion del Colegio Militar to purchase privately the materials necessary for the installation of an electro-technical cabinet and work-room, at a price not exceeding $13,096 m/n. (about £1,150).

A recent decree of the National Government approved an estimate of the Direccion General de Arquitectura for an installation of electric bells, telephones and clocks in the new building of the Colegio Nacional Central for the sum of $9,140 m/n. (about £794).

The report for the year 1916 of the Compania Industrial de Electricidad says the importation of electrical machinery and materials has been stopped, and the company's workshops were devoted primarily to the production of machinery for export. Profits (with the balance brought forward) were $113,075, of which amortisation fund required $77,000, reserve fund $1,803, directors and syndic., $3,607; dividend to shareholders of $5 per share, $30,000; and $664 is carried forward.

China.—The report on the foreign trade of China in 1916 published by the Chinese Customs Dept., shows that net foreign imports at Chinese Treaty Ports were valued at 515,015,404 Haikwan Taels (£85,497,537), compared with 449,589,059 Hk. Taels (£58,446,578) in 1915, of which the share of the British Empire amounted to 263,392,528 Hk. Taels (£43,722,170), against 267,783,488 Hk. Taels (£34,811,853).

Imports of metals, railway materials and electric appliances increased considerably. Electrical materials and machinery and motor cars are required in increasing quantities every year. The average value of the Hk. Tael was 2s. 7¼d. in 1915 and 3s. 3 $\frac{3}{16}$d. in 1916.

Portugal.—A Bill has been presented to the Portuguese Chamber of Deputies proposing to grant State assistance in the establishment of new industries and the development of existing ones.

In the granting of concessions preference will be given to certain industries, including the manufacture of materials for national defence purposes; manufacture of railway rolling stock; construction of vessels of over 1,000 tons; coal mining; mining of manganese, tungsten, chromium, copper and its alloys, zinc, lead and tin; manufacture of steam engines, motors, machine tools; utilisation of water-power; manufacture of electrical material; and chemical and electrochemical products.

It is proposed that new industries should be granted an abatement of 50 per cent. in the payment of land and industrial taxes for five years, and should also be exempt for 10 years from the payment of Customs duties in respect of raw materials imported from abroad. Exemption from export duties for materials produced is also proposed for a period of five years. The Bill further provides for special arrangements between the Government and banking concerns, and for the payment by the State of interest (not to exceed 3 per cent.) on capital issued by new enterprises.

The enterprises must be Portuguese, at least 80 per cent. of the people employed must be Portuguese, and the fuel and raw materials used must be of national production unless they are not obtainable in the country or would cost at least 10 per cent. more than those of foreign origin.

U.S.A. Government and German-owned Patents.—The House of Representatives has passed the Trading with the Enemy Bill, which prohibits business with any country with which the United States or any of its allies is at war, except under licence, and provides for the expropriation by the Government of enemy patents and the property of alien enemies.

MISCELLANEOUS.

Automotive Electric Association.—The first annual meeting of this Association was recently held at Hot Springs, Virginia, when about 40 members, representing 11 of the leading electric vehicle manufacturers of the U.S.A., were present.

The chairman of the Standardisation Committee presented his report and various sub-committees were appointed. In view of the immediate prospects of the member companies being called upon to supply electrical equipment to the Government for use on trucks and aeroplanes, a strong sub-committee was appointed to consider questions pertaining to this work.

The Association holds four quarterly meetings each year, the next meeting to be held in August.

B.E.A.M.A. Membership.—It is announced that the following firms have been elected members of the Association:—

Messrs. Daniel Adamson & Co., Cuthbert Andrews, Benjamin Electric (Ltd.), Burnley Ironworks Co., Fredk. R. Butt & Co., Cambridge Scientific Instrument Co., Cavendish Electrical Co., A. C. Cossor (Ltd.), Harry W. Cox & Co., Creed & Co., Davey, Paxman & Co., A. E. Dean & Co., Douglas & Grant, Gent & Co., Ernest Greville, Hathorn, Davey & Co., Heenan & Froude, Macfarlane Engineering Co., Micanite & Insulators (Ltd.), Newton & Wright, Newtons (Ltd.), Pinchin, Johnson & Co., Pirelli General Cable Works, Reid Brothers Engineers (Ltd.), Wm. Roberts & Sons, George Saxon (Ltd.), Schall & Schall, Small Electric Motors, Submersible & J. L. Motors, Urmson & Thompson and Wood Brothers.

Engineers' Wages.—An award has just been issued by the Committee on Production giving a further advance of wages to all grades of workmen employed by members of the Engineering Employers' Federation.

The award is given in pursuance of an agreement between the federation and 46 trade unions connected with the engineering and foundry trades, under the terms of which the Committee of Production may be called upon at intervals of four months (February, June, and October) to consider what alteration in wages is warranted by the abnormal conditions due to the war.

The previous awards of the Committee gave the men an advance in April last of 5s per week, and thereby established a general advance over pre-war rates of 12s. per week. The awards now issued give a further advance of 3s. per week, making the aggregate increase on pre-war rates 15s. per week. An advance of 1s. 6d. per week is given to boys and youths. The increases take effect as from Aug. 1.

New Book.—By the publication of "The Theory of the Submarine Telegraph and Telephone Cable," by H. W. Malcolm, M.A., Ph.D., D.Sc., an important addition has just been made to THE ELECTRICIAN series of standard electrical works. The book, which consists of 16 chapters and runs to nearly 600 pages, should prove indispensable to telegraph and telephone engineers. It is published at 18s. net by Messrs. Benn Bros. (Ltd.), 8, Bouverie-street, Fleet-street, London, E.C. 4.

Trevithick Memorial.—Mr. Leonard S. Merrifield, sculptor, has been commissioned by Lord Rhondda to execute a statue of Richard Trevithick, "the father of the locomotive engine." The statue will be erected at Cyfarthfa Park, Merthyr.

Unemployment Insurance.—The umpire has decided that contributions are payable in respect of:

Workmen engaged in the manufacture of telephone switchboards for use in war.

Workmen engaged in the repair of accumulators used in connection with electrical machinery in buildings or ships including cleaning sediment from the cells.

Digitized by Google

EDUCATIONAL.

University of Birmingham.—The full courses in the mechanical, civil and electrical engineering departments extend over four years, and students who enter after matriculation, and pass successfully the examinations at the end of each year will be entitled to the degree of Bachelor of Science in Engineering.

Heriot-Watt College, Edinburgh.—At this college there are complete courses of training for mechanical, electrical and mining engineers. The diploma course lasts for three years, and arrangements exist for shortened apprenticeships with local mechanical and electrical engineering firms. Particulars may be obtained from the Principal.

University of Liverpool.—An Advisory Board on Chemistry has been appointed, consisting of representatives of six large manufacturing firms and the chemistry staff of the University, in order to advise the Council, through the Faculty of Science and the Senate, on all matters dealing with the relation between the University and the chemical industries.

The constitution of the Board is as follows: Dr. E. F. Armstrong (Messrs. Crosfield & Sons and Wm. Gossage & Sons), Mr. Roscoe Brunner (Messrs. Brunner, Mond & Co.), Dr. G. C. Clayton (United Alkali Co.) Mr. G. H. Cox (Salt Union), Mr. John Gray (Messrs. Lever Bros.), Mr A. T. Smith (Castner-Kellner Alkali Co.), together with the following members of the University staff: Profs. E. C. C. Baly, W. C. McC. Lewis W. Ramsden, R. Robinson and Drs. Alfred Holt, F. W. Kay and J. Smeath Thomas.

University College.—The following awards have been made in the Faculty of Engineering:—

Goldsmid Engineering Scholarships.—Third year, P. S. J. Bovey; second year, A. A. Clements.

Engineering Diplomas.—Civil and municipal, A. Ezcurra and D. R. Sethi.

Cardiff Technical College.—The salary of the principal (Mr. Charles Coles, B.Sc.) has been increased to £600 per annum, rising by annual increments of £50 to £800.

New Technical Institute.—Mr. H. Seymour Berry has offered to equip a technical mining and engineering institute at Merthyr, at an estimated cost of about £10,000. The local Education Committee has accepted the offer with thanks.

Aeronautical Training.—The Aeronautical Institute of Great Britain has organised a scheme for giving a preliminary aeronautical training to students at the Institute's workshop previous to receiving cadetships in the Air Services.

TENDERS INVITED AND ACCEPTED.

Rotary or Motor Converters, Cable and Conduit.

ILFORD Urban District Council invite tenders for the supply of two Rotary or Motor Converters, 4,400 yds. 0·05 sq. in. three-core e.h.t. 3,000-volt cable and 3,600 yds. two-way stoneware conduit. Specifications and forms of tender from the engineer, Mr. Arthur H. Shaw, M.I.E.E., Electricity Works, Ilford, and tenders must be delivered to the clerk, Mr. Adam Partington, Town Hall, Ilford, by noon, Tuesday, July 31. *See also an advertisement.*

Rotary Converter, Transformer, &c.

MELBOURNE City Council require tenders by noon on July 30 for supply and erection of a 2,000 kw. rotary converter, with transformer and accessories. (Specification No. 388.) Specification, &c., from Messrs. McIlwraith, McEacharn & Co., Pty. (Ltd.), Billiter Square-buildings, London, E.C. 3.

Conduit Boxes.

The COMMISSIONERS OF H.M. WORKS, &c., require tenders by 11 a.m. July 23 for six or 12 months' supply of conduit Boxes. Forms of tender, &c., from the Controller of Supplies, King Charles-street, Westminster, S.W. 1.

DEWSBURY.—The Corporation has accepted the tender of Mossay & Co. for the supply of an electric vehicle, at £911.

DERBY.—The Corporation has accepted the tender of the British Thomson-Houston Co. for a rotary converter and switchgear at £2,314.

NEWPORT (MON.).—The Electricity Committee recommend acceptance of the following tenders for plant in connection with the extensions:—

Messrs. Musgrave & Co., induced draught plant; British Westinghouse Electric & Mfg. Co., electrical equipment for induced draught plant; Davenport Engineering Co., cooling towers.

SWANSEA.—The Council has accepted the tender of Thomas & Evans (at £73. 10s.) for wiring 27 Corporation houses on Trewyddfa Common.

APPOINTMENTS VACANT AND FILLED.

Switchboard attendants are wanted for a generating station in the Manchester district. *See an advertisement.*

The Walthamstow Educational Committee invite applications for positions as assistants in their engineering and trade schools, to commence duties on Sept. 1 next. Assistants are required for experimental science, practical mathematics, engineering workshop practice and in mechanical drawing, &c. Commencing salary £160 per annum. Candidates must be ineligible for military service, and application forms (which must be returned by July 31) from Mr. R. Dempsey, Clerk to the Governors, 2, Tower-chambers, Hoe-street Bridge, Walthamstow, E. 17. *See an advertisement.*

The Ministry of Munitions advertises for engineers experienced in estimating costs prices of machining work.

A test-room assistant is required by Messrs. Allen, West & Co., Lewes-road, Brighton.

An advertiser requires an assistant for electrical testing room, with experience in testing material and standardising work.

A lecturer in electrical engineering will be required in September at the University College, Nottingham. Particulars from the Acting Registrar.

A lecturer in electrical engineering will be required in September for the Liverpool Central Municipal Technical School. Commencing salary £250. Particulars from the Director of Education, 14, Sir Thomas-street, Liverpool.

An assistant electrical engineer is required at the Devon County Asylum, Exminster. Salary £2 per week, with residence. Applications to the Medical Superintendent.

Mr. Geo. Gerald Stoney, F.R.S., M.Inst.C.E., M.I.E.E., is recommended for appointment as professor of mechanical engineering in the Manchester School of Technology. Mr. Stoney, who was educated at Trinity College, Dublin, afterwards joined the staff of Messrs. C. A. Parsons & Co.

Mr. A. S. Hughes, electrical engineer of the Carron Co., has been appointed burgh electrical engineer at Falkirk, at a salary of £325 a year, in succession to Mr. R. Allan Brown, who has joined the R.N.A.S.

Mr. LorenzoW. Migotti, who for the past nine years has been electrical engineer to the Bahia Blanca North Western Railway and manager of the South American Light & Power Co., and who was formerly with the Underground Railways of London, has accepted the post of chief engineer to the Electrical Supply Co. of Rosario de Santa Fé, Argentine Republic.

Mr. Robert Wright, M.A., D.Sc., has been appointed temporary lecturer in organic and physical chemistry at Queen's University, Belfast.

BUSINESS ITEMS.

Patent Development.—Mr. S. M. Davison desires to arrange for the exploitation of patent No. 12,266/1913, for "Improved submarine signal receivers." *See an advertisement.*

Sale by Auction.—Messrs. Wheatley Kirk, Price & Co. will sell on the 25th inst. (by order of the Controller, Mr. E. W. E. Lean, A.C.A.) the entire stock of new machine tools of the United Machine Tool Co. (Ltd.), and also the goodwill of the business and the leasehold interest in 24, Southwark-street, London, S.E. 1.

Formite Products.—By an arrangement with the Lamard Lacquer Co. (Ltd.), 98, Bradford-street, Birmingham, Messrs. Pinchin Johnson & Co. have the sole selling agency for Formite products in Great Britain and certain Continental countries. All communications in reference to Formite products should in future be addressed to Messrs. Pinchin, Johnson & Co. (Ltd.) (insulating varnish department), 26-27, Bevis Marks, St. Mary-Axe, London, E.C.

LIQUIDATION.

Rural Districts Electric Undertakings (Ltd.) is being wound up voluntarily, and Mr. G. W. Brown, 24, Martin's-lane, Cannon-street, London, E.C., has been appointed liquidator, with power to enter into an arrangement for the transfer of the business of the company.

CATALOGUES, &c.

FREEZOR FANS—The General Electric Co., 67, Queen Victoria-street, E.C., are issuing to the trade an attractive glass showcard with an attractive prismatic design of the "Freezor" fan for display on the counter or in the shop window. We understand that this novelty, which is calculated to arrest the attention of vistors or passers-by, is being issued only to genuine dealers in Freezor fans.

SWITCHGEAR.—We have received from the British Thomson-Houston Co. a copy of their new descriptive list (No. 4,160) of their ironclad, draw-out, oil-break switchgear.

Digitized by Google

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Bury.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £210,476 (increase £7,119), of which £59,929 has been redeemed, while the sinking fund amounts to £14,236 and the reserve fund to £10,548.

Revenue was £46,596 (compared with £41,308 in previous year), generating costs were £29,447 (£25,455), interest required £5,969 (£5,989) and sinking fund £8,512 (£7,861), leaving net profit £2,668 (£2,003), of which £1,000 is allocated to relief of rates and £1,668 placed to reserve. Generating costs were 0·5d. (0·45d.) per unit, and total costs, including capital charges, 0·75d. (0·69d.). Average price obtained was 0·8d. (0·734d.). Maximum load was 5,027 kw. (4,806 kw.) and load factor 31·7 (32·1) per cent. Units generated were 15,664,466 and sold 13,971,547 (13,503,701).

Mr. S. J. Watson (engineer and manager) says in his report 25 consumers, with the equivalent of 7,466 8 c.p. lamps, have been connected, making a total of 1,064 consumers with 295,245 8 c.p. lamps. Two motors (=45 H.P.) have been hired out and 22 motors (=77½ H.P.) put in by consumers at their own cost. The net result is a decrease of 4 in number and an increase of 36½ in horse-power of hired motors and an increase of 24 owned motors (=88½ H.P.). The totals are now 58 (=624½ H.P.) hired and 971 (=8,014 H.P.) owned motors. Average price of coal was 17s. 9d. (against 15s. 9½d.), fuel used per unit sold was 2·95 lb. (3·06 lb.) and coal cost per unit sold was 0·281d. (0·259d.). Owing to the decision to defer extensions at the Chamber Hall power station the small and comparatively uneconomical plant at Rochdale-road had to be used to a considerable extent. In view of the importance of conserving the national supplies of fuel, Mr. Watson says it is unfortunate that the delay in providing an extension of the modern plant should have led to the use of 1,031 tons more fuel than would otherwise have been necessary and to an extra cost of £909.

Coventry.—The accounts of the tramways department for the year ended March 31 show gross capital expenditure £239,744 (increase £346) and the total amount of the sinking fund is £26,000.

Revenue was £61,447 (compared with £52,987 in previous year) and working expenses were £38,980 (£33,080). Interest required £8,636 (£8,300) and sinking fund £5,988 (£5,988), leaving net profit £7,279 (£5,091). Average total revenue per car-mile was 14·239d. (12·612d.) and working expenses, including power, were 9·033d. (7·874d.). Average fare charged per mile was 0·798d. Passengers carried were 13,766,182 (11,419,360), car miles run 1,035,683 (1,008,247), and units used 1,688,211 (1,677,143).

Harrogate.—The accounts of the electricity department for the year ended March 25 show gross capital expenditure £133,386, of which £69,181 has been redeemed.

Revenue was £19,736, and total expenditure was £11,456, leaving gross profit £8,280. Interest required £2,025, instalments of loans £1,890, and sinking fund £3,870, and £908 of capital expenditure was defrayed out of revenue, leaving £85 to transfer in aid of local rate. Units generated were 2,020,309 and sold 1,486,856. Total maximum supply demanded was 900 kw.

Manchester.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £3,165,134 (increase £52,728), and the mortgage debt now stands at £1,656,902.

Revenue was £742,072 (compared with £620,000 in previous year) and expenditure £447,397 (£346,070), leaving a balance of £294,675 (£273,930), of which £28,630 (£25,419) has been placed to renewals suspense account and £131,076 (£125,695) to sinking fund. Interest required £72,079 (£67,919) and income tax £31,805 (£25,444), £1,085 was applied to extension of works, &c., and £30,000 (£29,453, including £547 from reserve) contributed in aid of rates. Kelvins generated were 213,273,460 (181,322,835) and sold 172,267,789 (141,551,699), of which 143,927 267 (113,327,535) were sold to private consumers. Total maximum supply demanded was 51,700 kw. (42,976 kw.) for lighting and power and 10,000 kw. (10,000 kw.) for traction.

The report of the Electricity Committee states that the balance on the renewals suspense account is £184,087, and the reserve fund stands at £16,996, and profit applied in purchase of warehouse property and land and in extension of works is £99,869. At Stuart-street station the British Westinghouse Co. have completed the contract for a 5,000 kw. turbo-alternator, and Messrs. Jas. Howden & Co. have installed a high-pressure turbine for coupling to an existing 4,500 kw. alternator. The 15,000 kw. turbo-alternator, for which Messrs. Richardsons, Westgarth & Co. are the contractors, is expected to be in commission by September next. A further contract has been placed with the same company for a 20,000 kw. turbo-alternator. Messrs. Babcock & Wilcox have installed two boilers of 65,000 lb. evaporative capacity each, with coal conveyors, and the same firm have well in hand contracts for six additional boilers of large capacity. Messrs. W. J. Jenkins & Co. have in hand extensions to the coal-conveying machinery in the boiler houses. Additional cooling towers had been installed by the Klein Engineering Co., the Davenport Engineering Co. have further contracts in hand, and the British Thomson-Houston Co. have in hand contracts including the installation of high-capacity generator switchgears, 'bus-bar reactances and a new feeder board. For Bloom-street station the British Westinghouse Co. have also in hand the work of installing a 10,000 kw. turbo-alternator. The amount of coal carried in stock is to be increased, and to facilitate this further land is to be acquired for storage and mechanical coal-handling appliances are to be installed. The average price paid for coal rose 38d. per ton. The average weight consumed per kelvin was reduced by 0·04 lb. A net increase of 4 miles of mains is recorded. The efficiency of the distributing system was 87·21 per cent., the quantity lost or absorbed in mains and distributing stations having decreased 1·92 per cent. A list is given of 27 firms to whom new or additional supplies have been, or will shortly be furnished, chiefly through their own sub-stations, and it is stated that substantial additions to the plant at Corporation distributing stations have been made.

Sunderland.—The accounts of the tramways department for the year ended March 31 show gross capital expenditure £307,120 (increase £27), of which £148,950 has been repaid, while £10,853 has been contributed out of revenue for capital outlay.

Revenue was £85,513 and working expenses were £49,969, leaving gross profit £35,543. Interest required £6,808, income tax £4,094, repayment of loans £13,368, renewals fund £6,097, instalment for Wheatsheaf offices £400, and car covers £27, leaving £5,000 to transfer to borough fund in aid of rates. Revenue per car mile was 14·026d. (against 13·121d. in previous year) and working expenses were 8·196d. (7·372d.). Passengers carried were 21,711,489 (19,908,911) and car miles run 1,463,281 (1,447,177).

Taunton.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £81,558 (increase £142), of which £39,806 is outstanding.

Revenue was £12,749 and working expenses were £7,282, leaving gross profit £5,467. Interest required £1,232, loans fund account £3,532, renewals £14 and reserve £521. £134 has been transferred to capital account and £32 to substation, &c., account, and the balance carried forward is £360. Total maximum demand was 511 kw. (603 kw.). Units generated were 1,007,395 (1,177,306) and sold 784,395 (950,571).

Winchester.—The accounts of the electricity supply department for the year ended March 31 show gross capital expenditure £106,965 (increase £3,678), of which £6,490 has been repaid.

Revenue was £14,434 (compared with £14,408 in previous year), and working expenses were £8,833 (£8,582), leaving gross profit £5,600 (£5,826). Loan redemption and interest required £5,015 (as in previous year), reserve for redemption of loans £160, expenditure in the nature of capital £32 (£50), and bank interest £261 (£155), the net profit being £131 (£575). Coal used per unit was 6·10 lb. (5·53 lb.), costing 0·724d. (0·575d.). Units generated were 1,214,530 (1,307,030), and sold 910,131 (988,366) Maximum load on station was 59 kw. (616 kw.).

Mr. R. Ayton (city electrical engineer) says in his report the balance of revenue, after deducting working expenses, is 5·24 per cent. (against 5·56 per cent.) on the capital, this decrease being due to reduced output and increase in price of materials and of wages. Sales of current show a reduction of £1,184, due to decrease of private and public lighting and power units, the decrease in lighting units being attributable to the operation of the "Summer Time" Act and restricted lighting regulations, and the diminution of power units is due to shortage of labour, restrictions on "non-war" industries and a general desire for economy. Charges for current were increased 15 per cent. from Oct. 1 last, and further increased to 25 per cent. for the last quarter of the financial year.

Heating and cooking units (165,422) show an increase of 48·6 per cent. The sale of energy at a low price for these purposes, Mr. Ayton says, is undoubtedly a sound financial proposition. At present coal was costing £900 more per annum than in 1915.

L.C.C TRAMWAYS ACCOUNTS.

The accounts of income and expenditure of the tramways department for the year ended March 31, 1917, were submitted to the London County Council on Tuesday.

Owing to shortage of staff and the need for economy, certain tables and charts which are usually printed have, following the practice adopted last year, been omitted. The accounts have been approved by the Finance Committee. The tramways system on March 31, 1917, extended over a total length of 149 street miles, being 144½ miles of electric lines and 4·6 miles of horse lines. The whole of the system is worked by

Digitized by Google

the Council with the exception of 2¼ miles (partly double and partly single line) in Harrow-road which is worked by the Metropolitan Electric Tramways, Ltd. The only horse tramway routes not yet electrified are those in Burdett-road and Grove-road, &c., and in Southwark-park-road, &c.; and as the services on these tramways have been withdrawn, the system in operation consists entirely of electric tramways. During the year the only work of tramway construction undertaken was the doubling of certain portions of single line in Woolwich.

The total income during the year was £2,552,203. 14s. 3d. and the working expenses (including war service allowances) were £1,817,693. 19s. 3d., leaving a surplus of £734,509. 15s. The undermentioned charges have to be set against the surplus:—Debt charges—interest (£314,164. 12s. 2d.) and redemption (£429,850. 18s. 1d.), rent drawbacks, &c. (£7,557. 2s. 3d.), income and property tax (£73,000), parliamentary expenses (£18. 11s. 10d.), debt charges on cars and car sheds (amount due to Metropolitan Electric Tramways for mileage run off excess mileage run by Council in 1915-16) (£1,521. 8s. 1d.), a total of £826,112. 12s. 5d.

Less tax deducted and retained from interest on debt (£76,791. 19s. 1d.), interest on cash balances, &c. (£10,484. 15s. 11d.), rents from surplus property (£11,339. 16s. 9d.), debt charges on moneys advanced to London United Tramways for reconstruction of tracks (recoverable from company) (£4,252. 4s. 1d.), debt charges on cars and car sheds in respect of excess mileage run by the Council on behalf of East Ham Corporation (£50. 4s. 1d.) and surplus on Drake-buildings (£26. 7s. 9d.), a total of £102,945. 7s. 8d., leaving a surplus to be transferred to the renewals fund of £11,342. 10s. 3d.

The renewals fund amounted on March 31, 1917, to £282,978. 0s. 5d. Previously to the year under review there has been no payment into this fund since the year 1912-13, except interest paid on investments and amounts received from the London United Tramways (Ltd.). The general reserve fund on March 31, 1917, amounted to £72,390. 10s. 9d. In the case of both funds the balances stated take no account of the depreciation of investments.

The operating expenses were £1,694,609. 6s. 9d. (excluding war service allowances of £110,155. 12s. 10d. and certain special charges amounting to £12,928. 19s. 9d.). The total number of passengers carried during the year was 586,127,976; the number of car miles run was 49,478,973, compared with 545,423,397 and 47,879,675 in 1915-16. The gross passenger receipts were £2,476,309 against £2,278,115 and the average passenger receipts per track mile £17,479 against £16,097.

The capital expenditure on the undertaking up to March 31, 1917, amounted to £13,570,119. 1s. 11d., of which £53,542. 4s. 4d. represents expenditure during 1916-17. The amount of the debt incurred up to March 31, 1917, was £13,930,659. 17s. 7d. The net debt on March 31, 1917 (*i.e.*, debt outstanding, less sinking fund in hand, and less £120,216 in respect of the value of surplus land), was £9,141,826. 6s. 8d. The amount of capital expenditure, which up to March 31, 1917, had become obsolete owing to the electrification of horse tramways, was £2,024,687. 15s. 3d. Deducting the amount provided for the redemption of the debt in respect of such capital and the proceeds of the sale of horses and old materials, the amount still to be provided for in respect of the debt under this head is £943,740. 15s. Certain other expenditure amounting to £117,829. 15s. 4d., incurred in connection with electric traction, has also been rendered obsolete.

The sum paid as rates on the permanent way amounted in 1916-17 to £64,413. 7s. 10d., and represents an average relief to the rates of London of about ½d. in the £. The saving to the road authorities in consequence of the obligation of the Council to maintain the paving along the tramway routes is estimated by the Council's officers at about £140,000 a year on the present mileage; this estimate being based, of course, on the normal standard of maintenance. The amount chargeable to the tramways account in respect of the cost of effecting street improvements carried out along tramway routes, under resolutions already passed by the Council, is approximately £800,000, of which £733,463. 12s. 7d. had already been so charged up to March 31, 1917, whilst in addition the amount estimated to have been paid to tramway companies (as part of the purchase money for their undertakings) in respect of the expenditure incurred by them on street improvements is £40,576. The whole of the latter amount has been charged to the tramways account, making a total charge up to March 31 last of £774,039. 12s. 7d. The amount actually charged to the tramways account during the year 1916-17 in respect of rates on tracks (£64,413) and street widenings (£36,044), together with the estimated saving to local authorities on maintenance of paving (£140,000) gives a total of £240,457.

Workmen's car services are provided from 4 a.m. onwards on practically all routes at a fare of 1d. single and 2d. return. The average length of the workmen's routes is over 5 miles. The longest (from Beckenham-lane to Victoria-station) is 9½ miles, whilst the shortest, from Tower-bridge to Waterloo-station, is 2 miles.

The Highways Committee also submitted revised estimates of the receipts and expenditure of the tramways for the year 1917-18. In May it was anticipated that the traffic receipts would be £2,462,500, but they now thought that they would be increased by about £208,000, and instead of an estimated deficiency of £89,402 there would be a surplus of £8,598. The surplus on working is £717,300, and with interest, &c. (£22,112), the total working surplus is £739 412. Debt charges (including £428,320 for repayment of capital and £293,692 for interest on capital expenditure) amounted to £722,012, and income tax, expenditure on surplus property and sundry items £8,802, leaving £8,598 to be transferred to the renewals fund. The estimates contain provision of £114,300 for the payment of war service allowances to officers and employees on war service.

The estimates were adopted without comment.

COMPANIES' MEETINGS AND REPORTS.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—The revenue of the company (in Canadian currency) from securities owned and under contracts with subsidiary companies was $5,764,764.06, and with interest on advances to subsidiary companies ($254,709.02), the total was $6,019,473.08. General and legal expenses, administration charges and interest were $344,830.98, leaving a surplus of $5,674,642.10. Four quarterly dividends at 1¼ per cent. each on the preference shares ($600,000), and at 1 per cent. each on the ordinary shares ($4,251,488) were paid, and a surplus of $823,154.10 carried forward. The decline in the surplus compared with the year preceding the war is due to the fall in the exchange value of the milreis. The revenue in Brazilian currency derived from the operation of the enterprises has shown each year substantial gains, the gross and net earnings in 1916 being 84,942,232 milreis and 46,526,196 milreis, against 77,119,208 and 44,176,866 milreis in 1915 and 73,184,714 and 41,879,569 milreis in 1914. A new company, entitled "Rio de Janeiro & Sao Paulo Telephone Co.," has been incorporated under the laws of Canada for acquiring and developing the telephone enterprises. This company, which has a share capital of $5,000,000 and an authorised issue of $7,500,000 6 per cent. 30-year bonds, has acquired the shares of the Brazilianische Electricitats-Gesellschaft, the Interurban Telephone Co. of Brazil, the Companhia de Telephones Interestadoaes, the Companhia Telephonica do Estado de Sao Paulo, and the Companhia Rêde Telephonica Bragantina. The entire capital share of the new company has been issued as fully paid to the Rio de Janeiro Tramway Light & Power Co. or its nominees, in consideration of the transfer by the latter to the new company of the shares which it owned of the companies exploiting the telephone services in the City and State of Rio de Janeiro—viz., Brazilianische Electricitats-Gesellschaft and the Interurban Telephone Co. of Brazil. The arrangements for the purchase of large controlling interests in the other telephone companies referred to above were consummated early in 1914, but owing to the outbreak of the war, it became impossible to finance the expenditures in the usual manner by an issue of bonds. Under working agreements made between the new company and the five subsidiary telephone companies, the new company is entitled to all their earnings, and on the other hand, provides for their capital and other requirements. The plan of the new company is to consolidate these several undertakings into one comprehensive telephone system. A considerable amount of work in this direction was carried out during the past year and is still in progress, and the board has every expectation that the results which will be obtained from the fusion will prove eminently satisfactory. During the year the concessions and the plant and equipment used in the tramway services of Companhia Sao Christovao, Companhia Carris Urbanos and Companhia Villa Isabel were transferred to the Rio de Janeiro Tramway, Light & Power Co. (Ltd.), thus necessitating some adjustments in the accounts of the latter company. The surplus profits of the several subsidiary companies and this company since their incorporation, which at Dec. 31, 1915, remained undistributed in dividends, amounted to $14,773,244.32.

GENERAL ELECTRIC CO. (LTD.)—Mr. H. Hirst, who presided over the meeting on Tuesday, said the total net profit had increased by about £70,000 over the previous year; £30,000 of it was on trading account and about £40,000 was the increase in revenue from investments. The net revenue from investments had grown, mainly due to their acquisition of shares in the Osram-Robertson Lamp Works. The scarcity of raw materials and skilled labour and the uncertainty of the patent situation, as well as certain war work, which interferes with the standard output, made it more than likely that the revenue from that investment may not be quite up to this year's level in the near future. They had, however, planned extensions, acquired improved methods of manufacture, and made arrangements for the starting of a research laboratory, so that they felt that as soon as they could go full speed ahead they should again reap the fullest benefit from that bold venture. Raw material prices were still soaring at a great height. To-day the same amount of business as in pre-war time necessitated the employment of nearly double the amount of money; on the other hand, credit was considerably shorter, purchasing was more irregular, through difficulties of transport, and funds must therefore be at their disposal at a moment's notice in order to secure materials when they were to be had. He hoped that the ordinary shareholders would approve their refunding the income-tax to preference shareholders by way of a special bonus. The ordinary shareholders were reaping the full benefit of the prosperity of the company, not only by an increased dividend, but also by the appreciation of the value of their shares. The directors felt that they had been just to the demands of labour and employees, and thus the only class suffering under present conditions was the preference shareholder, who had a fixed rate of income with an increasing rate of income-tax.

Some ordinary shareholders thought that the results of the year warranted a bigger dividend. He appealed to them to be satisfied with their proposal. The present war would change many things—perhaps everything. Nothing would be quite as it was before the war, but of all the changes that would alter industry in this country, the electrical industry would undergo the most drastic transformation. Electrical plant in the country at the present moment was run at high pressure to a premature death. Under present conditions none but the most important plant could be replaced, and the replacement and re-organisation necessary after the war would be a tremendous task for the existing electrical companies, which had yet to make good a deficiency in output to cover the demand which in pre-war times was supplied by importation.

Digitized by Google

War had taught this country the necessity for home production. Many industries on which this country relied would have to modernise their methods and rejuvenate themselves. Electric power, heat and light were primary essentials in the carrying out of such a programme. The depletion of rolling stock in the country would have to be made good, and railway electrification on a large scale had suddenly appeared within the realm of immediate practical politics, for which many of us must prepare. Greater efficiency and economy throughout the country occupied the mind, not only of industrialists but also of Government departments. He was convinced of the necessity for the creation of large generating stations in some 15 to 20 centres throughout the kingdom, so that, instead of coal being transported to big power units, big power units would be transported to the coalfields, and after the extraction of by-products, electric current or gas, or both would be transmitted to towns and industrial undertakings to supply power, light and heat through cables and pipes, and the necessity for the conveyance of coal by rolling stock would be reduced to a small proportion. Many industries, especially certain chemical industries—above all, the production of fertilisers—would thus become practicable in this country, whereas in the past they were relegated only to countries where water-power was available. Power, the foundation of all modern industry, would then, thanks to our natural resources, be produced in this country as cheaply as, if not more cheaply than, in any other part of the globe. Their capital and the skill of their directors and staff would, however, not alone bring about these changes which were so essential for the national benefit. They must, above all, have the co-operation of labour. He was happy to think that the relationship between the management of the company and labour throughout their history had been good— as good as that of any concern in the country. Yet there had been in the past occasional periods of tension and stress which, in spite of goodwill on both sides, had been difficult to overcome. He was glad to think that present conditions had brought about better vision. The conditions of the country, and more particularly the outlook after the war, had made it clear to all that mutual understanding was essential in the national interests. The leaders of industry and labour had at last met to exchange views; they were comparing notes and formulating ideas, even programmes, which should go far to remove a great many of the past difficulties, and he hoped that before this war was finished a means or machinery might be found which would solve any future difficulties. Mistrust and prejudice had been preached, and it required not only goodwill and intention, but also a period of probation and experiment of the most varied kind to bring home to each side a conviction of the sincerity of the other. After referring to the employees in H.M. service, he said they were also proud of their men who were left at home. Thanks to their unselfish devotion, extraordinary efforts and self-denial, it had been possible to fill the gaps created by the absence of their brothers in the Army. In addition to their own increased duties, both staff and workpeople, had spared neither health, time nor energy to impart their knowledge to women and unskilled labour, and had devised new tools and methods to suit present conditions, so that the company's output has not only been maintained, but considerably increased.

The report and accounts were then adopted, a dividend of 10 per cent. per annum on the ordinary shares was declared, and the retiring directors and auditors were re-elected. The resolution to refund to the preference shareholders the income-tax deducted from their dividends was also approved.

LANCASHIRE POWER CONSTRUCTION CO. (LTD.)—The directors' report states that the trading profit of the Lancashire Electric Power Co. for the year 1916 amounted to £38,710, and with interest on hire purchase plants, &c. (£1,129), the total was £39,839, compared with £32,843 for 1915. The balance brought forward from 1915 was £2,064, making the amount available for division £41,903. Debenture interest required £4,500; and £15,000 was placed to reserve fund, and a dividend of 3 per cent. has been declared on the share capital issued (£14,700), leaving to be carried forward £7,703. The units generated in 1916 were 40,842,652, against 35,768,064 in 1915, and 32,157,185 in 1914. The maximum load was 11,900 kw. against 10,740 kw. in 1915, and 10,210 kw. in 1914; the horse-power connected was 30,600, against 29,000 and 27,018 respectively. The receipts were £97,964, £72,395 and £65,433; the expenditure was £59,254, £40,160 and £35,472, and the profit on trading £38,710, £32,235 and £29,961 respectively.

The revenue account of the Lancashire Power Construction Co. shows that the total interest, dividend and other receipts for the year ended March 31, 1917, amounted to £19,205. 1s. 4d., and after deducting debenture interest, trustees' fees and general charges payable (£15,468. 7s. 2d.) there is an available balance of £3,736. 14s. 2d., which it is proposed to carry to reserve. The bill to re-arrange the capital of the company and for other purposes, having passed both Houses of Parliament and received the Royal Assent, the rearrangement of the company's capital will now be proceeded with.

NORTH MELBOURNE ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The gross receipts for the year ended Sept. 30 last show an increase from £33,462 to £40,358. The expenses (principally due to increased wages and high cost of materials and freight) increased from £21,730 to £28,888; the net revenue was £11,470, compared with £11,732. Capital expenditure amounted to £1,917. A contract has been entered into with Melbourne City Council for the lighting of Flemington and Kensington, and the work of laying the mains and erecting the standards is being proceeded with.

W. & T. AVERY (LTD.)—After making provisions for depreciation, excess profits duty, munitions levy and reserve, the available balance is £53,740. A further dividend of 10 per cent. (less tax), making, with the interim dividend, 12½ per cent. for the past year, has been declared; £13,000 has been placed to reserve, and £12,564 carried forward.

At the extraordinary general meeting, held on the 17th inst., it was decided to alter the articles of association to extend the scope of the business, so as to include the following: "Mechanical and electrical engineers, electricians, manufacturers of machines and appliances for the generation, storage and distribution of electricity, hardware and tool makers, machinists, &c."

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

ALFRED HERBERT (RUSSIA) (LTD.) (147,920.)—Private company. reg. July 10, capital £25,000 in £1 shares, to carry on in Russia or elsewhere the business of buying, selling, manufacturing, repairing and letting on hire machines, machine tools and plant, electric, hydraulic and mechanical engineers, &c. Permanent governing director, A. Herbert.

ATWELL FOUNDRIES (LTD) (147,857).—Private company, reg. July 2, capital £5,000 in £1 shares. , Iron, aluminium, copper, tin, bronze, brass and steel founders and casters, boiler makers, wire drawers, cable manufacturers, electricians, &c. First directors are:—E. H. Sollas and S. W. Oakley. Reg. office: 52, Gracechurch-street, E.C.

C. A. CARPENTER (LTD.) (147,868).—Private company. reg, July 3. capital £4,000 in 3,000 10 per cent. non-cumulative preference shares of £1 and 20,000 deferred shares of 1s. each, to take over the patent rights of C. A. Carpenter, connected with burglar and fire alarms, and to carry on the business of electrical and general engineers, &c. Reg. office: 79, Gresham-street, E.C.

LOCHSIDE ENGINEERING CO. (LTD.) (147,897).—Private company, reg. July 6, capital £10,000 in 9,500 preferred ordinary "A" shares of £1 and 10,000 deferred ordinary "B" shares of 1s. each. mechanical and electrical engineers, founders, &c. Agreement with M. L. Jones. First directors are:—R. Mitchell, J. O. Early, F. J. Roden, T. T. Williams and M. L. Jones. Reg. office: 117, Victoria-street, S.W.

MARINE METAL CO. (LTD.) (157,855.)—Private company, reg. June 30, capital £10,000 in £1 shares, concentrators, smelters, crushers, refiners and treaters of ores, minerals and alloys, engineers, founders, metal workers, manufacturers of electrical or other furnaces, &c.

MORTGAGES AND CHARGES.

ELECTRICAL CONTRACTS & MAINTENANCE CO. (LTD.)—Particulars of £3,000 debentures created June 20, 1917, have been filed, whole amount being now issued. Property charged: company's undertaking and property, present and future. No trustees.

TYNE ELECTRIC STEEL FOUNDRIES (LTD.)—Issue on June 19, 1917, of £200 and on June 25 of £100 debentures, part of a series of which particulars have already been filed.

RECEIVERSHIP.

PULLAN ENGINEERING CO. (LTD.)—Notice of appointment of T. Paton, 3, Piccadilly, Bradford, as receiver and manager on June 21, 1917, under powers contained in debenture dated Nov. 18, 1916, has been filed.

CITY NOTES.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—The directors have issued an interim report of the position of the company. It is stated that in 1900 the City of Vancouver entered into an agreement with the company which contained a clause for the purchase of the company's undertaking under certain conditions, but recently the corporation promoted a bill to enable them to engage in electricity supply, and the Legislature has now passed this bill, which will enable the city to compete with electric light and power business after June 1, 1919. It is also pointed out that in view of the provision of the company's franchise and the special clauses on the subject contained in the Vancouver Incorporation Act, it cannot be contended that the company's charges for light and power afford any justification for the breach by the Legislature of a bargain made 17 years ago on the faith of which the company has invested many million pounds in British Columbia. The report also deals with the position of the company's employees, &c.

CREED & CO. (LIMITED & REDUCED).—A petition for confirming a resolution reducing the capital of this company from £130,000 to £90,000 will be heard by Mr. Justice Eve on July 24.

MATHER & PLATT (LTD.)—An interim dividend of 5 per cent. (less tax) has been declared on the ordinary shares for the half-year ended June 30, being at the rate of 10 per cent. per annum.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—An interim dividend of 2 per cent. per annum (1s. per share) has been declared on the ordinary shares for the past half-year.

RANSOMES, SIMS & JEFFERIES (LTD.)—Messrs. James A. Goodwyn, John H. W. Pawlyn and Victor W. Bone, who have all been responsible members of the staff for many years, have joined the Board as managing directors.

Digitized by Google

THE ROUND TABLE.

By "KVA."

According to a recent newspaper report a householder applied at the local police station to ask for advice in connection with war bread. He produced a sample which he could not eat, and which on no account must he throw away. After this experience it would be as well if Mr. Selvey or some other fuel expert inquired into the calorific value of this material. It may be that a lot of B.T.U.s might with advantage be converted into B.O.T.U.s.

* * * *

It is becoming more and more apparent that the Coal Controller will function only in respect of the transport and not of the price nor the quality of our coal. In other words, though he is Coal Controller he is in no sense smoke or soot controller.

* * * *

Through the courtesy of British Insulated & Helsby Cables I am able to reproduce this quite artistic little snapshot of the Lady Cable Layers. Now that the navvies are all over-seas potting Huns or making roads, the laying of cables must still be carried on. But I think there might be some improvement on the trousers. Why not putties in Blackley or Guttaroid tapes? They would be more in keeping with the work in

THE LADY CABLE LAYERS AT WORK.

hand, and I'm sure the ladies would put them on becomingly. Incidentally, I understand that cable laying is conducive to improvement in one's vocabulary; the "lady ganger" in the picture (with the lamp) looks too charming even in trousers to be given to strong language. I wonder what she says when the "gang" put a kink in the cable and try to straighten it out with sledge-hammers.

* * * *

There are no flies on the editor of "Edison Life." My copy for June has just arrived from Boston, and contains the following, which set me figuring:—

In anticipation of the preparations necessary Congress voted a war loan of $7,000,000,000, an amount of money equivalent to an expenditure of approximately $7 per minute since the beginning of time.

I thought it was a very tall claim, but work it out yourself. There are over half a million minutes in the year. Still, I expect Mr. Hope Jones would dispute that that was the beginning of time!

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, July 17, 1880.]

MONTREAL.—Experiments have been made with the electric light for the purpose of ascertaining how far it would permit of continuous work in the harbour. It was found that practically loading and unloading vessels could be carried on by its aid as well by night as by day.

STRIKE OF TELEGRAPH BOYS.—It is stated that the telegraph boys of Newcastle-on-Tyne object to a reduction of the payment per message delivered, and in consequence, to the number of more than 80, have struck work. We think the boys have been ill-advised, and that it would have been better to have had the case considered carefully by the central authorities before takng siuch a rash step.

STOPPING ENGINES.—An improved method of stopping engines has been devised by Mr. James Tate. The main object of this device is to enable any child or unskilled person in any part of a mill to stop the engine in case of an accident. By touching a spring similar to the spring of an electric bell an electric ball is set in motion, and the ball drops and shuts one of the valves, which prevents the steam from escaping, and the engine is brought to a standstill.

There may, indeed, be a tendency of all the present energies of nature ultimately to pass into one uniformly-diffused heat quiver; it may be, indeed, that, in some incalculably remote age, all the changes will have been rung upon the present distribution of the forms of energy, and that the vitality of all nature will exist merely in a universal pulse. Yet the grand generalisation of modern times constrains us to believe that in that pulse will be found the exact representation of every motion and form of energy at present operating around us, that, in fact, energy is co-eternal with matter.

The Diffusa Reflector Fitting.—The Sun Electrical Co. (Ltd.), 118 and 120, Charing Cross-road, London, W.C. 2, has placed on the market a new type of Sunlite P.E. reflector fitting. This unit is designed for use with half-watt lamps and consists of a standard Sunlite P.E. extensive reflector fitting, having an opalescent reflector bowl suspended from it by three chains and ingenious spring clips. These clips, while securely holding the bottom reflector in position, do away with the necessity of boring the glass bowl. The bowl is so placed in relation to the top reflector that the resulting illumination is a combination of diffused and indirect light. The lighting effect is similar to that obtained with the company's standard semi-indirect unit, but is concentrated over a slightly smaller area. The three-

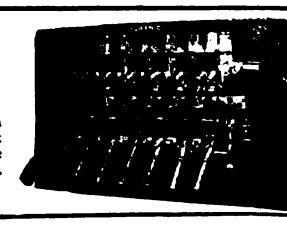
point suspension does away with the shadows usually thrown by ring fittings. Ample ventilation is provided, there being in addition to the opening between the top reflector and bowl adequate ventilation holes in the neck of the fitting, which is shown in the accompanying illustration. This system of lighting is especially suitable for use where fine intricate work involving great accuracy is carried out, as it does not tire the eyes.

'IGRANIC'

No. 30. MULTIPLE SWITCH STARTERS
with TOGGLE JOINT interlocking levers
and HEAVY LAMINATED CONTACTS.

High inertia machinery, such as crushing mills, individually driven by electric power impose abnormal stresses on the motor starter for which special provision must be made.

Sliding contact starters under such conditions have only a short life and require constant renewals. Toggle Joint Multiple Lever Starters always withstand this severe service satisfactorily and give full protection to the motor.

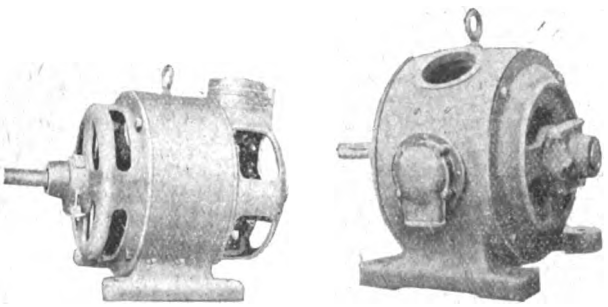


IGRANIC ELECTRIC Co LTD 147, QUEEN VICTORIA STREET, LONDON.

Digitized by Google

SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current. For Three-phase Current.

for
ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept. 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

"FORMITE"

(Trade Mark)
For Moulded & Built Up Insulation

HEAT, ACID & SOLVENT RESISTING.

Apply—
PINCHIN JOHNSON & CO., Ltd.,
MINERVA HOUSE, BEVIS MARKS, LONDON, E.C.
Sole Selling Agents for
THE DAMARD LACQUER CO., Ltd.,
BIRMINGHAM.

E. SHOWELL & SONS, LTD.,
STIRCHLEY, BIRMINGHAM.

SOLID FORGED BRASS WING NUTS.
Tapped Standard Whitworth and B.A. Standard.

Made from No. 1 tapped ¼" to No. 9 tapped ¾".

Sole Agent for the Electrical Trade:—
LIONEL ROBINSON, 3, STAPLE INN, LONDON, W.C.
TELEPHONE: Holborn 6323.

ELECTRIC DRIVE IN HOSIERY FACTORY.

Early in 1914 Messrs. George Brettle & Co. (Ltd.), the well-known firm of hosiery manufacturers, decided to extend and re-equip their Belper works, the alterations covering the conversion of their power plant from a single steam engine to an electric drive, in addition to the installation of an important textile plant of the latest description. The outbreak of war and the subsequent building restrictions unfortunately curtailed the extensions to a certain extent. Nevertheless, the results obtained both in regard to the enormous increase of output and the great reduction in the cost of

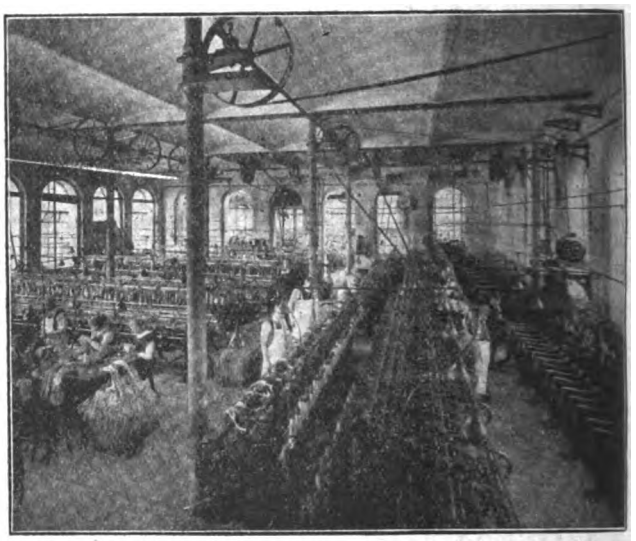


FIG. 1.

power generated, invest the installation with a special interest, both to electrical and to textile engineers. The increase of output has been obtained through the installation of a large number of the latest pattern of textile machines, while the reduction in the cost of power is directly attributable to the conversion to the electric drive.

Almost immediately after the conversion was commenced, Messrs. Brettle received important and very urgent contracts for the supply of clothing to the Army, which precluded the stoppage of any part of their factory for effecting the change over, and the electrical con-

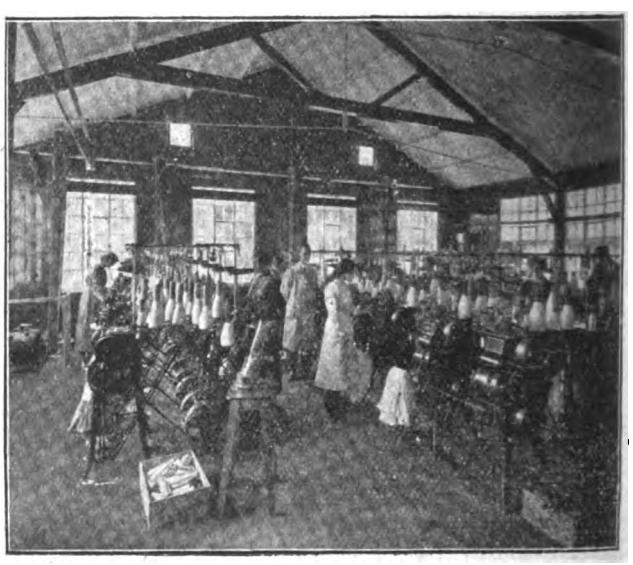


FIG. 2.

tractors, the General Electric Co. (Ltd.), of Witton, Birmingham, and 67, Queen Victoria-street, London, E.C., undertook to complete their contract without any stoppage except during ordinary closing hours, and this undertaking was fully complied with. Contemporary with the scheme for modernising their power plant, Messrs. Brettle decided that a favourable opportunity presented itself to replace their existing high pressure gas lighting by electric light, and this work was also entrusted to the General Electric Co.

The power plant installed consists of two "Witton" continuous current interpole dynamos of 50 kw. and 25 kw. capacity respec-

Digitized by Google

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless · Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite—Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1912 to 1917.

ATTWATER & SONS,

Telegrams: Attwaters, Preston. Telephone No. 1046 (2 lines).

Hopwood St. Mills, PRESTON.

Established 1868. Codes: 5th Edition A B C & Western Union.

J. P. DEVINE CO., BUFFALO.

MANUFACTURERS OF

Vacuum Drying and Impregnating Plant.

(PASSBURG SYSTEM.)

The Devine Co. are well known in the United States and Canada as the leading manufacturers and experts in Vacuum Drying and Impregnating Plant and have over 1,500 such plants in successful operation.

AIR PUMPS, COMPRESSORS,
VULCANISERS,
CONDENSING PLANT.

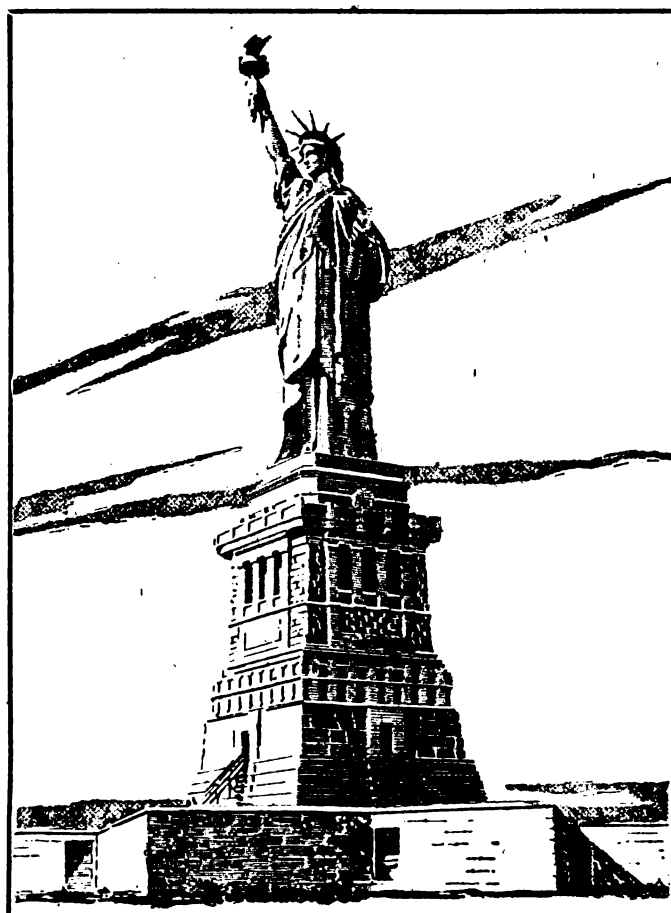
Solvent Recovery and Derisinating Plant a Speciality.

Sole Representative:

JAMES LIVINGSTON, LTD.,

IMPERIAL HOUSE, KINGSWAY, W.C.

Telegrams and Cables: "GERRARY, LONDON." *Telephone:* GERRARD 2300.



LIBERTY AND FREEDOM.

It has been well said that the price of Liberty is eternal vigilance.

The price of Freedom from troubles in the erection and use of Electrical Conductors is the current price of Simplex Conduits Fittings and Accessories.

That Freedom also is purchased by the same eternal vigilance in all the processes of manufacture.

The price includes not only value in material things, but the added value that is contained in 20 years of experience in the selection of the fittest, and the elimination of the "good enough."

SIMPLEX CONDUITS LIMITED

GARRISON LANE, BIRMINGHAM.

LONDON— 113-117, Charing Cross Rd, W.C.
MANCHESTER— 16, Corporation Street.
GLASGOW— 72a, Waterloo Street.
NEWCASTLE— 61, High Bridge.
BRISTOL— 10 & 11, Denmark Street.
LIVERPOOL— 96, Whitechapel.
LEEDS— 6, White Horse Street.
SWANSEA— 14, Heathfield Street.
CARDIFF— 4, Westgate Street.
ABERDEEN— 1, Crimon Place.
SHEFFIELD— 281-3, Attercliffe Common.

Digitized by Google

REGULATING RESISTANCES

"BACK OF BOARD" TYPE—FOR FIELD REGULATION.

ISENTHAL & CO., Ltd.

(Department 4)

Denzil Works,

Willesden, LONDON, N.W.10.

Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, &c.

LIST ON REQUEST.

FOR

High and Low Tension SWITCHGEAR

THE

NEW SWITCHGEAR CONSTRUCTION CO., Ltd.

SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

For Effective Impregnation

use "LACWATT"

Black or Golden Brown.

JENSON & NICHOLSON, Ltd., Insulating Varnish Department., Goswell Works, Stratford, E.15.

REWINDING AND REPAIRING

of ARMATURES, MOTORS & DYNAMOS.

PROMPT EXECUTION and MODERATE CHARGES.

A. BROWN, 1, Norgrove St., BALHAM, S.W. 12

tively, being belt driven from two Hornsby town gas engines. These dynamos supply electric current to a switchboard which is arranged for either single or parallel running. Building restrictions precluded the erection of a new power house, and resort had to be made to two spare store rooms, which were slightly altered and turned into a useful, though slightly cramped engine room. In installing the electric motors the chief difficulty to be contended with was the fact that all the textile machines already existing in the factory were designed for a drive from slow-speed line shafts operated from a slow-speed steam engine, so that the possibility of an individual drive to each of the larger machines, however desirable, was precluded by reason of the number of countershafts which would have to be employed. After a number of tests for power consumption had been carried out by the contractors, it was decided to regroup the machines on to existing line shafts into banks of approximately the same power consumption, and, in order to take advantage of the benefits which naturally accrue from the installation of one size of motor only, the 3 H.P. motor running at 700 revs. per min. was adopted as a standard, and, with one exception, the whole of the motors throughout the factory are of this size. A number of views are given of the latest pattern machinery installed in these works, and afford an excellent illustration of the practicability of fixing motors in positions where they occupy no floor space. Considerably more than half the motors are carried on window sills, with the result that the floor is left entirely clear for the arrangement of the bulky textile machines in even and uninterrupted banks. Fig. 1 shows one of the knitting rooms, including seamers, leggers and similar plant.

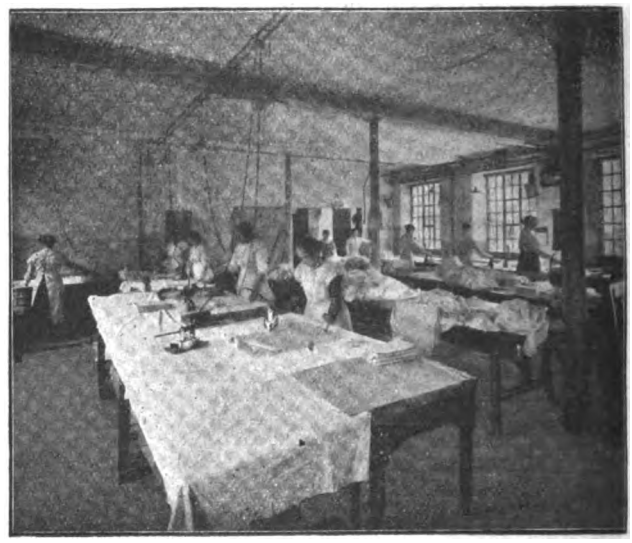


FIG. 3.

As textile manufacturers are well aware, next to reliability the first necessity in connection with their power plant is constant speed; and those who are conversant with the electric drive will realise the benefit which Messrs. Brettle have derived in this direction from the conversion, apart from the great saving which has accrued through

LONDON & LANCASHIRE FIRE INSURANCE COMPANY

FIRE — ACCIDENT — MARINE.

BOILERS, ENGINES, ELECTRICAL PLANT, &c.,

insured against Damage by Breakdown, &c.

REGULAR INSPECTIONS by Staff of Expert Engineers.

SECURITY - £6,652,243.

Full information on application to

Head Offices { 45, DALE STREET, LIVERPOOL. 155, LEADENHALL STREET, E.C.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power,
Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

WE WANT YOUR MONEY.

That is why we try our level best to give you the highest and most enduring value in exchange.

Our aim is extraction without exaction.

We endeavour, by faithful service, to render the process so beneficial that you will come back for more—and then some.

Please examine the list of inducements on the left.

BRITISH INSULATED & HELSBY CABLES.

LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

QUARANTEED SECOND HAND

MOTORS

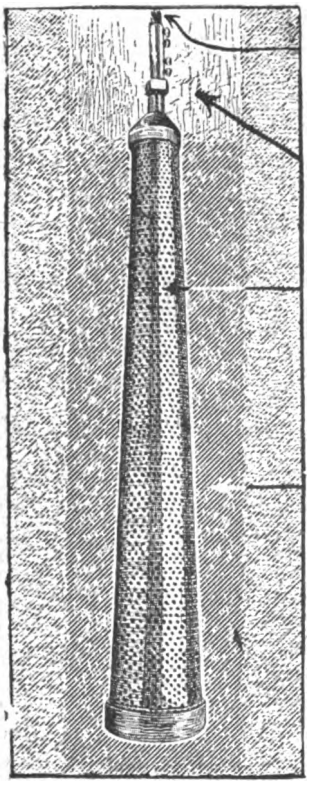
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Victoriaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh. *See our Illustrated Advt. July 6th.*

Digitized by Google



THE
PARAGON
Earth Cone
ensures a
Certain
&
Permanent
Earth

Exhaustive tests have proved that the Paragon Cone keeps the earth moist for an indefinite period, thus ensuring a reliable contact. The fact that engineers in all parts of the world are frequently sending repeat orders is a sound testimony to its merits.

Write to-day for illustrated folder.

SCHOLEY & CO., Ltd.,
56, Victoria Street,
LONDON, S.W.1.

freedom from "shuts-down" which were of necessity very frequent when the plant consisted of one engine driving the whole works through a forest of line shafts and beltings. Fig. 2 shows a few of the machines for knitting circular hose.

One of Messrs. Brettle's latest developments has been the organisation of a department for the manufacture of fabric gloves, and here again the adaptability of electrical drives has been demonstrated. Owing to the building restrictions, Messrs. Brettle were compelled to find for this factory premises opposite the main factory. Whilst remodelling their works, Messrs. Brettle, having in mind the welfare of their employees, installed a number of electric fans where necessary to improve ventilation. Previously the ironing was effected by 28 lb. irons prepared in steam-heated ovens. The work is now done by 17 lb. irons, which reduction in weight greatly lessens the labour of the ironers, apart from the fact that they do not now have to carry the 28 lb. irons to and fro from the ovens to their bench. The ability to work continuously with a uniform heat has also been a factor tending to increased output. Fig. 3 shows one of the ironing rooms in which the finished products are pressed by "Magnet" electric irons.

The whole works is now lighted by "Osram" and "Atmos" lamps, according to the intensity of light demanded by the various textile operations. Suitable reflectors have been utilised at every point to meet the special requirements of the situation, and the great amount of eye-strain which has thereby been avoided could only be realised by those whose experience permitted a comparison of doing intricate work under this type of reflector and under a high-pressure gas mantle.

With the aid of the new textile machines installed during the alterations, and as a direct outcome from the speed constancy and of the freedom from breakdowns, the output of the factory is now 230 per cent. greater than it was when the conversion was taken in hand; yet, after making allowances for increase on cost of coal, gas, &c., the total running cost is now some 20 per cent. less per annum than originally, even including the coal, &c., for one boiler which is still kept understeam all the year round for the supply of hot water for the washing plant. There has, in addition, been a considerable saving on the maintenance charges owing to the large amount of gearing, shafting and belting which has been eliminated by the change, but unfortunately no accurate figures are available to enable an estimate to be formed of the saving in this respect. The whole of the electrical equipment and power plant was manufactured by the General Electric Co. (Ltd.) at their various works, and Messrs. Brettle are to be congratulated on the success of their progressive efforts.

Swedish Patent Law.—In virtue of the Law of May 19, 1917, special regulations which have been made with regard to the protection of certain foreign patents came into force on May 24.

The purport of the regulations is that a foreign patent application lodged in a foreign State after July 31, 1913, can claim priority in Sweden from the date when the foreign application was lodged, provided (1) that the foreign State in which the foreign application is first lodged issues reciprocal regulations, and (2) that the application for a Swedish patent is lodged before Aug. 24, 1918. The application of the law is, however, made subject to the issue of a Royal Decree, which has not yet been published.

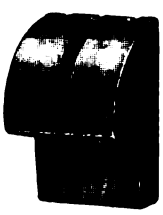
BELLING FIRES GRILLERS BOILERS OVENS

ALSO ALL KINDS OF SPECIAL ELECTRICAL APPARATUS FOR MUNITION WORKS & MANUFACTURING PURPOSES

BELLING & CO.,
ELECTRIC HEATING & COOKING SPECIALISTS,
Derby Road Works, Montague Road,
UPPER EDMONTON, LONDON, N.

"ANTI-SULPHURIC" ENAMEL
Should be used in all **ACCUMULATOR ROOMS**
For Protection from Acid Fumes.
SOLE MAKERS: **GRIFFITHS BROS. & CO., LONDON, LTD.** Mack'e-rd., Bermondsey, LONDON. S.E.

H. Weidmann, Ltd., Rapperswil, Switzerland.



MAKERS OF PRESSPAN AND INSULATING MATERIAL.

Pressboard (Presspan) in Sheets, Rolls and Tapes, Oiled Presspan, Black Presspan, Presspan Tubes and Stampings.
Amianite (Vulcanised Asbestos) Coil Frames, Spools for Apparatus, Dynamos, Motors and Transformers. Insulating Blocks, Tubes, Plates, Boxes, &c.
Bakelite & Cornite (high tension material) Handles of Switchgear and Heating Apparatus, Controller Insulation, Moulded Pieces, Terminal Covers of all kinds.
Asbestos-Cement in Plates, Arc Shields for Controllers, &c.

Mica and Substitutes, Insulating Pearls, Transformer Spools.
Japanese Felt and Paper in rolls and tapes.
Oil-Varnished Linen, Diagonal Tapes, Oil-Varnished Silk & Paper.
Artificial Leather Discs for Friction Drive.
Insulators for Electric Furnaces, Tramways, &c.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,045. [Vol. LXXIX. No. 17.] FRIDAY, JULY 27, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 651
Arrangements for the Week 653
Electricity Supply Costs. By Frank H. Whysall. Illustrated .. 654
Expansion Effects as a Cause of Deterioration in Suspension Type Insulators. By J. A. Brundige 656
Notes on the Design of Electromagnetic Machines. By Stanley Parker Smith, D.Sc. Illustrated 658
Patent Law 660
Industrial Research. By Herbert W. Rowell 661
Low Temperature Carbonisation and Power Supply 663
ON TECHNICALLY OBTAINING SOMETHING FOR NOTHING 664
REVIEW 664
Some Electric Kitchens by Carron Company. Illustrated 667
Manufacture of Synthetic Nitrates by Electric Power. By E. Kilburn Scott 668
Labour Unrest 670
CORRESPONDENCE 671
LEGAL INTELLIGENCE 671
Patent Record 672
Volunteer Notices 672
COMMERCIAL AND INDUSTRIAL SECTION 675
Electricity Supply 676
Tenders Invited and Accepted 678
Financial Matters 679

NOTES.

Industrial Unrest.

WITH commendable promptitude the Commission of Inquiry into Industrial Unrest, which was only appointed on June 12th, has completed its task in five weeks, and the results of its deliberations have now appeared in the daily press, with a summary by Mr. G. N. BARNES. The recommendations are given under 14 headings, and of these we think it will be agreed that the most important is the first, which refers to food prices. The opinion is expressed that there should be an immediate reduction in prices, the increased price of food being borne to some extent by the Government. There will probably be some difference of opinion as to the desirability of the Government bearing any of the cost. Leaving this point on one side, however, what is undoubtedly in the mind of the working man is that the price of food commodities have been increased far more than the increased cost of production. We quite believe that the working classes would not grumble about paying the increased cost in so far as this has been rendered inevitable by war conditions, but they very rightly object to paying high prices if by so doing they merely provide the middleman and profiteer with increased wealth—profits which are obtained mostly at the expense of the nation by taking advantage of national difficulties, and not as a true return for services rendered. Something has been done in the regulation of food prices, but in such a way as to be largely ineffective from the point of view of the consumer, and so that the middleman and retailer have been unaffected.

Lack of Confidence.

OF the other points that are brought forward by the Report, one of the most important is lack of confidence in the Government. This lack of confidence appears to be due to a number of causes. For example, there has been delay in the settlement of disputes; in some instances 10 weeks have elapsed without a settlement, whereas if a strike has taken place the matter has been put right in a few days. Then there is the feeling that the trade union rules will not be restored, that changes in working conditions have been introduced without consulting the men, that the industrial future is uncertain and that there is inequality of sacrifice. Other causes are inconsiderate treatment of women, delay in granting pensions to soldiers and other reasons to which we need not refer. We feel that this lack of confidence, at the root of which there probably lies a lack of frankness on the part of the Government and the idea that the working classes may be to some extent disregarded in framing regulations, is a most important matter, for the simple reason that it is easy for doubts to arise in a somewhat indefinite way, and when once they have taken root they are difficult to eradicate. At the same time, lack of confidence leads to instability; it is an insidious source of trouble, and, therefore, from every point of view steps should be taken to eliminate any cause which may lead to this feeling. More intimate contact between employer and employed, as outlined in the Whitley Report (which is endorsed) will help in this respect. It would also be well if irresponsible criticisms, made in ignorance of the facts and of the difficulties, were more often refuted by those in authority.

Prof. Spooner on Industrial Fatigue.

THE inclusion of industrial fatigue in this report as a cause of labour unrest makes the appearance of Prof. H. J. SPOONER'S articles on this subject very opportune. They have been issued by the Labour Co-partnership Association, and include prefatory remarks by SIR ROBERT HADFIELD, F.R.S., and Mr. J. R. CLYNES, M.P. Sir ROBERT makes the interesting statement that his firm adopted a 48-hour week 23 years ago, and found it a decided advantage. Also, during the early part of the war, with the exception of one or two holidays, his firm ran for 18 months without a stop from Monday morning to Sunday night, but this was not found to pay. Consequently, Sunday work has now been knocked off, with the result that the output has been equally great. Mr. CLYNES refers briefly to the impression which has been forced upon the workman that when changes have been proposed to secure increased output such changes have in the past led to reduced wage rates. It is pointed out that increased production is all important, but this should carry with it increased rewards to the producer, and the producer himself should be regarded as a man first and as a workman afterwards. With these sentiments we think every enlightened employer will agree.

Some Points for Consideration.

WITH regard to Prof. SPOONER'S articles, these include much with which our readers are already familiar, put in a brief but readable form. It is pointed out that the most efficient length of working day is not necessarily the same for every employment, and that often equal or greater output is obtained by shortening the day, with material advantage to the worker. Reference is made to the difficult question of restriction of output, and it is pointed out that if a workman's fear of unemployment, due to increased output, is to be abolished we must so organise our industries that the employees who work to the best of their ability may be reasonably free from anxiety. If that is done then scientific management should give rise to no

Digitized by Google

fears, it being understood that such management when applied to piece work does not mean the cutting of rates. One of the many problems about which there has been much talk, but comparatively little done so far, is undoubtedly the difficult problem of housing. We notice that this is one of the subjects to which reference is made in the report on industrial unrest, and we believe that the conditions at some munition centres have been exceedingly bad. This may be unavoidable under present conditions, but it will call for serious remedy when peace returns. The most important point of all, however, is the "after-war attitude," and with regard to this the words of LORD LEVERHULME cannot be taken too much to heart, in which he remarks that industrial defeat will be certain if our organisation is founded on attempted oppression of labour on the one hand or restriction of output by labour on the other. We only hope that neither Labour nor Capital will adopt an uncompromising attitude.

Alleged Preferential Charges at Hackney.

ONCE again the gas interests have sought to substantiate the charge of preferential rates against an electricity undertaking. In this instance it is the Hackney Borough Council which was the object of attack. There is nothing peculiar in the tariffs that are available at Hackney. There are the usual maximum demand and flat rate tariffs, and since there are numerous power consumers these are given the very reasonable concession that they may use up to 20 per cent. of the electrical energy with which they are supplied for purposes of factory lighting, the charge for this being at the power rate. The contention of the Gas Light & Coke Co., by whom the action was brought, was that this tariff drew a distinction, which was not permissible, between one lighting consumer and another. The lighting consumer who required no power paid at a higher rate than the lighting consumer who was also a power consumer in so far as lighting was concerned; therefore, it was argued, there was preferential charging.

The True Criterion.

SUCH a contention, however, is fallacious. The Electric Lighting Act of 1882 provides that any person is entitled to a supply on the same terms as any other person under "similar circumstances." The circumstances of a power consumer are not the same as those of a lighting consumer. If it is argued that there is differentiation between two lighting consumers, it is forgotten that a lighting consumer who takes power is not in similar circumstances to one who takes no power. The case is very different from that at Long Eaton, where a charge of undue preference was proved, for there the difference in rate depended on whether the consumer was using gas or not. "Similar circumstances" must, of course, be from the electrical point of view, and cannot depend upon gas or any other outside causes. We are glad to note that Mr. Justice ASTBURY, before whom the case was brought, fully appreciated the points at issue, and last Wednesday gave judgment in favour of the defendants. Thus another attempt of the gas interests to hamper electricity supply has failed. We congratulate the Hackney Borough Council upon their success in defending their position, for it would have been a serious matter for electricity supply undertakings if their defence had failed.

Medal Awarded to Orville Wright.—The Royal Society of Arts has awarded the Albert Medal for the year to Orville Wright "in recognition of the value of the services of Orville and Wilbur Wright to the solution of the problem of mechanical flight."

Electric Supply Company's Majority.—ERRATUM.—We regret that in our note on this subject last week it was stated that the applications to the Company per annum amounted to 3,000 kw. This should have been 5,000 kw.

Suggested Tax on Electricity in the U.S.A.—It appears that in their search for war revenue the authorities in the United States have had in mind a tax on electricity designed to raise 1,800 million dollars. It is believed, however, that the suggestion will not be accepted in the House, in view of the recognition that any such tax will inevitably be passed on to the consumer.

Refractory Materials Available for Glass Manufacture.—The above subject was discussed at a joint meeting of the Faraday Society and the Society of Glass Technology at the University of Sheffield on June 21th, Prof. Ripper, Vice-Chancellor of the University presiding. The object of the meeting was to promote the development of local clays and other materials applicable to the manufacture of refractory objects required in glass technology. As an instance, the varieties of clay needed for making pots for glass furnaces was mentioned.

"Theory of the Submarine Telegraph and Telephone Cable."—A number of articles on this subject by Dr. H. W. Malcolm appeared in THE ELECTRICIAN in 1912 and following years. These articles have now been published in book form with much additional matter. Apart from the introduction, the subject is divided up into four parts, dealing respectively with purely periodic phenomena (the telephone cable), purely transient phenomena (the telegraph cable), methods of telegraphic transmission, and, lastly, with the future progress of cable telegraphy. A review of the work will appear in our columns in due course.

Board of Trade Committee on Electric Power Supply.—The Association of Municipal Corporations has issued a circular letter with regard to this Committee. The Association states that three witnesses have been nominated by the Association to give evidence before the Committee from the City of Leeds and the Boroughs of Blackburn and Sutton Coldfield respectively. It is pointed out that the following (amongst other questions) will probably come under consideration:—(*a*) The question of forming entirely new and large areas of supply and distribution irrespective of existing municipal boundaries; (*b*) the question of the constitution of the managing body to deal with the supply in each of these areas. The Association asks to be furnished with any observations which the Councils think would be useful for their witnesses to have.

Aeronautical Research.—From the annual report of the Advisory Committee for Aeronautics for 1916-17, which has recently been issued, it appears that a good deal of research work has been carried out.

Owing to the war, an increasing number of special problems have been presented for investigation and these have constantly occupied the attention of the staffs, both at the National Physical Laboratory and the Royal Aircraft Factory. The subjects dealt with include the testing of aeroplane models, experimental work in aerodynamics, strength of construction combined with lightness, experimental work of engines, and investigation of light alloys. Seaplane floats have been tested in the William Froude National Tank, and this work is extending. Experiments relating to bombs have been continued. The Committee is indebted to Prof. Karl Pearson, F.R.S., for communicating the result of his calculations of bomb trajectories. This question has also been the subject of investigation at the National Physical Laboratory. Problems in connection with the aeroplane compass have been further considered. Other instruments and apparatus for use on aircraft have also been investigated.

Diesel Engine Users' Association.—At the June meeting of the Diesel Engine Users' Association, the result of the negotiations with the Inland Revenue authorities in regard to allowances for depreciation of Diesel engines for income tax assessment was announced (namely, a rate of 10 per cent. to remain in force for three years after the war). Some further discussion took place on the Paper by Mr. Geoffrey Porter, read at the previous meeting, on "Tar Oil Fuel and Diesel Engines," the question of the influence of sulphur in fuel oils

Digitized by Google

receiving special attention. The full discussion of this Paper is being reprinted and copies will be available on application to the hon. secretary (Mr. Percy Still, 19, Cadogan-gardens, S.W. 3). The President also announced that reprints of the report by Dr. E. Graefe on "The Influence of Sulphur in Liquid Fuels in Inter-Combustion Engines," previously issued in February, 1915, would again be sent out to members and subscribers to the Association.

Tests of Electric Vehicles.—We have received from Mr. J. A. Priestley, cleansing superintendent at Sheffield, the following tests of the travelling time of horse vehicle, petrol wagon and electric vehicle over a measured mile, with stops as shown :—

Horse and Cart.

	Total travelling time.
Stopping every 10 yards	33 mins., 31½ secs.
„ „ 20 „	32 „ 24 „
Petrol Wagon.	
Stopping every 10 yards.....	14 mins., 48 secs.
„ „ 20 „	10 „ 51½ „
Electric Vehicle.	
Stopping every 10 yards.....	11 mins., 20 secs.
„ „ 20 „	9 „ 20 „

Average time taken by each vehicle to cover 10 yards and 20 yards distances from starting to stop :—

	10 yards.	20 yards.
Horse and cart	11·4 secs.	22·1 secs.
Petrol wagon	5·0 „	7·4 „
Electric vehicle	3·8 „	6·3 „

Two-ton vehicles were used in each case. The results serve to show the advantage of the high acceleration of the electric vehicle.

Utilisation of Irish Peat.—The Fuel Research Board, with the sanction of the Committee of the Privy Council for Scientific and Industrial Research, has appointed a committee of inquiry into the utilisation of Irish peat deposits. The terms of reference to the committee are as follows :—

To inquire into and to consider the experience already gained in Ireland in respect of the winning, preparation and use of peat for fuel and for other purposes, and to suggest what means shall be taken to ascertain the conditions under which, in the most favourably situated localities, it can be profitably won, prepared and used, having regard to the economic conditions of Ireland ; and to report to the Fuel Research Board.

Though the inquiries of the committee will ultimately lead up to the consideration of peat as a source of energy in central power stations, there are sound reasons why this aspect of the problem should be postponed to a later stage. On the one hand, the Fuel Research Board is already organising an extensive inquiry into the problems of fuel economy in connection with power production, and the results of this inquiry will supply the fundamental data and information which will be required when the time comes for the consideration of any wide scheme of development in Ireland. On the other hand, any schemes of development must be based on a more exact knowledge than is at present available regarding the selection of the more favourably situated bogs and the possibilities of winning and transporting partially dried peat to centres at which it may be converted into marketable products. It is obvious, therefore, that the inquiries of the committee are likely to be most fruitful if they are concentrated on the fundamental problems, for until these are settled no satisfactory progress can be made.

The following appointments have been made to the committee : Sir John Purser Griffith, M.A.I., M.Inst.C.E. (*Chairman*), Prof. Hugh Ryan, M.A., D.Sc., F.I.C., Prof. Sydney Young, D.Sc., F.R.S., Mr. Geo. Fletcher, Prof. Pierce Purcell, M.A., M.A.I., Assoc.M.Inst.C.E. All communications should be addressed to the Secretary, the Peat Inquiry Committee, University College, Dublin.

We think the course outlined above is desirable. The use of peat for power purposes on a large scale presents many difficulties which should be taken at a later stage.

Scientific Training.—In his Presidential Address to the Society of Chemical Industry at the annual meeting in Birmingham last week, Dr. Charles Carpenter, referring to the close connection between the chemist and the engineer, said it should not be left to chance for the lad whose natural bent was in either direction, to make his choice of one of them. If the teaching authority had properly guided and taken pains, it should be an easy task to sift the pupil's learnings and direct his course in accordance with them. As a preliminary step towards this end, first principles of experimental science should be compulsorily taught in all primary schools. Our educational system needed alteration at its foundations. In his opinion, a boy was old enough to learn science when he was old enough to learn history and geography. When he reached the age of 16 years he should commence work either at the desk or in the factory with compulsory attendance at continuation schools. After two or three years he would, if showing himself to possess the necessary ability, be fit for entrance to the university to follow a further course of study along paths adapted to his temperament and qualities. In the past the nation's youth had been developed as unscientifically as its fuel resources. In coming into contact with men holding important positions in this country he had been struck by the remarkable fact that although they had been qualified to deal with affairs—they had been responsible for building up large businesses and controlling large organisations—they overlooked the enormously important fact that the bulk of the country was, after all, made up of the working classes, and in dealing with the working classes they had not the least idea how to manage, and how to deal with, these employees. The reason for that was because they had no opportunity in their early training for getting into close and personal contact with them. That could best be done in the early stages of life, and at 16 he thought a lad should begin to be trained to receive these impressions of humanity which would be all-important to him in the future. He should be brought into contact with the working classes and learn their views of life. That experience would be of enormous importance to him even if he subsequently became a member of Parliament or of the Cabinet.

OBITUARY.

ALFRED MOSELEY.—We regret to record the death of Mr. Alfred Moseley, C.M.G., a well-known advocate of industrial reform and of educational efficiency. In 1902 he organised and sent to the United States at his own cost an Industrial Commission, and in the following year an Educational Commission, whose report, issued in 1904, was regarded as of considerable value.

ROBERT PICKETT.—We regret to record the death of Mr. Robert Pickett which occurred at Port Talbot on the 12th inst.

Mr. Pickett was engaged in supervising the erection of some new steel furnaces for Messrs. Wellman, Seaver & Head, and while crossing the yard he was knocked down and killed by a train. Deceased, who was 62 years of age, was the father of Mr. Frank Pickett (of Messrs. Allen, West & Co.), and had many friends in the electrical industry.

DEATHS ON ACTIVE SERVICE.—As announced in our last issue, Major Basil de Ferranti, M.C. (R.G.A.), died of wounds on the 12th inst.

The deceased officer, who was the elder son of Dr. S. Z. de Ferranti, was educated at Repton and the University of Sheffield, where he studied engineering. After serving an apprenticeship at Messrs. Yarrow's (Glasgow) he worked at Messrs. Vickers and acted as assistant to his father. At the beginning of the year he was promoted to the rank of Major. Major de Ferranti, who was only 26 years of age, was at the front over two years and was wounded by a shell while in a hut. We tender our sincere sympathy to his father and mother on the loss of a son of great promise.

The following deaths are also reported :—

Second-Lieut. Thos. Hunter, S.M.R.E., late chief engineer to the Musselburgh Electric Light and Tramway Co., was killed in action on the 16th inst.

Pte. Walter Ball (King's Own Regt.), who has been killed in action, was formerly employed at Marton tram-shed, Blackpool.

The death in action is reported of Pte. Geo. Baldwin (East Lancshire Regt.), who has been employed by Burnley tramways department about 13 years.

PERSONAL.

Mr. J. Mackenzie, assistant controller of the Central Telegraph Office, has been promoted to the position of deputy chief inspector of telegraph and telephone traffic.

We regret to learn that the electrical engineer to the City of London Corporation, Mr. H. R. Mott, has been compelled to obtain leave of absence in consequence of ill health.

WAR HONOURS.—The following particulars of the manner in which Major W. A. Vignoles (borough electrical engineer of Grimsby) won the D.S.O. are given in a "Supplement" to the "London Gazette," dated July 18 :—

Temp. Major WALTER ADOLPH VIGNOLES, Linc. Regt.—For conspicuous gallantry and devotion to duty during a hostile counter-attack upon the battalion, of which he was in temporary command. His prompt initiative and coolness at a most critical moment enabled him to rally his men, and to bring a heavy fire upon the advancing enemy, and subsequently to organise and carry out a counter-attack with complete success.

Digitized by Google

ELECTRICITY SUPPLY COSTS.*

BY FRANK H. WHYSALL.

DETERMINING FACTOR IN SELECTION OF SITE.

It is generally agreed that condensing water facilities nowadays form the determining factor in the selection of a site. This is emphasised in the lay-out of the new Dalmarnock power station for Glasgow, which is being laid out on ground on the bank of the river Clyde. The ideal site for a generating station is one at the coal-pit mouth, at the water edge, and in the centre of its area of supply. These conditions cannot, however, in practice, be fulfilled, but they should *all* be kept in view when deciding on the most suitable site for a power station.

By establishing works at the water edge, the cost of pumping and cooling water is eliminated, except to the extent of passing it through the condensers. An ideal arrangement is, of course, a gravity flow, where sufficient water is available. In Greenock, at the Dellingburn power station, there is a gravity flow of condensing water during certain periods of the day, but the demand on the works has now

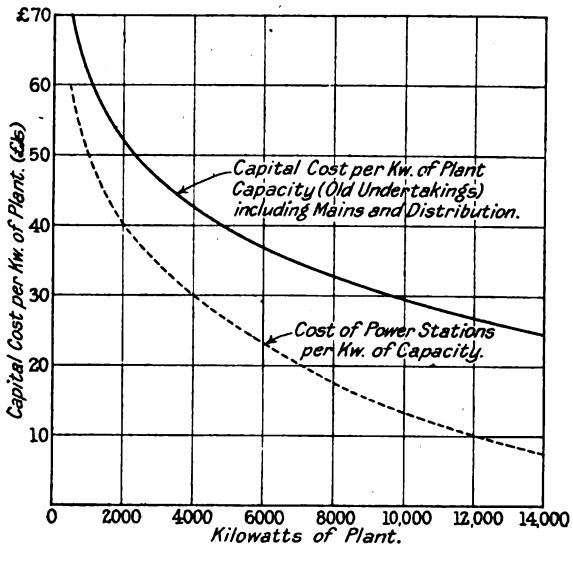


FIG. 1.

outgrown the capacity of the gravity water, and it has been necessary to instal cooling towers, and very shortly it will be necessary either to further extend these cooling towers or pump water from the Firth of Clyde.

An engineer may have no difficulty in deciding which is the best site for a power station, but he finds in practice that vested interests are against acquiring it on reasonable terms, and it is this factor which, in nine cases out of ten, constitutes the real reason why power stations are found on what appear to be most unsuitable sites. Having decided that one can obtain ideal condensing water facilities, the question of fuel supplies falls next to be considered, and the site must be well served by railways or by water-ways, or both. In short, the cost of getting the coal from the colliery to the site decided upon must be carefully considered, and it should be possible to draw upon a sufficiently large field to ensure the competition necessary to keep prices within reasonable limits. While touching on the cost of coal it should be mentioned that it is important that there should be sufficient land for coal storage adjoining the site chosen. A great deal may be saved by having such land available, with proper coal-handling plant. It is possible to take advantage of the coal market, and put coal down on the ground when it is not greatly in demand, and better terms can be got from collieries when the authorities are in a position to give the collieries elasticity in the matter of delivery. It is possible in this connection also to establish crushing plant, which enables the authority to buy a great variety of coal and save money in this way also. Opportunities for purchasing large coal at a very reasonable figure have to be refused without such provision.

After dealing with questions of capital charges, diversity factor, load factor and costs generally, the author passes on to a discussion of the better use of the heat in a generating station.

As showing the cost of electric energy per annum per horse power installed for different trades taking electric supplies from a central power station, I include the following figures taken from the records of the Greenock electricity department.

	Per annum per H.P. installed.
Engineering trades	£3 6 11
Laundries	2 3 4
Joiners and builders	1 15 11
Printers and publishers	2 10 8
Sawmills	0 17 8
Shipbuilding	2 6 1
Tanners	2 6 5

EFFECT OF SIZE OF UNDERTAKING ON COST OF SUPPLY.

A modern power station for supplying an industrial area nowadays seldom considers units of less than 5,000 kw. capacity, and several stations under contemplation have decided on 25,000 kw. units. The average industrial works gives something less than 800 kw. of a maximum demand.

Fig. 1 is a curve showing how the capital cost of an electricity undertaking per kilowatt capacity is reduced by increasing the size. For a station of 1,000 kw. capacity, the cost of every kilowatt would be £60, while for a larger undertaking, with a capacity of 10,000 kw., the cost per kilowatt is only £30.

Assuming the case of a 1,000 kw. consumer with a maximum demand of 800 kw. The private plant required consists of three 500 kw. turbines, two for the load and one as spare. From the "cost per kilowatt" curve the capital necessary would be 1,500 kw. at £45 per kilowatt=£67,500. With central station supply, the capital expended by the undertaking would only be 800 kw. at £25 per kilowatt=£20,000. It is evident that the size of the undertaking will also help greatly in working economy, as the economy of a 5,000 kw. turbo-generator is very much better than the economy of a 500 kw. set, all other things, of course, being in proportion.

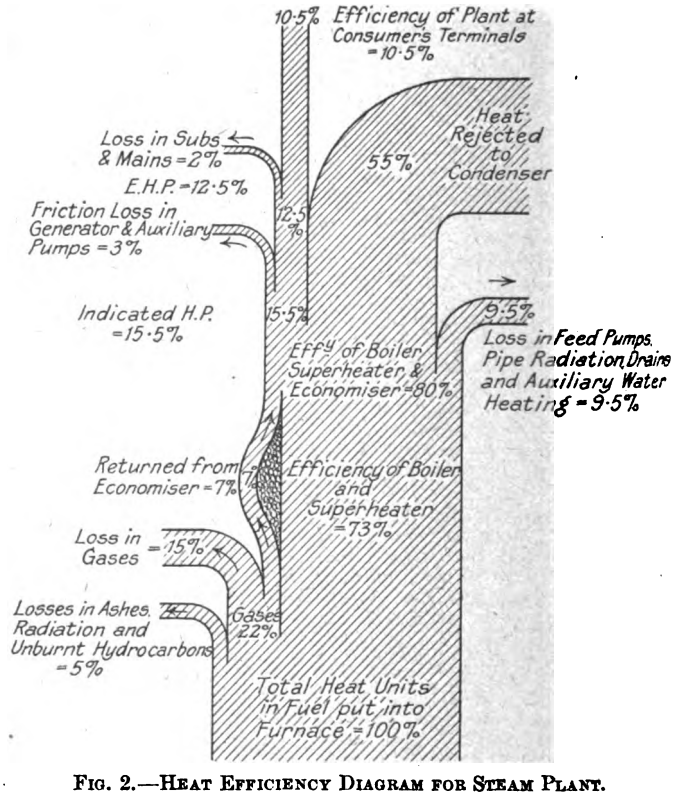

10·5% Efficiency of Plant at Consumers Terminals =10·5%
Heat Rejected to Condenser
55%
Loss in Subs & Mains=2%
E.H.P.=12·5%
Friction Loss in Generator & Auxiliary Pumps=3%
12·5%
Indicated H.P. =15·5%
15·5%
9·5%
Loss in Feed Pumps, Pipe Radiation, Drains and Auxiliary Water Heating=9·5%
Effy of Boiler, Superheater & Economiser=80%
Returned from Economiser=7%
Efficiency of Boiler and Superheater =73%
Loss in Gases =15%
Losses in Ashes, Radiation and Unburnt Hydrocarbons =5%
Gases 22%
Total Heat Units in Fuel put into Furnace=100%

FIG. 2.—HEAT EFFICIENCY DIAGRAM FOR STEAM PLANT.
Boilers, Economisers, Superheaters, Turbines and Generators.

For example, the steam consumption of a 500 kw. turbo, set at 90 lb. per square inch, not superheated, is 22·5 lb. per kilowatt-hour at full load, and 26 lb. at half load. Working as a low-pressure turbine at 16 lb. absolute pressure, the full-load consumption is 35 lb. per kilowatt-hour.

The steam consumption of the latest 5,000 kw. turbo-alternator at Greenock, including steam for air and extraction pumps, is 14 lb. per kilowatt-hour, with steam at 190 lb. per square inch, superheated 150°F., and vacuum at 28 in. I understand that a 30,000 kw. turbine, built by the American Westinghouse Company, has a steam consumption of 11·25 lb. per kilowatt-hour, or 8·44 lb. per horse-power-hour.

* Abstract of an article in the "Channel."

Digitized by Google

The usual question asked by the exponent of the private plant is: "What about distributing mains? The interest on the money will create such a charge that these economies will count for nothing." The point need not be laboured. The generating economies, and the economies in capital charges obtained by central station concentration far outweight these considerations.

The author cannot leave this subject without referring to the use of exhaust steam for industrial purposes. The author had figures put before him relating to the supply of electricity at a chemical

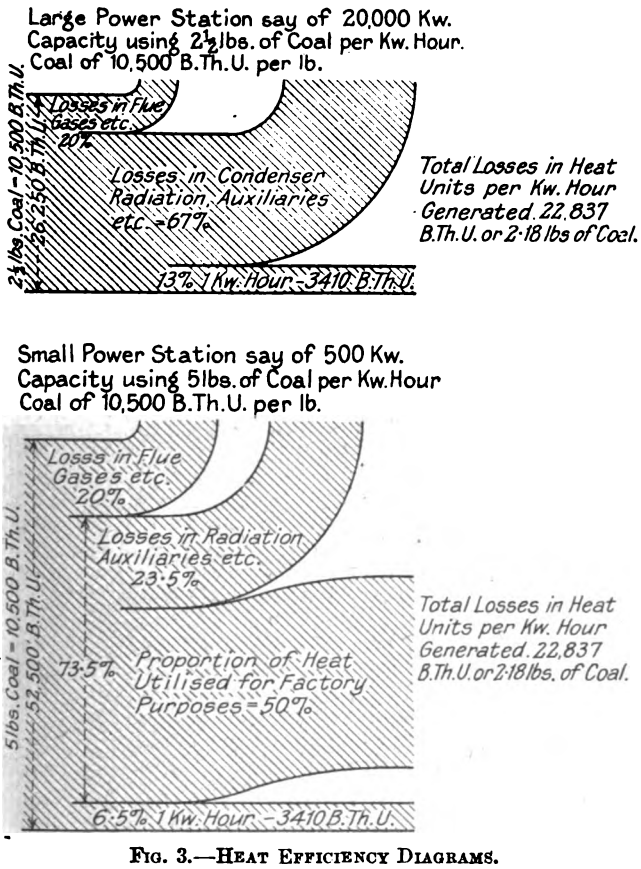

Large Power Station say of 20,000 Kw.
Capacity using 2½ lbs. of Coal per Kw. Hour.
Coal of 10,500 B.Th.U. per lb.
2½ lbs. Coal = 10,500 B.Th.U.
Losses in Flue Gases etc. 20%
Losses in Condenser Radiation, Auxiliaries etc. = 67%
13% 1 Kw. Hour = 3410 B.Th.U.
Total Losses in Heat Units per Kw. Hour Generated. 22,837 B.Th.U. or 2·18 lbs of Coal.
Small Power Station say of 500 Kw.
Capacity using 5 lbs. of Coal per Kw. Hour
Coal of 10,500 B.Th.U. per lb.
5 lbs. Coal = 10,500 B.Th.U.
Loss in Flue Gases etc. 20%
Losses in Radiation Auxiliaries etc. 23·5%
73·5% Proportion of Heat Utilised for Factory Purposes = 50%
6·5% 1 Kw. Hour = 3410 B.Th.U.
Total Losses in Heat Units per Kw. Hour Generated. 22,837 B.Th.U. or 2·18 lbs. of Coal.

FIG. 3.—HEAT EFFICIENCY DIAGRAMS.

Comparing Large Power Station with Small Power Station, the latter supplying proportion of Heat for Factory Purposse.

works. These works required steam for their processes, and the scheme proposed by the consulting engineer who drew up the report was, that the steam pressure at the boilers should be raised to a suitable working pressure for high-pressure engines, and the exhaust steam from the engines used for the industrial processes as before. He advocated the use of electricity for power distribution, and he proposed to use a high-pressure engine for driving the dynamo for this purpose. This report was given to the author in order that he might make out a case for a supply of energy from the city of Manchester supply stations. The matter was very carefully considered, all the calculations tested from first principles, and whichever way the problem was looked at, these people were either to get steam for nothing, or electricity for nothing. The author's chance came very soon in the form of an application for a supply of steam for heating and cooking for a very large new building, erected adjacent to Manchester's oldest power station, where there were installed ideal units for the supply of exhaust steam on the lines laid down by the consulting engineer in the case of which the author has already spoken. Contracts were drawn up for the supply of steam for a period of years. The installation so far as the supply of steam was concerned, was highly satisfactory to the consumer; business followed as fast as it could be dealt with. At first one working disadvantage and then another cropped up, until the only reason for congratulation was that the contracts for the supply of steam had been based on what was estimated would be the cost of supplying *live* steam direct from the boilers, and when it was possible to shut this particular generating station down, and get all the current requirements from the modern station having units up to 15,000 kw. capacity, it was found that it was cheaper to supply live steam. One of the first things that drew attention to the wastefulness of supplying exhaust steam under certain conditions was that the requirements were very much less than had been estimated by the heating engineers, and, instead of getting an economical load for the unit it was found that 5,000 lb. of steam per hour was quite sufficient, and, unfortunately, this represented the friction load of a set. The consequence was that the engine was suffering wear and tear, it was using oil, and it required a driver. It was thought that this disability would be removed by an increase of business when it would be possible to fit steam requirements to the electrical capacities of the generating sets adapted for the service, but the large turbo-generating sets again put the proposition out of court.

When electrical engineers glance at the heat efficiency diagram for a modern steam plant (Fig. 3), they cannot but feel ashamed that out of the total heat energy in the fuel burned, only 10·5 per cent. is available as electric energy at the consumer's terminals. The greatest loss is the heat rejected to the condenser which passes away in the circulating water—namely, 55 per cent. of the total heat energy in the coal.

But the factory owner who requires steam for heating purposes states that the central station destroys all the latent heat in the steam, and that on the other hand, he makes use of the whole of the latent heat in his factory. Fig. 3 is a diagram to illustrate the comparison from a heat efficiency point of view. The top diagram shows the losses in a large plant using 2½ lb. of coal per kilowatt-hour. This amounts to 22,837 B.Th.U. per kilowatt-hour. In the lower diagram is shown a similar diagram for a small plant, using 5 lb. of coal, the losses—despite the fact that 50 per cent. of the heat is sent into the heat process—are just as before, namely, 22,837 B.Th.U. The diagram assumes that all the heat sent into the heat process is made use of, a condition which is obviously never obtained in practice. When you look at the diagram you will see that, although one may talk glibly of saving the latent heat by using high pressure engines on the premises instead of taking current from the supply authority, the user of the exhaust steam plant pays so much more for his latent heat than the supply authority, that if the user saves all his latent heat, the supply authority still has the advantage. The author's point is, that the best results obtained by private plants are on the average no better than 5 lb. of coal per kilowatt-hour generated under the best working conditions; in fact, the majority are seldom better than 12 lb. Some of the neglected installations run up to 100 lb. per horse-power hour for high pressure engines. Supply stations can afford to pay for skilled supervision, and have ready means of checking working costs, and the results for a load-factor such as is enjoyed by a large proportion of industrial works are in the region of 2½ lb. of coal per unit. Where a central station power supply is not available it pays a works to use the exhaust steam from its own engines. In conversation with the head of one of the oldest-established firms dealing with these problems, the author was informed that, in the light of their experience, they shared his views,

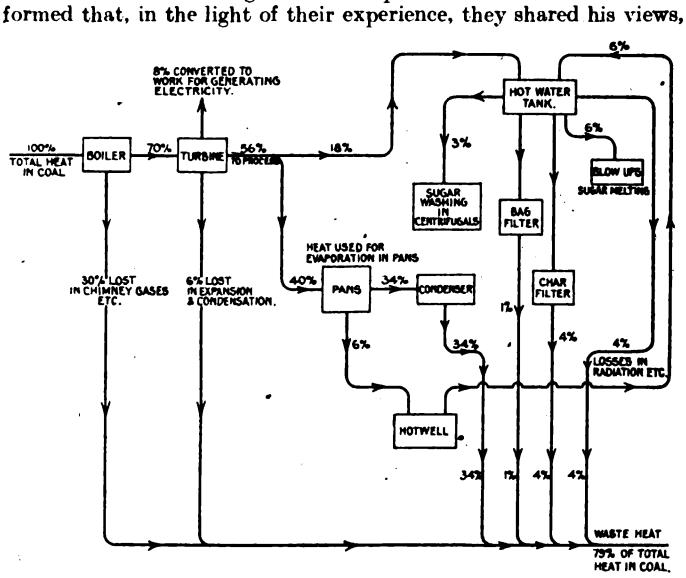


FIG. 4.—HEAT IN SUGAR REFINERY WITH ELECTRIC GENERATING PLANT.
(Expressed in percentages of Total Heat in Coal.)

and as soon as a public supply became available they adopted it for their own works throughout, and they never advocated the use of exhaust steam plant nowadays when a supply from a central station was available.

In the sugar refining industry, large quantities of steam are required for evaporation, melting and washing purposes, about 70 per cent. being required for evaporation alone. The process carried through entail an enormous waste of heat. In a certain sugar refinery, out of 70 per cent. of steam admitted to the heater coils in the pans, a proportion—10 per cent. of the total heat in the steam in process—is condensed in the coils and runs into the hotwell; the

LIBRARY OF THE UNIVERSITY OF CALIFORNIA

Digitized by Google

remainder—60 per cent. of the total heat—being used to evaporate the liquor in the pans. The vapour is condensed in a condenser, and the latent heat allowed to run to waste in the drain. The 30 per cent. not sent to the pans, is used to heat water for melting and washing, and of the heat in the water, 10 per cent. is used for sugar melting, 5 per cent. is used for sugar-washing in the centrifugals, while other 10 per cent. is used for char de-sugaring and washing, 5 per cent. is used for bag filter de-sugaring and washing. Four-fifths of the heat in the water used for washing char and one-fifth of the heat in the water for the bag filters runs to waste; and if we add, say, 10 per cent. waste heat in radiation, &c., the total heat losses of the steam supplied to a sugar refinery would be approximately :—

Latent heat of vapour from pans given up in condenser	60 per cent.
Washing char filters	8 ,,
Washing bag filters	1 ,,
Losses in radiation, &c.	10 ,,
Total heat energy lost in processes	79 per cent.

In the case taken, the condenser used for the vacuum pans is a jet condenser, using salt water injection water. If a surface condenser is installed with fresh circulating water, a considerable quantity of the latent heat from the vapour could be utilised by using a part, if not the whole, of the hot circulating water for washing and boiler feed purposes, but with high vacua in the pans, the temperature of this water may, in many cases, be too low for these purposes.

Fig. 4 is a heat diagram for a sugar refinery in which the steam is raised to a pressure suitable for the generation of electric energy in a turbine and exhausted into the process. Assuming that all the exhaust steam from the turbine goes to the heating process, the various percentage losses of the total heat in the coal would be approximately :—

1.	In the gases, &c.	30 per cent.
2.	In expansion and condensation in turbine	6 ,,
3.	In radiation, &c.	4 ,,
4.	In condenser in connection with pans, where latent heat of vapour is destroyed to obtain vacuum in pans	34 ,,
5.	In washing bag filters	1 ,,
6.	In washing char filters	4 ,,
		79 per cent.

The heat made use of is, approximately :—

1.	Converted into energy in turbine	8 per cent.
2.	In evaporation in pans and for washing purposes	7 ,,
3.	In sugar melting	6 ,,
	Total heat made use of	21 per cent.

EXPANSION EFFECTS AS A CAUSE OF DETERIORATION IN SUSPENSION TYPE INSULATORS.*

BY J. A. BRUNDIGE.

Summary.—In seeking causes for the rapid deterioration which has been encountered in suspension type insulators, two leading hypotheses, viz., porosity and mechanical cracking through expansion effects, have been advanced by different groups of investigators. These are briefly outlined in the Paper, after which the author presents data in support of the latter. Some of the operating problems attendant upon insulator deterioration are also discussed.

The continued and seriously high rate of deterioration occurring in all parts of the country in high-voltage suspension insulators of the cap and stud type, has caused investigations towards the design of a durable insulator. Mechanical cracking of the porcelain brought about by expansion effects (possibly assisted by heavy cable loads) is held by some to be the principal cause for the trouble experienced. Unless the more recent designs and methods of assembling have sufficiently reduced the mechanical stresses set up inside the cap troubles with this type of insulator may be expected to continue, regardless of the degree of perfection and freedom from porosity attained in the manufacture of the porcelain shells.

On the other hand, there are investigators who believe that practically all insulator deterioration is ultimately attributable to porosity, which either makes the porcelain weak electrically after moisture has been absorbed, or causes cracking through the capillary absorption and crystallization of salts taken up from the adjacent cement used in assembling, or causes a combination of both. The porosity hypothesis is in part based upon the results of experiments made with apparatus designed to measure extremely high resistances. With such apparatus, it has been shown that all porcelain is more or less conducting and that quite wide resistance differences exist between various specimens. A considerable variation in the resistance of certain specimens when subjected to treatment for the purpose of altering their moisture content has been also noted. These results suggest that all porcelain is inherently porous to such an extent as to make it unsuitable for manufacturing satisfactorily durable insulators.

While having no desire to minimise the importance of porosity effects, the author has arrived at the belief that expansion effects are causing the major part of insulator deterioration, and the following notes and comments are given in support of this view.

GENERAL.

Statement of Conditions Inside of Cap.—Before referring to observed results, it is instructive to review the conditions existing inside the cemented metal cap of a suspension insulator.

It is well known that Portland cement after setting does not attain its ultimate hardness for a considerable period—usually months—but when this state is finally reached, it will withstand and transmit fairly large compressive stresses. Under these conditions, the porcelain inside an insulator cap is directly subjected to varying forces which it is poorly adapted to withstand. The temperature expansion coefficient of porcelain being only approximately one-half that of steel, it is perceivable that from this source alone stresses amply sufficient to cause damage must occur as the result of seasonal temperature changes. Expansion in the steel stud on hot days is doubtless responsible for much of the trouble.

But another and even more serious form of expansion takes place inside insulator caps where Portland cement has been used for assembling, the existence of which has not been generally recognized. This is the expansion and contraction of the cement itself that the influence of varying moisture conditions. Mr. A. H. White, in a series of experiments extending for a period of nearly five years, on both old and new samples of concrete and cement obtained from various sources, has shown that from a dry to a completely moistened state, neat cement briquettes will expand as much as 0·15 per cent, which is equivalent to a temperature expansion change in cement of nearly 270 deg. fahr. (150 deg. cent.). The effect is gradually progressive, the samples exhibiting a slight increase in length with each cyclic change. The generally accepted explanation is that Portland cement exhibits reversible collodial characteristics to a limited extent, analagous to the softening and swelling up of glue in the presence of water. The progressive expansion taking place with the cyclic changes is attributed to the incomplete hydration of some of the particles of cement, which are initially sealed up and protected, but as the expansion and contraction goes on, more of these are exposed to moisture so that additional setting takes place, accompanied by a certain amount of permanent expansion.

The much greater deterioration experienced with insulators hanging in the tension or horizontal position as compared with that occurring in those suspended vertically, may be accounted for by the fact that the cement in the former is much more directly opposed to the elements, thus affording greater opportunity for the taking up of water; also because of the greater relative exposure of the horizontally placed units to the hot sun, resulting in their undergoing more abrupt temperature changes. The great difference in the rate of deterioration observed in the two positions cannot be wholly accounted for by the fact that the tension insulators usually support heavier mechanical loads. While it is believed that excessive loads accelerate deterioration, several instances have been encountered where tension insulators carrying loads less than those on adjacent suspension insulators have shown percentage failures from 2 to 3 times as great and equalling the failures observed in tension insulators generally elsewhere on the same systems.

* Abstract of a Paper read before the American Institute of Electrical Engineers.

Digitized by Google

DATA AND OBSERVATIONS.

The following notes relate to data from megger and oscillator tests made during the last three years on transmission systems located in widely separated parts of the country embracing an aggregate of over 600,000 suspension insulator units.

Electrical Stresses Not a Necessary Factor in Deterioration.—Owing to the greater electrical stresses to which the end units of insulator strings are theoretically subjected, it might be expected that these would fail in comparatively greater numbers if such electrical stresses were a material factor. With one exception, the data on which have not been fully confirmed, no evidence has come to the notice of the author that the end units do fail at a greater rate.

Another phenomenon of much more conclusive nature showing that deterioration takes place independently of electrical stresses is the loss often observed in insulators where they have been left for some time in the original crates. In one instance reported from the Pacific coast, it was found that the percentage deterioration in a lot of several hundred units left over from line construction amounted to practically the same as that occurring in the ones in service. The crates containing the excess insulators were of the usual open type, and had been stored in a yard for a period of approximately four years. Tests were made by means of the megger, and the loss totalled nearly 5 per cent.

Insulator Failures are Not Proportional to Degree of Firing in Kiln.—Referring to a lot of 877 units subjected to oscillator tests in 1915, and which represented the entire commercial range of firing, it was found that failures did not occur any more frequently in underfired shells than among the others. In fact, the overfired shells were the ones which showed a tendency to fail in excess of the average. This would indicate that the failures observed were influenced more by mechanical strength of the porcelain than by the degree of porosity.

A more striking instance is the failure on a certain system of a large number of foreign insulators, the porcelain of which was exceptionally well fired and uniform in character. Although excellent service was afforded for the first three years, trouble afterwards became very serious, and it is reported that practically all of these insulators have now been removed from the lines, after approximately six years' operation. In this case, it has been fairly well established that the deterioration was due to cracking which was accentuated by a very unfavourable design of the head, including long embedded studs.

Rate of Deterioration.—In testing with the megger it has been found that the great majority of the units read zero or nearly so when first discovered. The few units which did not read zero at first have, so far as observed, since changed in resistance but slightly, and such of them as the author has examined show unmistakable evidences of porosity.

The rapidity with which deterioration takes place in insulator units is in many cases quite remarkable. On a certain high-voltage line, it is reported that insulators sometimes fall in resistance from infinity reading on a 2,000 megohm megger to apparent zero during the course of a few days. This is indicative of cracks rather than of porosity.

Porosity in Small Amounts not Believed to be Excessively Harmful.—The theory which has been advanced that conducting areas are formed by moisture within the body is undoubtedly valid for those cases where the porosity is marked, but the author believes that the performance of the numerous pin-type insulators which have been in use for comparatively long periods shows quite conclusively that reasonably small amounts of porosity are not necessarily injurious. All of these older insulators are unquestionably of greater porosity than many of the suspension type manufactured comparatively recently, and which have failed to a serious extent.

It has been determined by Prof. Creighton that where a porous insulator has become saturated with moisture, it is easily punctured by application of potential at ordinary frequencies. This fact led to the suggestion by others that insulators only slightly porous, after having been in service for several years so as to absorb moisture, might be discovered and weeded out before reaching a dangerous condition by subjecting them to a 60-cycle test at near flash-over voltage in order to line up the particles of moisture to form a conducting path, similarly to the lining up of particles of foreign matter between the electrodes in an oil testing set. Experiments were undertaken by a transmission company to apply this hypothesis, but the results obtained were negative in character so far as concerned substantiating the presence of porous ware. Such breakdowns as did occur could nearly always be traced to manufacturing defects in the porcelain.

Indications of Cracking.—While the author has not had opportunity for the careful examination of any large number of faulty insulator units by the removal of the metal caps, such work as has been done has afforded fairly consistent results. In order to remove the caps without disturbing the porcelain, a helical cut of suitable pitch is taken with a hack saw, beginning at the lower edge, which enables the metal at the side of the cap to be removed in the form of a strip, thus freeing the upper portion.

With the caps taken off it is still by no means an easy matter to locate the existing cracks unless they have become opened up somewhat or are discoloured through age. It has been found, however, that in some instances the cracks may be identified by carefully examining the surface of the cement which has been in contact with the porcelain. The cement may show a fine crack corresponding to the crack in the porcelain, or only darkened lines which for lack of a better term have been called "weathering lines."

While the cause for the weathering lines is not definitely known, it is probable that they are the result of ozone liberated by slight electrical discharges through the crack while the unit was in service.

OPERATING PROBLEMS.

Deterioration in insulators is proceeding at such a rate that it is debatable whether all suspension insulators of the cap and stud type now in service will not have to be replaced within a comparatively few years. Obviously this constitutes a very serious situation for the operating engineer, and it is imperative that insulators approaching the end of their usefulness be detected and removed from the line before conditions develop threatening the continuity of service.

The question arises as to whether anything will be gained by subjecting all insulators in service to a periodic test at high voltage for weeding out those pieces undergoing incipient deterioration. It is apparent that if a test could be devised which would insure safe operation for a period of three or more years without the necessity for attention to the insulators in the meantime, much of the cost of insulator patrol and maintenance of the lines would be obviated. It is believed that a high-voltage test might prove useful should it be established that porosity is a serious factor. On the other hand, it is not likely that much benefit would be derived from the testing of units in this way which are liable to deteriorate through cracking. It is known that each application of high potential will indefinitely continue to break down additional units and many of these would doubtless be of service for a considerable time before necessity arose in the ordinary course of events for their replacement. Moreover, failure by cracking proceeds at such a rapid rate that many of the insulators might make a good showing on test and fail very soon afterwards.

CONCLUSION.

Summarised briefly, the reasons for believing that expansion effects are the principal cause for deterioration in suspension-type insulators are as follows:—

1. The conditions existing inside the metal caps are sufficient to explain, through temperature expansion alone, much of the trouble experienced. Expansion occurring in the cement because of moisture absorption is of an even more serious nature.
2. No evidence of importance is at hand showing that electrical stresses have caused the trouble under discussion.
3. Except for bad cases of underfiring which are generally easily detected, losses of insulators in service do not bear any apparent relation to the degree of firing.
4. So far as observed, deterioration takes place quickly, such as would be expected during the formation of cracks. On the other hand, slightly porous ware absorbs moisture only very slowly, and were porosity the predominating cause for failure, large numbers of units would undoubtedly have been discovered in the intermediate resistance stages.
5. Cracks of more or less long standing have been identified in a majority of cases where it has been possible to carry on post mortem examinations on defective insulator units.
6. The relatively good showing made over long periods by pin-type insulators having cemented parts and by Hewlett units, none of which represent as high development of the porcelain manufacturer's art as some of the later suspension insulators, would indicate that porosity is not the factor of most immediate concern.

It is to be borne in mind, however, that after losses from expansion effects have been more or less completely eliminated, porosity in porcelain may remain as a problem of considerable importance and that the work done in this direction by investigators will become increasingly valuable, unless, perhaps, a better material for insulators will then be available. Progress in overcoming expansion will doubtless include, as one of the steps, the elimination of Portland cement from the designs and this incidentally will be of aid in simplifying the problems arising from porosity.

Digitized by Google

NOTES ON THE DESIGN OF ELECTROMAGNETIC MACHINES.*

2. ALTERNATING-CURRENT GENERATORS.

BY STANLEY PARKER SMITH, D.SC.

The subject is divided into the following three parts :—

I. Theory.
II. Design of a Slow-speed Alternator.
III. Design of a Turbo-alternator.

PART I.

THEORY.

Part I. is divided into the following sections :—

1. Method of Working of Synchronous Machine.
2. Armature Windings for Three-phase Synchronous Machines.
3. E.M.F. Induced in Three-phase Windings.
4. M.M.F. of Three-phase Windings.
5. Inductance of Three-phase Windings.
6. Conversion of Energy in Synchronous Machine.
7. Effect of the Number of Phases on the Output of an Armature Winding.

1. METHOD OF WORKING OF SYNCHRONOUS MACHINE.

Power and Reactive Components of the Current.—The action of the synchronous machine can be readily understood from the diagrams in Fig. 1, showing the effect of the interaction between the flux and the armature current for different positions of the coils with respect to the poles, when the machine runs at synchronous speed. For the present, the ohmic and inductive pressure drops in the armature windings will be ignored, and the flux assumed constant in value and fixed in position.

The current in the coil under consideration is assumed to reach its maximum value in the positions indicated in the space diagrams, whilst the E.M.F. induced by rotation always occurs when the coil-sides lie under the pole-centres, as shown in diagram (A). We can now consider diagrams (A) to (F) separately.

Diagram (A).—Here the current I reaches its positive maximum value at the same instant as the induced E.M.F. E; in other words, the current is produced by the induced E.M.F., which in this case forms the terminal pressure V. The physical meaning of this is seen to be that the force due to the interaction between the flux and armature current opposes the motion, so that mechanical power must be supplied to drive the machine, and we have an electric generator. Thus when the current is in phase with the induced E.M.F., the mechanical power Fv is converted into the electrical power EI.

Diagram (B).—When the current I reaches its negative maximum value at the instant the induced E.M.F. E reaches its positive maximum value, an outside pressure $V=-E$ is needed to maintain it, whilst E acts as a back-E.M.F. The torque is now seen to be reversed and the interaction between flux and armature current produces the motion. We have, therefore, an electric motor, the supplied electric power $VI=-EI$ being converted into the mechanical power Fv.

Diagram (C).—In this position the current reaches its positive maximum a quarter of a period later than the induced E.M.F. E and no torque whatever is produced, since the pull exerted by one coil-side is neutralised by that exerted by the other coil-side. Thus the machine is neither a generator nor a motor in this case. At the same time, it is seen that the armature M.M.F. opposes the pole M.M.F., so that the latter must be increased if the flux is to remain constant. Thus, whenever a current lags behind the induced E.M.F. in a synchronous machine, the armature M.M.F. tends to demagnetise the field.

Diagram (D).—When the current I leads the induced E.M.F. E by 90°, the conditions in (C) are reversed, and the armature and pole M.M.F.s have both the same sense, consequently the poles must be under-excited to maintain a constant flux or induced E.M.F. Here, again, the machine converts no power, the current being purely reactive. Thus, whenever a current leads the induced E.M.F. in a synchronous machine, the armature E.M.F. tends to magnetise the field.

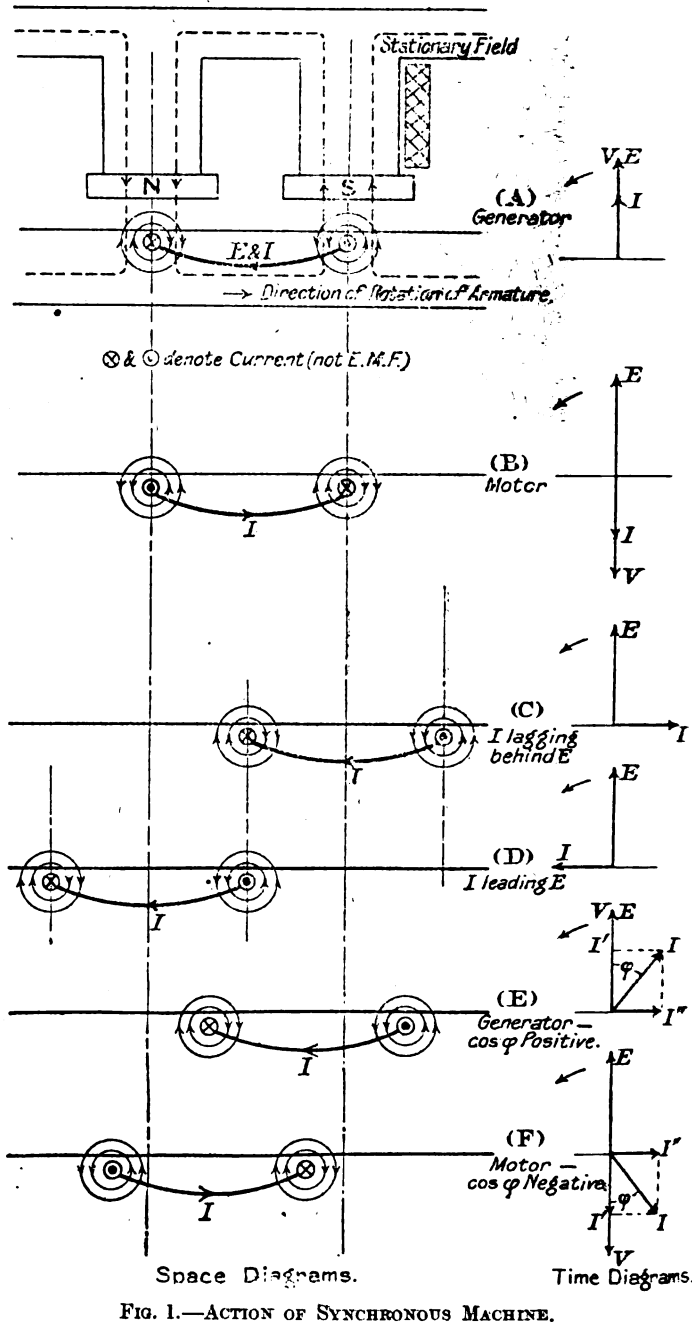


FIG. 1.—ACTION OF SYNCHRONOUS MACHINE.

(Space diagrams show position of coil when *current* is at a maximum. E.M.F. reached its positive maximum in position shown in (A). E=induced E.M.F.; V=applied pressure; I=current.)

We shall now see what happens when the current has both a power and a reactive component, that is, when we have a combination of case (A) or (B) with (C) or (D).

Diagram (E).—This represents the case of a generator working on an inductive load. The current I has a power component I' in phase with the induced E.M.F. E, so that the electrical power EI' is generated. The reactive component I'' lags 90° behind the induced E.M.F., and exerts a weakening

* The first article of this series dealt with Continuous-current Machines and the first part appeared in THE ELECTRICIAN of June 2nd, 1916 (Vol. LXXVII., p. 280).

Digitized by Google

effect on the poles, so that the exciting current on load must be greater than on no-load, to maintain E at the same value. This is the normal condition for which alternators have to be designed.

Diagram (*F*).—Here we have an over-excited synchronous motor. The power component I' flows against the back-E.M.F. E, and the electric power VI' is converted into mechanical power; whilst the reactive component I'' lags 90° behind the induced E.M.F. E, and thereby serves to counteract the over-excitation and so maintain the flux and induced E.M.F. constant.

Though lagging with respect to the induced E.M.F. E, it is seen that the reactive component I'' leads with respect to the applied pressure V, and for this reason it is usual to speak of an over-excited synchronous motor as supplying a leading current to the line. The object of supplying this reactive current to the line is to relieve the generators, since it is quite immaterial from what source the magnetising current needed for the inductive parts of the circuit (chiefly induction motors) is obtained.

It is thus seen that if a synchronous machine has a component of current in phase with the induced E.M.F. E, the machine is a generator; if in opposition, a motor; whilst a current component lagging behind the induced E.M.F. weakens the field, whereas a leading component strengthens it. In the generator the induced E.M.F. is the terminal pressure; in the motor, the induced E.M.F. forms the back pressure, which opposes the applied pressure.

From the above argument will be understood the effect of varying the excitation of a synchronous machine or rotary converter working in parallel with other synchronous machines. Assuming the impedance drop to be negligible, any change in the exciting current of a machine is at once counteracted by a corresponding change in the reactive component, just as any change in the load is at once responded to by a change in the power component of the current. The function of the reactive current, therefore, is to maintain the flux at the value required for the induced pressure, which must be equal to the pressure in the system. A common illustration of this is the rotary converter with negligible reactance in the circuit. Here, as is well known, the exciting current can be varied at will without affecting the pressure at the commutator brushes appreciably.

Though the direct magnetising or demagnetising effect of the reactive component of the armature current on the pole excitation is so important, the reaction of the power component is not negligible. Here the effect is to distort the main flux—in the case of the generator the flux becomes more concentrated at the pole tip where the conductor leaves, while the reverse effect occurs in the motor.

Vector Diagram of Synchronous Machine.—Strictly speaking, vector diagrams are not applicable for showing the reactions in an alternator, because the various changes do not follow a sine law. Nevertheless, sinusoidal variations of flux can at least be approximated in a turbo-alternator with a uniformly-slotted cylindrical rotor and constant air-gap, provided that saturation is not appreciable, whilst it is shown in section 4 that the assumption of a sine curve for the distribution of the 3-phase M.M.F. is quite justifiable. Despite its limitations, the vector treatment serves to bring out the fundamental principles of these machines in a simple manner, and is widely used in the design office, occasionally with, but usually without, further refinement.

In Fig. 2 the vector diagram is drawn for one phase of a generator working on an inductive load—the common case in practice. Though both the pole M.M.F. and the flux are steady (*i.e.*, non-pulsating) quantities, their assumed sinusoidal distribution causes them to vary sinusoidally with respect to the armature winding in the same way as the synchronously revolving armature M.M.F., so that it is allowable to represent them by vectors.

On *no-load*, the flux Φ is produced by the ampere-turns AT_r (on the poles) and induces the E.M.F. E in the armature phase under consideration. It is convenient to show the flux vector leading the vector of the E.M.F. it induces by 90°, in the same way as in a transformer, where the flux actually varies.

On *load*, the current I flows through the armature winding and produces the armature M.M.F. AT_a. With respect to the phase in question the vector representing AT_a will have the same direction as the current, as will be shown later in the M.M.F. diagrams for the armature winding (*see* Fig. 7).

With the current lagging as shown it is seen that AT_a tends to weaken AT_r, so that to maintain the latter constant, the excitation of the poles must be increased and the poles must advance through the angle χ with respect to their former position. Thus the ampere-turns on the poles are increased from AT_r on no-load to AT_p on load. If the armature winding had neither resistance nor inductance, the flux Φ would now remain unaltered in position and magnitude, and the terminal pressure E would be unaffected.

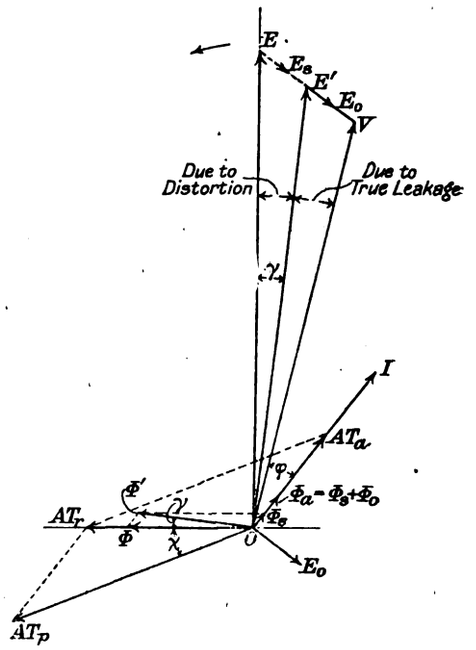


FIG. 2.—VECTOR DIAGRAM OF SYNCHRONOUS GENERATOR, ASSUMING SINUSOIDAL QUANTITIES.

Actually the winding has inductance, in consequence of which the flux will be shifted in phase and the terminal pressure altered in value, whilst the resistance will cause an ohmic drop. The vector representing the ohmic drop has the same direction as the current, but its effect (1-2 per cent. of the terminal pressure) is usually too small to take into account in the diagram. The E.M.F. due to self-induction is represented by a vector 90° behind the current, and has much more effect than the resistance.

To consider the effect of the inductance of the winding, let us imagine the poles are removed and the current I is sent through the winding. For this purpose a pressure must be applied to the terminals, one component of which will be consumed by the resistance and the other in overcoming the back-E.M.F. of self-induction, $E_x = \omega LI = XI$ (the calculation of the inductance L is dealt with in sect. 5). The flux Φ_a caused by the current I flowing through the winding and inducing the back-E.M.F. E_x is commonly referred to as the leakage flux of the winding, and is in phase with the vector AT_a producing it. In general the leakage flux Φ_a consists of two parts—the overhang flux Φ_o, associated with the overhang of the winding, and the slot flux Φ_s, associated with the slots and tips of the teeth. The former depends largely on the type of winding used, whilst the latter depends mainly on the slot and gap dimensions.

When, however, the poles are present and excited, there is the additional main flux Φ produced by AT_r—the resultant

Digitized by Google

of AT_p and AT_a. In the overhang the two fluxes Φ and Φ_o scarcely affect one another, but in the gap and teeth Φ and Φ_s have a common path, and consequently cannot have a separate existence.

Thus, on load, the main flux Φ combines with the slot flux Φ_s to form the flux Φ', which is displaced from the no-load flux Φ by the angle γ and induces the E.M.F. E_s' in the winding, where $E'/E=\Phi'/\Phi$. In addition to the reaction of AT_a on the pole excitation, therefore, the armature ampere-turns skew the flux in the gap, and so with a lagging power-factor, cause less flux to enter the armature core and reduce the induced E.M.F. accordingly. In Fig. 2 the line joining E and E' is drawn dotted, because it does not represent a real E.M.F., but is merely equivalent to what would be induced if the slot flux Φ_s had a separate existence.

On the other hand, the flux Φ_o in the overhang actually exists and generates the back-E.M.F. E_o, which further reduces the pressure at the terminals of the machine from E' to V.

Though not an exact account of what takes place in the gap and teeth of a synchronous machine, the above description serves to illustrate the difference between the effect of the inductance of the coil-sides and the inductance of the coil-ends—the former effect being to distort the flux in the gap so that the amount entering the core is altered, and the latter the same as if a reactance were placed between the winding and the terminals. For all practical purposes, then, we can say that to produce the pressure V at the terminals on load, the flux Φ' entering the armature core must be proportional to the real E.M.F. E', whilst the flux Φ passing through the gap must be proportional to the fictitious E.M.F. E. Thus the poles must be excited to produce the flux Φ in the gap, though only the part Φ' of this induces E.M.F.—the remainder being "blown" circumferentially round the gap, without linking the winding.

In practice the problem is usually to maintain the terminal pressure V constant, so that from no-load to load the flux entering the gap must be increased in the ratio E/V, and the flux entering the core in the ratio E'/V, that is to say:

flux in gap on load $\Phi_g=\Phi E/V$,

flux in stator core on load $\Phi'=\Phi E'/V$,

where Φ=flux on no-load to give V volts (cp. Fig. 17).

It must be remembered, therefore, that it is only for the sake of convenience in calculation that we regard all the fluxes as real, and we are justified in doing so because the effect on the terminal pressure is the same whether the leakage E.M.F. is real or fictitious; but when the densities and losses in the iron have to be computed, care must be taken to allow for this accordingly.

In passing, it may be mentioned that in a slow-speed alternator the real and fictitious leakage fluxes are of the same order, as a rule, whereas in a turbo-alternator the real component is mostly much larger than the other.

A similar line of argument to the above applies also to the leakage flux in transformers and induction motors.

(To be continued.)

Automobile Headlights.—The "Transactions" of the Illuminating Engineering Society (U S.A.) for April contains a series of three Papers by W. F. Little, S. C. Rogers, and E. J. Edwards on the design of automobile headlights. The point of chief interest in the discussion is the elimination of glare. Quite a number of devices have been applied to restrict the light mainly to below the horizontal—*i.e.*, to light up the road, but not to throw the beam into the eyes of approaching drivers and pedestrians. For example, light reaching the upper hemisphere may be cut off by an opaque screen, or half the lens-surface may be frosted, or the mirror made in two sections of unequal foci. It is recognised, however, that besides the main beam for the road-surface the motorist requires a moderate general illumination of surrounding objects. One frequent cause of glare is the misuse of the "spot lights" on either side of the car, which are normally capable of being directed at different angles. Some drivers use this in a somewhat reckless manner, and its function ought to be more clearly recognised.

PATENT LAW.

At the annual meeting of the Society of Chemical Industry in Birmingham on Thursday last week, Dr. Rée read a short Paper dealing with the position of patents under present legislation. After pointing out that the compulsory working clauses of the Patent Act of 1907 were directly traceable to the efforts of the Manchester Chamber of Commerce, he drew attention to the manner in which these had been rendered very largely nugatory through the judgment of Lord Parker some 15 months later in the Hatchett case. That judgment was based largely on the argument that it was unreasonable to call on a defendant to prove or disprove the plaintiff's case, and that to do so was contrary to the principles of English justice. This reduced the compulsory working clauses to an absurdity, because it was obvious that all the patentee had to do was to refuse any information as to adequate manufacture here. The plaintiff might produce witness after witness to show that he was unaware of any manufacture in this country, but that would be no proof of non-working. As a fact, the principle of calling upon a defendant to prove or disprove what the plaintiff alleged was not contrary to the rules of English justice, and many examples could be cited in which this practice was followed. There was, for instance, the case of the trader who applied to the railway and Canal Commissioners for a lower railway rate. The railway company was then called upon to show that the rate was a reasonable one. A receiver of stolen goods had to account for possession of the goods, and a publican had to show justification for serving a man who was drunk. In his opinion an applicant for revocation of a patent should have the same right of discovery as the applicant in a Chancery case, viz., by interrogatories.

He would like to revert to the position under the Statute of Monopolies in order to prevent Germans taking out patents in this country preventing manufacture here, and working them abroad, thus creating a protected market in this country for the goods at our expense, fostering the foreign industry and damaging ours. It should not be enough that part of the invention should be worked here. The importance of insisting upon this would be apparent to all who had knowledge of what happened at the outbreak of war, when one of the difficulties was not the production of certain products but the impossibility of obtaining certain intermediate substances. If this principle had been insisted upon years ago in regard to chemical patents we should to-day have had an organic chemical industry rivalling that of Germany. He disputed the argument that this was primarily a matter of education. If the Chambers of Commerce had got what they asked for years ago, there would have been plenty of suitably trained English chemists to carry on.

Either we must revert to the interpretation put upon the compulsory working clauses before Lord Parker's judgment, or to the position as it was before 1907. Compulsory licences were useless, as the patentee would always be years ahead of the licensee, to whom he would not give the latest information because it was well known that very few patents were worked strictly in accordance with the final specification. The Germans had been fully aware of the benefits to them of the old patent law, and therefore they were the most embittered opponents of any attempts to alter it. For years and years every device was used to prevent any amendment; indeed, it was urged that if any attempt were made to do so it would lead to retaliation. At that time they had clauses in the German patent law far more stringent than the ones proposed in ours, and nothing happened.

Mr. A. G. BLOXHAM remarked that Dr. Rée not only wanted to reform the patent law, but wanted to cut away the prime principles of Free Trade. Thus, any discussion of this subject must become far more a political matter than might at first sight appear likely. He submitted that the author was wrong in what he said with regard to retaliation on the part of the Germans, because within a very short time—only a year, he believed—of the passing of the 1907 Act, both Germany and Austria altered their laws, and put them on precisely the same basis as the clauses in the 1907 Act—*i.e.*, German patents in the hands of foreigners were to be revoked if the patentees worked the inventions mainly abroad.

Dr. REE replied that the clauses of the German Patent Acts with regard to compulsory working were more stringent than ours, and when they were brought into line with our compulsory working clauses in the 1907 Act it really made things easier for us.

Mr. J. W. HINCHLEY thought the chemical industry had reached a point at which there was an entire breakdown of the patent system. To patent a process was only to tell everyone what the patentee was doing, and from that point of view a patentee required more protection from the State without so much expense. Many inventions were made which were not patented simply because the man who worked out the process, or whatever it was, would not be protecting himself at all. He would simply be giving away what he had done. Therefore, it seemed to him that before long we must have some system of State protection quite different from our present patent law. There had been instances recently in which inventions had changed hands for quite considerable sums of money without their having been patented.

Digitized by Google

INDUSTRIAL RESEARCH.*

BY HERBERT W. ROWELL.

SOME PRINCIPLES OF INDUSTRIAL RESEARCH ORGANISATION.

Industrial research covers a wide range of scientific activity, from chemical and physical work in the laboratory and experimental department to the lay-out and design of plant, and to the final details of economic production.

Pure chemical and physical research is an entirely different proposition, and occupies a distinct sphere of usefulness of its own. Some American concerns have separate laboratories for this work, supplying exact data to the industrial research organisation, and incidentally publishing the results to outsiders who may be interested.

Work of this type can be, and a little is, done by our universities, but it should be State-aided and systematically encouraged by manufacturers.

An attempt is made below to specify the main principles producing satisfactory results from industrial research. It is necessary to have a broad-minded leader of an industrial research organisation. The only fit person to undertake the control of research and the development of industrial technique is the scientifically trained chemist, engineer or physicist, as the nature of the work demands, because he has the best metal equipment and method for discovering the true cause lying behind an observed effect or for combining causes to produce a desired effect.

All matters of research and experiment in an industrial organisation should be centralised to one laboratory under the control of one person, even if the organisation is interested in various types of manufacture in separate works. Routine control testing should be done in separate works laboratories. In large organisations this should include a unit experimental factory, and in small organisations the experimental floor may profitably be used for the manufacture of small lines required as raw material for various works operations, or for direct sale where the bulk of output is small and skilled supervision is required.

The initiation, organisation and carrying through of all research and experiments up to the experimental works stage should be in sole charge of a trained chemist or physicist, with works experience, responsible directly to the executive. Research and experimental work should not be under the direct control of the works, but the research department should depend almost entirely on the advice of the works manager in matters of existing methods and troubles in manufacture, and to a great extent on what matters require investigation. The head of the research department must keep in personal touch with the processes in the works and with the heads of departments, and must realise in a broad-minded way the difficulties in manufacturing.

The research staff in larger organisations will necessarily be divided into departments dealing with separate types of chemical and physical work, each under a qualified superintendent, and where a problem requires the attention of several departments, then these superintendents should meet regularly so that each obtains a complete survey of the problem in hand. The individuals on the staff should, firstly, have a proper scientific training in their own special line and in collateral subjects; secondly, they should have the research outlook which includes initiative, imagination, a balanced judgment, perseverance, resourcefulness and *esprit de corps*; and, thirdly, should have experience in methods of manufacture and works routine.

While the initiation of research should lie principally with the head of the research department, there should be some safeguard of giving credit for ideas and improvements to those who originate them. Suggestion bureaux for works employés and direct report to the executive in the case of management staff are used by a number of firms.

Wherever possible the results of research should be covered by patent rights, and where the publication of discoveries, methods of analysis and similar matter does not seriously damage commercial interests, the results should be contributed to the common stock of scientific knowledge. In these more scientific days it rarely happens that discoveries can be made "secret processes" with advantage over patent or registered design, although the law on these matters and the attitude of the Patent Office could be modified with advantage to the State and to the manufacturer. Every distinct item of research should be properly planned, and all available information on the subject collected and properly indexed and digested before starting practical work, although re-planning will probably be necessary as the work proceeds. The cost of work should be estimated where possible, or a definite sum allotted to the work by the executive for experimental plant and laboratory expenses.

The principle of elimination by trial and error should not be used on the chance of obtaining a quick result. There are occasions when no other method is available on account of lack of data; but systematic research, based on scientific principles and properly planned application of them produces more valuable results, provides data for future work and frequently produces side lines for new investigations of value.

Comprehensive records of results, details of observations, unusual properties of substances and specimens handled should be properly kept and indexed, together with typical and standard specimens as working data in connection with the library. The methods of reporting results of analyses and investigations in a manner intelligible to the works and to the executive should receive careful attention.

No experimental work should be done in the manufacturing departments, except such as is required in starting a new machine or process after working on a smaller scale in the experimental departments, or such as is required in enlarging the production of a machine or process without alteration of the principle on which it operates. Loss of production and leakage of information are usually more costly than a special experimental machine.

SCHEMES FOR CO-OPERATIVE INDUSTRIAL RESEARCH.

Our Government has been impressed with the necessity for national research on a large scale to the extent of contributing large sums of money for the purpose of encouraging it. The chemical, textile and other trades have already discussed co-operative research with expectations of doing something practical; but apparently only wealthy and influential firms are interested in the schemes. The smaller concerns do not realise the importance of the movement. Co-operative research is entirely unknown in Britain, while it has been established for several years with considerable success in other countries.

If the annual cost of research is compared with the capital or gross annual profit of some of the large American concerns it will be seen that these large sums spent represent only a very small percentage of profits or capital. A large research organisation can afford to buy better brains and plant, can risk more on unsuccessful work, and has more success and is less costly in proportion to its results than a small laboratory. We require in this country some system enabling the smaller firms to carry out industrial research under the best conditions at a minimum cost and with the best prospects of profitable results. In reviewing the existing facilities, we find that there are comparatively few works in this country, even in the distinct chemical industries, employing separate research staffs, fewer still which thoroughly equip their staff, and none which spend sums comparable with German or American firms of similar importance.

The schemes suggested below are put forward as outlines which might profitably be considered by groups of manufacturers, and the essential points considered are:—

1. That a properly equipped laboratory and experimental station should be established on such a scale that it could afford to employ experienced industrial research men of high grade to organise and supervise the research and experiments.

2. That the manufacturer may safely entrust all the details of his processes to the organisation without risk to business interests.

3. That discoveries made should be the property of the manufacturers initiating and bearing the cost of the experiments.

4. That the cost of experiments should be decidedly less than if the manufacturer had employed his own staff and laboratory, and that the probability of success should be greater.

The war has forcibly brought home to us the fact that we are not so much individuals as a nation in trade and manufacture, and it seems that the individual firms in many industries will have to formulate working agreements of various kinds if they are to meet successfully American and similar world competition.

This suggests the broadest type of scheme on the lines of the technical combination of about 20 firms of incandescent electric lamp manufacturers in the United States, which spends a huge sum annually on co-operative research

* Being abstracts of two Papers read before the annual meeting of the Society of Chemical Industry.

Digitized by Google

In future it must be British industry against foreign competition, instead of a single manufacturer against his home industry and the world in general, and this involves buying and selling agreements and other safeguards which are arranged in other countries, and can be arranged here, and it certainly involves more efficient employment of capital, material and labour, and eventually means more profits and lower prices.

At the other end of the scale we have something on the lines of the Mellon Institute in Pittsburg. A large institution in charge of an experienced director and a small permanent staff of specialists is erected and endowed by subscription. It is fitted with a number of private chemical and physical laboratories, and is or may be fitted with experimental machinery of the type required on a small works scale. The manufacturer lays his problem before the director, who will find him a university graduate with suitable qualifications to carry out the work at an agreed salary. It is then agreed to carry on the work for a maximum time, and this chemist will have the sole use of one of the laboratories and certain experimental plant, the guidance of experts on the staff, the use of the library and other general assistance for a definite sum, or the institute may agree to use the permanent staff only and take part payment by results.

This scheme practically amounts to a consulting chemists' laboratory on a very large scale (and such exist in the United States), and therefore on more successful lines. The Mellon Institute has produced some good work in the course of its few years' existence, and has a deal of work in hand.

There is no doubt that the first scheme of co-operation throughout a trade is the most profitable to all concerned. Something less ambitious, organised in such a way that it can be developed into the full scheme as progress is demonstrated, seems to meet our present state. The tar trade may be taken as the first example, for it seems to be faced with both a commercial and technical revolution after the war. Coke ovens and large gas plants are partly refining their own products in competition with the tar distiller. Coke oven and vertical retort tar is quite different from the old types, and an increasing supply and crude benzols and ammonia are more fully recovered. Methods of distilling and fractionating are altering and require alteration, and the products of distillation will have to be marketed in a different state of purity, and the values of tar products—never very stable—are likely to be altered considerably. The analytical tests accepted for sale purposes in the trade are sheer guess work, and the chemists employed are not allowed to alter them. Yet the Ministry of Munitions recently altered the tests for benzene and toluene, and other good work has been done.

If the tar distillers can have commercial agreements as to raw materials, sulphate of ammonia and creosote, why not in standard tests and products and in research and development of the trade?

The tar producers and distillers could subscribe, say, in proportion to their capital or turnover, to institute a central laboratory and experimental works, while control testing and efficiency of existing plant would remain a matter for the attention of the individual works. This laboratory could have two functions, one an analytical department for devising specifications and standard methods of analysis, and acting as a referee laboratory for the trade, and the other a research department with an experimental works and staff of chemical engineers attached to it.

The specifications and tests devised by the analytical department would be common property, and would link producer and consumer, and would help to stabilise the trade, while the results of experiments, patented processes and plant and other profits of the research department would be the property of the subscribers to the scheme. If it were made into a limited company with a scale of payments to it for the use of ideas evolved the commercial aspect of the laboratory could easily be solved.

The central analytical laboratory idea offers no difficulty, the cost would be small, and the results of distinct value; but unless the trade is closely allied by commercial agreements, then the question arises as to what work could be undertaken by a central research department. A phase of work of general importance, in which business interests could not clash is in raising the demand for and consequently the price of tar products and in meeting competition from other trades and nations.

If a research department could make pitch equal to natural bitumen, tar oils into fuel and lubricant equal to petroleum oils, or discover a use for creosote oil equal to the present demand for timber preservation—and these things are by no means impossible it would cover its cost many times over.

The tar works is the proper place in which to make dyestuff intermediates, as it economises capital, material, transport and labour. Many concerns have now nitric acid, oleum, nitration, sulphonation and acid recovery plants, and have only vague plans for their use after the war.

Other matters of a non-competitive nature which might be taken up are the carriage of dangerous goods, better and cheaper packages, safety measures against fire, explosion, and industrial disease and fuel economy. The methods of distillation and the value and composition of the tar produced, and the possibilities in blast furnace, producer gas and oil gas tars are matters for investigation of profit both to producer and distiller.

The quantities and value of the coke, gas and so-called by-products can be greatly modified by alteration in the method of working as well as in the design of apparatus, and as coke ovens, gas plants and recovery plants are usually in charge of an engineer, the chemical aspect of the problem does not get full consideration. A coke-oven plant would call upon the research organisation to inquire into the efficiency of all or part of its plant, or have experiments made on a more suitable type for its particular class of coal. The tar distiller could have his tar supplies tested out on a works scale and be advised of a better plan of working them to obtain a more profitable fractionation. There are great possibilities in this which cannot be shown on a small scale laboratory test. The distillers in general could have experiments made in washing and purification of the various products and the numerous problems of fractionation, distillation and filtration which trouble the works could be solved on practical lines for the mutual benefit of the subscribers.

It could be agreed that certain details would be private between a subscriber and the research staff, while the majority of the work could be detailed to those in the combination who required it. It would probably result that in time no works would consider a new type of plant offered by manufacturers until the research departments had reported on it.

This very rough outline is enough to demonstrate what could be done with the tar industry at the present time, and as a second example we may take another really British industry, the iron trade.

The steel industry has received special and successful attention in this country during the last decade, but the smelting and casting of iron is still done in the same way and in many cases by the same plant which was antiquated 20 years ago.

The grading of pig iron and foundry mixings is still determined by the fracture of the metal and by the district in which it was smelted. A large number of chemists are employed in iron works, but their routine tests are mainly the result of the demands of the steel works for definite raw material, their salaries are usually very small, and no research work of any note has been published in this country; and, in fact, investigation work is not encouraged in any way. Americans, on the other hand, have developed dry blasts, fuel economy, rapid working, slag cement and the working of low-grade ores by the liberal application of research.

A combination of iron masters, foundry men and mild steel makers, quite apart from the remainder of the steel trade, could profitably institute a research organisation to standardise pig iron grades and foundry mixings in the first place, and then develop improved smelting methods, more economical charges, heat treatments, foundry methods and iron and mild steel foundry mixings for standard purposes.

If such an organisation could make blast furnace slag worth 1s. a ton, or reduce production costs by 1s. per ton of pig, its existence would be very amply justified. The trade is faced with big rises in prices of ore, fuel and labour after the war, and when the demand for munitions ceases, and the only way to meet foreign competition at home and abroad is by utilising expert advice in engineering, chemical and works efficiency.

As the last example, we might take the large number of works in the Birmingham district—mostly small concerns—which melt, cast, roll, stamp and otherwise work alloys of copper, zinc, tin, nickel, lead and other non-ferrous metals. Practically none of these works employs a chemist or metallurgist, because of the comparative cost, yet they all feel the need of expert advice.

Except for certain mysterious dopes which are added to meltings—often without practical effect—some foundry methods and a few very special alloys, which can easily be analysed, there are no secrets in the trade, and business interests would not be adversely affected by the institution of a co-operative laboratory.

Quite a modest affair could be started for analytical work and general advice on technical problems, but designed to expand into a full research department and experimental works, where fuel consumption and furnace design, crucibles, heat treatment of castings, casting methods, micro-structure, rolling and stamping and finishing problems could be solved to meet the severe competition of scientific methods employed in Germany and America.

These three schemes are put forward as typical suggestions on which a meeting of manufacturers might take competent counsel from chemists and engineers experienced in their particular industry.

Digitized by Google

The time for organisation is short. We look for some help from Government departments and committees, from scientific societies, from preferential and protective tariffs, from pure research in the universities and better education; but if the manufacturers, and particularly the average and small-sized works, do not evolve their own salvation by the prompt adoption of scientific research and control, coupled with scientific management and business methods, the issue is certain and disastrous.

DISCUSSION.

Mr. BERNARD HOWARD asked how the author could be so emphatic that there was no co-operative research in this country. All the research that went on was not made public. There seemed to be too great a tendency to assume that the manufacturer had never had any technical training, that the chemist was the genius, and that the members of the boards of manufacturing companies were absolutely ignorant. It might be so, and he would be prepared to accept it if it were proved to him. If it were so, then he would suggest that in the schemes for technical education should be a class for the education of those about to join the boards of manufacturing companies.

Mr. E. W. SMITH suggested that the author ought to have been aware of the large amount of co-operative research work that was being carried on in Birmingham in connection with the brass trade.

Prof. C. A. KEANE said that during the war we had had research with a big R written over the portals of industry and education, and he thought the writer of the Papers had gone a little too far in saying what should and what should not be. There were many ways of arranging research, and we must look to them all and put as many as possible on trial. With regard to the industrial fellowships at Pittsburg, the influence of the war had been something extraordinary. He had been informed by the authorities there that during 1916 over 80 men were engaged in industrial research work there, employed indirectly, via the university, for specific researches by chemical firms. However, we were not altogether without knowledge of such organisations in this country. Experiments were on trial in more than one institution on lines somewhat similar to the industrial fellowship system at Pittsburg, and encouragement should certainly be given to such fellowships in this country as one contribution towards industrial research. Some of our manufacturers' associations were already interested in the work at Pittsburg, and he had recently heard of an instance in which a firm wrote to Pittsburg for information as to where industrial research could be carried out in this country. Nevertheless, it was encouraging to know that manufacturers' associations here were looking to that kind of co-operation. There was some tendency to lay the blame at somebody else's door, but that attitude should be ruled aside entirely. We had all learned a big lesson as the result of the war, and there was no special door at which to lay the blame. We were all to blame, and let us share the blame as fully as possible by putting our respective houses in order. The industrial fellowship provided a link between the academic course and industry. That was one way. Another was by manufacturers, and especially smaller manufacturers, sending their problems to the educational institutions. The terms would not be difficult to arrange so long as the governing bodies or the local authorities would recognise that the men in charge of their institutions were respectable, honourable men, to whom confidence could be given, and to whom, also, authority could be given. That was fundamental. As soon as educational authorities and governing bodies wanted to know everything that was going on the whole system must fall to the ground. Those in charge of our educational institutions must be trusted, and the experience of the war had shown that they were capable of being trusted and doing work of considerable national importance. One of the great difficulties in training chemists in industrial occupations was to keep in touch with the requirements of industry and this would be a means of leading in that direction, and providing a supply of trained men who would be a help to industry when they got into it. It would also be the means of helping the most brilliant of the students to secure industrial positions, and so avoid the blind alley of university and college demonstratorships. Such co-operation between the universities and industry would imbue those responsible for the former with a sense of greater responsibility. The present system rendered them liable to become irresponsible, and to acquire the feeling that nothing much mattered in regard to the training of their students. He hoped that manufacturers would bear this suggestion in mind as one means of the teacher and the manufacturer together making some amends for the defects of the past.

Prof. W. A. BONE also protested against the remarks in the Paper that British manufacturers were behindhand, especially in the iron and steel industries, and suggested that the author should consider the advisability of re-wording that portion of the Paper.

Mr. ROWELL, in reply, said the Paper had been purposely put together in a way to get information, and he thought he had succeeded. Whilst agreeing with Prof. Keane that there were many ways of dealing with industrial research he thought Prof. Keane had, if he might say so, given the show away as regards the position in this country when he mentioned the instance of the British firm going to America for information. The fact was that nobody here knew anything about it, and the chemical trade was not alone in that. It had been forcibly brought to his notice in the textile industry and another instance was that of one of the largest and most successful sellers of motor tyres who did not employ a chemist, and who asked why they should when they got on so well without one.

LOW TEMPERATURE CARBONISATION AND POWER SUPPLY.

The extent to which chemists and engineers still differ in their opinions upon low temperature carbonisation was again emphasised during the congress of the Society of Chemical Industry, which was concluded at Birmingham on Friday. The subject of low temperature carbonisation is of considerable interest to electricity supply having regard to the experiments that are now being carried out at Glasgow, the results of which were given during the I.M.E.A. annual meeting this year by Bailie Smith, and the arrangements that have been made at Brighton and elsewhere for gas firing.

In the course of a Paper on "Industrial Fuel from Gas Works," on Thursday, Mr. E. W. Smith, of the Birmingham gas department, made severe criticisms of the manner in which low temperature carbonisation experiments have been carried out hitherto. There seemed, he said, to be no general agreement as to the object of the commercial development of low temperature carbonisation. Those who had attempted to extend the process from the laboratory stage to practical working had varied in their aims. Some had hoped for high benzol yields, others anticipated high tar yields, whilst others had as their main object the production of a solid fuel which would burn easily in the domestic grate without producing smoke. Those who had been in closest touch with many of the processes agreed that no really satisfactory results had yet been obtained. That, however, did not mean that there was nothing in low temperature carbonisation, but in his opinion there had not been sufficient competent research work carried out to enable an opinion to be passed one way or the other. If one judged from the average published results, no more would be heard of the process. The recent Paper by McLaurin, of Glasgow, was typical of what he meant. One of the chief advantages of low temperature carbonisation was that power stations could be put at the pit's mouth, and the gases used for generating electricity, whilst a domestic fuel would be produced. The chief advantage of that would be to centralise carbonisation and power generation, but it would de-centralise domestic fuel supply. It had been overlooked that the amount of coke produced would be very large, and that the question of freightage in distributing it to consumers would provide some difficulties. Again, if the question was examined on the basis of the figures which had so far been published it would appear that the cost of obtaining the light spirit for motor purposes, &c., were such as almost to neutralise the value of the increased volume of tar obtainable by low temperature means. Taking all things into consideration, he thought there was need for the appointment of a strong scientific committee, versed in conditions of carbonisation to go into the whole subject in an independent manner in order to arrive at some definite conclusion as far as was possible at the present time

The PRESIDENT (Dr. Charles Carpenter), referring to the last suggestion, said it gave him some satisfaction to be able to say that the Fuel Board, which was a branch of the Research Department, had decided that the matter was so important and that the opportunities for arriving at a definite conclusion were so unsatisfactory, that it was a matter of national importance that experiments should be made which were absolutely unimpeachable in accuracy. That was quite a broad minded view to take, and one which could hardly have been expected some years ago, but it was the fact that negotiations were in a fairly forward state with regard to a site for the erection of the necessary works.

Mr. DRUMMOND PATON, as one who had worked for years on the problem of low temperature distillation, objected to the disparaging attitude taken by the author towards the experiments upon low temperature carbonisation. Only by such means would the millions of tons of waste coal now produced be used. The difficulty of transport of the resultant coke could be got over by briquetting, as in that form the coke could be much more expeditiously handled.

Mr. SMITH, in reply, said he had no intention whatever of casting any reflection upon the bona-fides of experimenters on low temperature carbonisation. What he deprecated was that this work was the only work that had been done. It should have been carried out by men who probably had less experience in coal and more experience in research in conjunction with the other workers.

Submarine Craft Without Periscope.—The "Journal" of the Royal Society of Arts, quoting from the "Revista Maritima," mentions that submarines are now being constructed without periscopes of the ordinary type. Instead of the usual vertical tube arrangement a system of two lenses, one on either side of the vessel, is being employed. It is claimed that this device is much less visible from a distance, although it has the drawback that the vessel must navigate nearer to the surface. The device appears to be only in the experimental stage.

Digitized by Google

The Electrician.

FRIDAY, JULY 27th, 1917.

Editorial and Publishing Offices:—

8, BOUVERIE STREET, LONDON, E.C. 4.

Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

ON TECHNICALLY OBTAINING SOMETHING FOR NOTHING.

There is a very natural desire on the part of most of us to obtain something for nothing in this world, and in this endeavour we are liable at times to fall into serious error. As an example of this desire the exhaust steam turbine may, perhaps, be taken, though not of the illogical kind. At one time it was fashionable to ut in these turbines in order to extract work from steam discharged from the exhaust of other steam plant. Obviously, if an electric generating station was running non-condensing the addition of exhaust steam turbines opened up the possibility of a great improvement. Thus exhaust steam came to be looked upon as quite an asset. Although excellent results were obtained in this way the adoption of this course was really an admission of inefficient (*i.e.*, defective) running in the first instance, and at the present day it would generally be considered better practice to start afresh and to replace the inefficient plant by high pressure turbines working under good condensing conditions.

This subject has been brought to mind by an article, a part of which we reproduce elsewhere, by Mr. F. H. WHYSALL. In this article Mr. WHYSALL refers to the case of a chemical works which required steam for their processes and at the same time required electrical power. The scheme they had in view was to generate electric power and to use the exhaust steam for the required heating. The effect of so doing was apparently the obtaining of electricity for nothing, or of heat for nothing, whichever point of view was desired. It must be remembered, however, that there is no magic about the question. The heat available for transformation by steam plant depends upon the temperature limits, and if the lower limit is raised to serve another purpose the economy in power production must suffer accordingly. Undoubtedly such projects are often very plausible, and off-hand it is not always easy to explain how it is that a generating station can nevertheless provide electrical energy at such a figure as to show an advantage over the private works. The fact that the generating station loses 50 per cent. or more of the heat in the coal by the action of the condenser gives the impression that something very much better can be done if heat is also required for any other purpose.

There are two or three reasons why the central station is still able to compete. As Mr. WHYSALL points out, one reason is that the private plant, which is generally of small capacity, must use a great deal more coal per kilowatt hour than the power station, more particularly if steam is to be used for heating purposes. Even if the amount of steam required is not very large, and if reducing turbines are used for the purpose, this contention still holds good. It is easy for a generating station to produce electrical energy at the rate of 2½ lb. of coal per kilowatt-hour, whereas the private works as a rule requires at least double this amount. Thus, in the end, a larger amount of heat per unit may be required by the private installation than by the generating station, even though a larger proportion of the total heat may be put to a useful purpose, as in heating or chemical work. Further, when it comes to capital cost per kilowatt this is all in favour of the power station. Lastly, although a certain efficiency may be shown under favourable conditions, it generally happens that the amount of heat required does not correspond with the amount of electric energy required, or vice versa, and therefore the conditions are not actually as satisfactory as are assumed.

In all cases of this kind it is well to be quite clear as to what is desired, whether it is heat or whether it is electric power. Careful estimates can then be made of the cost of what may be termed the "by-product," and its adverse effect upon the main product. In some cases the amount of heat required may be quite considerable, as in the sugar refining industry mentioned by Mr. WHYSALL, but even in such cases the electric power station is likely to show to advantage over the combined private plant. In the sugar refinery the total heat usefully employed in a combined plant is calculated to be 21 per cent. or about double the figure realised in a somewhat inefficient power station. This seems to show considerable possibilities for the private plant, but before adopting this view it is necessary to take everything into consideration; and it is significant that those who handle these problems are beginning to discard the use of exhaust steam for power purposes in private works if a public electricity supply is available.

REVIEW.

Pole and Tower Lines for Electric Power Transmission. By R. D. COOMBS, C.E. (London: Hill Publishing Co.) Pp. viii.+272. 10s. 6d.

This book has primarily been written for the use of American engineers, and, for the most part, it deals with the mechanical rather than the electrical aspects of electric power transmission. Coming from the pen of an author who is well versed in current American practice it is worthy of close attention, and it will be found to contain useful information and some valuable data. It is, however, open to the criticism that it is occasionally rather vague when definite guidance might have been given. For instance, on page 97, we are told that "in the direction of the line, the strength [of a wood A-pole] is twice that of the single poles, while it is considerably greater in a transverse direction, the amount depending largely on the bracing provided to prevent buckling of each pole." Specific information on this subject is available in Mr. C. Wade's Paper, *see* "Journal" I.E.E., Vol. XXXIX., p. 304, 1907.

We congratulate the author on the clearness of his style, the choice of his illustrations (162), the absence of padding, and particularly on the comparative freedom from Americanisms. There are only a few examples of the "new spelling," and these lead to trouble—*e.g.*, in Figs. 33 and 34, "Formulas" and "Formulæ" are both used.

In Chapter I. attention should be directed to the curve in Fig. 7A, which shows "Sag in feet" of conductors plotted against "Separation in feet." The author rightly emphasises the importance of a location plan, or, as we call it, a route map, being prepared before construction is started, and in connection with it he gives in Fig. 17 a useful templet method of determining sags and clearances.

In Chapter II., on "Loading," the author makes out a good case for taking the wind pressure *per square foot of projected area*, as 13·00 lb. for flat surfaces and 8·00 lb. for wires covered with 0·5 in. deposit of ice. The factor of safety to be used should depend on the locality, and he rightly points out that "bridges and buildings are not designed to withstand tornadoes, nor need power wires be absolutely immune from failure." This remark is typical of the common-sense way in which the book has been compiled. The point has been thoroughly grasped in England, and especially by the G.P.O. engineers.

Digitized by Google

Chapter III., on "Wires and Cables," contains no new matter, but we entirely concur in the statement that "the choice between aluminium and copper will depend on the relative cost of the two materials and their accompanying construction, together with the allowances which can be made for the scrap values."

Chapters IV., VI. and X., on "Design," "Steel Poles and Towers" and "Protective Coatings" are valuable, and should be closely studied by engineers who may be concerned in steel poles, although these do not find much favour in this country because of climatic conditions and cost.

Chapter IV. should also be read in conjunction with Chapter V. on "Wooden Poles." The latter contains much of interest, but most of the timbers dealt with are not commonly procurable here. The question of creosoting timber is touched on, and it is clear that American engineers would do well to copy our G.P.O. practice. The Rüping and other protective processes are not mentioned.

Chapter VII., on "Special Structures," calls for no special comment, but we must take strong exception to the statement that "satisfactory insulated cable is not obtainable for higher voltages" than 22,000. This may be true in the U.S.A., but it certainly is not so in the United Kingdom.

Chapter VIII. shows that "Concrete Poles" have been more extensively used in America than here, while Chapter IX. contains useful information on "Foundations," as does Chapter XI. on "Line Material." Chapter XII. deals with "Execution and Costs," and Chapter XIII. with "Protection." Chapter XIV. is worth close study for its "Joint Report Specifications for Overhead Crossings of Electric Light and Power Lines" and "General Specifications for Electric Light and Power Lines."

The volume is provided with an index, and can be recommended to the notice of engineers who have already some experience of overhead lines design.

B. WELBOURN.

SOME ELECTRIC KITCHENS BY CARRON COMPANY.

Although a rapid advance of electric cooking in private houses cannot be anticipated at the present time, owing to war demands in every direction, it is otherwise with the electric kitchen in the up-to-date works, for there is no doubt that electric cooking in such cases enables the management to cater for the needs of their employés in an eminently satisfactory manner. This remark is prompted by a visit which, through the courtesy of Carron Company, we were permitted to pay on the 12th inst. to the well-known cotton mills of Messrs. Richard Haworth & Co., Ltd., of Manchester. Here four electric kitchens, three of which are in regular operation,

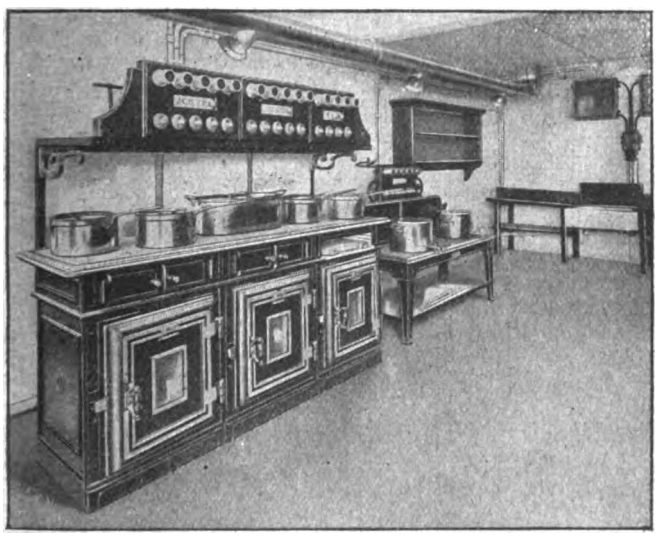


FIG. 1.—KITCHEN ATTACHED TO ORDSALL WEAVING SHED.

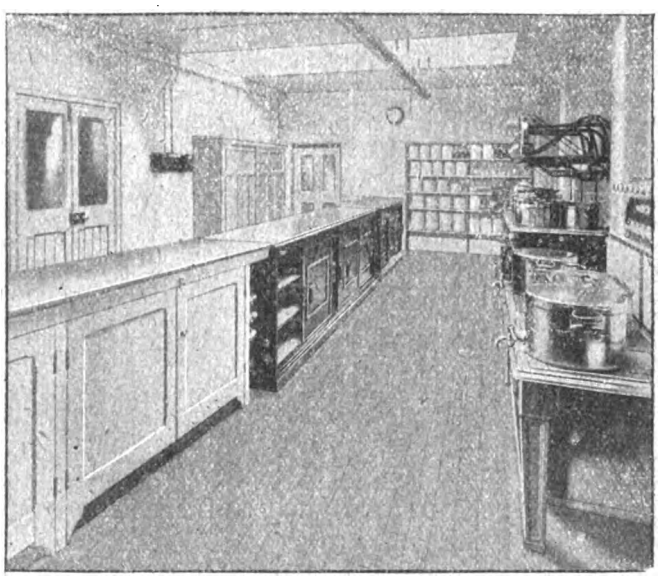


FIG. 2.—"NO. 3 TATTON" ELECTRIC KITCHEN.

are giving every satisfaction, and it is found that these and similar measures have done much to increase the efficiency of the employés taking advantage of them, owing to the better state of health, and that machine efficiency, which is normally 75 per cent. of the maximum output, has risen as high as 95 and even 100 per cent. at times. Naturally it takes time for the advantages of new arrangements to be appreciated, and thus at present only some 500 employés patronise these kitchens, the alternative being either to return home for the midday dinner or to bring food with them, and to have it cooked in an older kitchen equipped with coal-fired ranges.

These kitchens are each equipped with a large three-oven range, having ample boiling and grilling accommodation, a hot closet measuring 22 ft. over-all, and a further heavy boiling table 6 ft. over-all. The appliances embody the latest constructional improvements and the best possible finish throughout, with white porcelain enamelled back plates and nickel-plated and polished mouldings and facings, the black parts being bright stove enamelled.

Each range comprises three standard "Carron" ovens measuring 22 in. by 20 in. by 22 in. inside, built up on the unit principle; they have top and bottom heating elements, each arranged for three-heat control, and loaded to a maximum of 5·5 kw. The linings are porcelain enamelled throughout, and the runner gates, shelves and heating elements can all be removed in a few moments, so that the interior of the ovens can be thoroughly washed out when necessary. The doors of these ovens are each fitted with a toughened glass inspection window and a thermometer, so that there is no guess work in the cooking operations, and everything can be done with mathematical precision, under observation, in a manner hitherto impossible with the previous coal ranges. Over these ovens is mounted a hotplate having two boiling sections, each section having three intensely heated portions arranged for various degrees of heat regulation; whilst a third section is worked at a lower temperature for simmering purposes. Under this is arranged a griller and toaster, white porcelain enamelled inside, and wired for 5 kw., having two separately controlled elements. The hinged doors under the two boiling sections enclose hot closets or warming chambers, which are heated from the sections themselves, and are also fitted with white porcelain enamelled trays. Over the hotplates at the back is erected a strong white porcelain enamelled splash plate, which carries extension brackets supporting the switchboards, and on these are mounted the three-heat rotary indicating switches, fuses and pilot lights. Connecting-up boxes are fitted at the back, and where possible a space of 2 ft. is allowed behind the range, so that there is easy access to these boxes.

The approximate loading of each of these ranges is 32 kw., making a total of 132 kw. with the four. Each range is run on 440 volts direct current, the loads being balanced on either side of the neutral.

With regard to the hot closets, these are built up in two sections,

Digitized by Google

each measuring approximately 11 ft. over all, or 22 ft. altogether. The outer cases are constructed of fine cast-iron, with panels at ends and back, whilst the sliding doors are built up of mild steel, also panelled. They are lined throughout with white porcelain enamelled sheets, and are fitted with two perforated shelves, also white enamelled, and faced on the edges with half-round iron nickel, plated and polished. The "Carron" patent heating elements are fitted in the back of the compartment, and are all interchangeable, and can be removed at a moment's notice, as they have pin and socket connections.

The total loading of these hot closets is 21 kw., each section being separately controlled. The connection wires are carried to terminal boxes at opposite ends, where the three-heat rotary indicating switches and fuses are mounted.

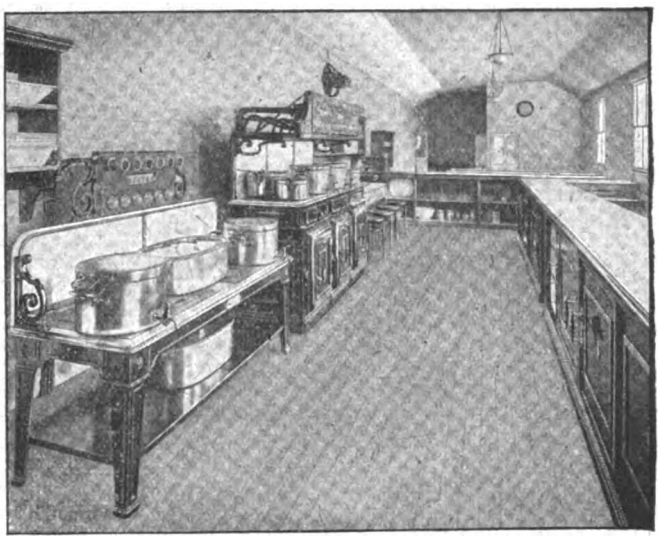


FIG. 3.—KITCHEN AT EGERTON MILL, WHERE APPROXIMATELY 200 DINNERS ARE SERVED PER DAY.

There are two sizes of heavy boiling tables installed, some of which are 6 ft. long and others 3 ft. long, but in both cases they are built up on the unit principle of sections having intensely heated areas, each separately controlled. Each table is mounted on heavy cast-iron feet, has a pot rack underneath, white porcelain enamelled splash plate and switchboard over this, carrying the three-heat rotary indicating switches, fuses and pilot lights. Each 6 ft. table is loaded to 12 kw. maximum, and the smaller tables to half this loading. The total load of the complete equipment in these kitchens is 268 kw.

All the food for breakfasts and dinners is cooked on these appliances, and this includes whatever boiled or steamed foods are required. In addition to this, a considerable amount of pastry is baked that is not taken at these meals, but is sold to the mill operatives and consumed out of meal hours. With regard to the question of cost, no definite records are as yet obtained, as, although some of the kitchens have now been in operation for many months, they are not yet working at their full capacity, and no allowances have been made for the revenue from sales of foods, apart from the meals, nor for ventilating fans, which are worked off the same mains.

It is interesting to note, however, that, even without these allowances, the cost of energy works out at less than ½d. per person per meal, and when working at a maximum output this cost can be still further reduced. Electric energy is supplied to the works generally on a basis which works out to 0·5d.–0·6d. per kilowatt-hour.

In regard to details, it is worth noting that the boiling tables were at first equipped with circular boiling plates, which were let in flush with the surface of the table, there being an annular space round each boiling plate. This was found to give trouble through liquids boiling over and through overheating. Consequently the hot plates are now made in one piece with the heating elements clamped to the lower surface, these parts being isolated to a slight extent by a groove around them in the upper surface. Since this groove is not carried right through, no liquids can now penetrate to the elements. The usual impression is that this form of construction involves more energy consumption than the isolated hot plates; but we were informed by Mr. Forbes, the electrical engineer of Messrs. Haworth and Co. (Ltd.), that his experience was just the contrary. Two of the kitchens have been at work for about a year, and their boiling tables have proved to be very satisfactory. The whole of the apparatus was erected under the supervision of the manager of the Electric Cooking and Heating Department of Carron Co., Mr. A. R. Wood.

The firm of Messrs. Richard Haworth & Co. (Ltd.) is one of the oldest established firms of its class in the country, if not in the world, and it ranks as a pioneer in all modern developments. We believe it is the first firm of its class so far to consider the welfare of its operatives as to cater for them in the manner described. From what we saw on the occasion of our visit there is no doubt that the innovation is appreciated by them, and nothing but good can come from such a movement. A plate of well-cooked food, consisting of a cut from the joint with two vegetables, well served, and everything scrupulously clean, should appeal to a large proportion of the employés. The charge for this is 4d. to a woman and 6d. to a man. Extras can be had in the shape of soup, pastry, rock cakes, &c. In addition to the three kitchens now in operation, there is a fourth which is equipped, and which will be used after the war for the purpose of cooking puddings, pastries, &c., of a kind which the operatives can purchase and take away with them for home consumption during the week-end. This should certainly prove a boon to many a household. The charges made barely meet the cost.

There is a vast field for development in this direction among the 800 odd similar factories situated in Lancashire and Yorkshire, and it only requires the owners to realise the benefits obtained from looking after the creature comforts and welfare of their employés for them to take steps from which they will surely reap their reward.

MANUFACTURE OF SYNTHETIC NITRATES BY ELECTRIC POWER.*

BY E. KILBURN SCOTT.

Details of Furnaces.—When fixing atmospheric nitrogen in an electric furnace, the reaction mainly depends on the contact of air with the electric arc, and clearly therefore that design is best which provides for most air to come under the action by the arc.

Many furnaces are faulty because a large proportion of the air passing them cannot come into contact with the arc, and on the reason being investigated it is found to be due to these being of the single-phase type. In the Birkeland-Eyde furnace the arc alternately fills the top and bottom half, but never both simultaneously, and as air flows into the reaction chamber through all the holes it follows that only half of it can be on the side where the arc is at any moment. There is thus a leakage of air and it is especially pronounced through the holes nearest the periphery. Similar effects are described in the Schonherr and Pauling furnaces.

In the three-phase furnace the three electrodes are arranged with intervening firebricks, so that together they entirely enclose a six-sided conical space. Air entering the bottom expands and fills the cone before passing out by the only exit, at the top. The electrodes receive the three-phase currents, and these currents interact in much the same way as they do in a three-phase motor producing an arc flame which rotates rapidly in accordance with the periodicity of the supply—viz., 50 times a second. Since the air takes longer than 1/50 second to pass up through the reaction chamber, every particle must come into contact with the rapidly revolving sheet of flame.

Magnetic Blow v. Air Blow.—For the proper working of nitrogen fixation furnaces, it is essential to blow the arcs into flames, and this can be done by a magnetic field as in the Birkeland-Eyde furnace, which has a stable magnetic field, or in the Moscicski furnace which has a rotating magnetic field. On the other hand, it can be done merely by the air flowing through the furnace as in the Schonherr, Pauling or Kilburn Scott types.

One objection to the magnetic blow is that in addition to alternating current for the arc, direct current is also required to excite the magnets. Seeing that in any event air must pass through the furnace it may just as well be used for creating the flames.

Electrodes.—For a given power or output the trouble of operating electric furnaces may be said to vary with the number of electrodes. Also the energy lost in electrodes will vary with their number. The material of which electrodes are made has an important bearing on the yield. For example the electrodes of the Birkeland-Eyde furnace are a special alloy of copper which has been found from experience to be beneficial. The modified Pauling furnaces which Dr. Rossi has at work in Legnano have electrodes made of an aluminium

* Abstract of a Paper read before the Society of Chemical Industry.

Digitized by Google

alloy, and he claims that the metal has a catalytic action which is favourable to the yield.

Starting Furnace.—Single-phase furnaces are started by approaching the electrodes together until the air gap is sufficiently narrow for the voltage to jump across. These adjustments have to be carefully made. As the electrodes are at high tension, also there is great liability of having heavy shocks and surges on the electrical machinery. In the three-phase furnace, I dispense with adjustments because the arc flames started pilot or trigger sparks. This method of starting is a great advantage because the electrodes can be set at the best distance apart for the air supply. A lower pressure can be used to operate the furnace, for without the pilot sparks the voltage has to rise to a certain point before current begins to flow, and this affects the power factor. I have found it convenient to keep the pilot sparks on all the time because it improves the yield and tends towards continuity of working. In all electric furnaces it is most important to have continuity of working. Because if the arcs keep stopping and starting, surges and other electrical phenomena are liable to cause trouble. The three-phase furnace has a special advantage in this respect because currents are always flowing in the phases and the arcs assist in maintaining each other. The energy is practically always at a maximum, whereas in a single-phase furnace it varies from zero to a maximum twice in each period of alternation of the current.

Preheating the air not only economises heat and raises the temperature of the furnace, but it also enables the air to enter the furnace dry, which is an advantage. Prof. Guye found a slight increase in yield when the air was dry, enough to warrant the removal of moisture in a commercial plant.

Preheating.—In order to get easy operation of the furnace the air must be preheated, and so long as such preheat is not detrimental in other ways, the higher it is the better. Ionisation is helped by preheating and this condition is necessary for easy electrical working. I have found it advantageous to use 250°C.

It is convenient to get the preheat from the heat of gases leaving the furnace and one large efficient preheater may serve several furnaces.

Cooling.—The chemical reaction being reversible, it is important to chill nitric oxide gas quickly. With single phase furnaces, it can only be effected by blowing excess air through the furnace, whereas in the Kilburn Scott furnace it is done largely by having a boiler to form the roof. A blown arc flame acts on the boiler in much the same way as any ordinary flame burning to carbon dioxide. The centre of the arc flame is the neutral point, and as the boiler is connected to earth, there is no trouble with the electrical connections. The metal is not affected because nitric oxide does not attack. Nitrogen peroxide may do so, if the temperature is below 600°C., but even it is slow and requires moisture present.

In Norway the furnace gases are passed through an ordinary Babcock-Wilcox boiler when the temperature has been lowered to about 200°C., so they use gases at a temperature when they are able to do damage. From the point of view of action on metal it is much safer to use the boiler *directly* on the furnace where the gas is still in the nitric oxide stage.

Results.—The yield which it is generally assumed can be obtained from single-phase furnaces is 50 and 60 grms., of pure nitric acid per kilowatt-hour, or, say, half a ton of pure acid per kilowatt year. As a result of tests carried out on my three-phase furnace it would appear that yields 50 per cent. greater than the above are quite feasible.

The yields are much improved by having a boiler immediately over the arc flames, and there is no appreciable difference in yield when steam is being made. Tests have shown that of the total energy put into the furnace, about 10 per cent. can be obtained as low pressure steam.

The yield rises to its full value in about ½ hour from time of starting the furnace, which is important from the point of view of stopping the furnace during off peak hours.

The pressure at which the furnace would operate (under 1,500 volts) is very considerably lower than the voltage used in furnaces abroad. When the furnace was running well, power factors of over 0·85 were obtained.

Absorption Towers.—The most commonly used absorption system consists of a range of high towers made of acid-proof brickwork, the towers being filled with quartz pebbles or one of the many patented forms of acid-proof filling. A first condition of good absorption is that the gas should move very slowly and the next is that the contact surface should be as large as possible; also, as mentioned above, there should be opportunity for the further oxidation of the nitric oxide which is formed in the towers. Prof. Moscicski has also found that it is desirable for the liquor to pass down the towers intermittently, so that the filling is alternately wetted and then allowed to run dry, as this improves the absorption very much. By the Moscicski method the absorption of the nitric peroxide gas is nearly complete being about 97 per cent., whilst the nitric acid may be drawn off at a concentration of 40 to 50 per cent.

The author concludes by drawing a comparison between the direct and indirect methods of making nitric acid.

DISCUSSION.

Mr. BOWER said it was really time we in Great Britain made a start in the direction indicated in the Paper, and made use of the air for other purposes than the mere ordinary process of breathing. He was very much impressed by the discussion in the Paper of the absorption process of Moscicski. This seemed a very good method, because in the absorption of those gases it was necessary to carry out a double function—viz., to oxidise and to absorb, and the Moscicski process seemed to take all the factors into account.

The PRESIDENT (Dr. Charles Carpenter) said this matter had not altogether been neglected by the authorities, and a good deal of work was being done at the present time. The outstanding difficulty when entering on the erection of plants of this magnitude was to decide which process to adopt—viz., the one requiring the minimum amount of power or the process described by Mr. Scott, in which it was suggested that the power requirements were considerably larger, yet the other advantages were such that it might be found in the long run to be the best process to adopt.

Dr. E. FYLEMAN asked whether there was any possibility of electrolytic corrosion in the boiler. He understood from what he could gather in a general way that it was almost, if not entirely, impossible under practical conditions to convert completely the nitric oxide obtained in this process into nitric and nitrous acids, and that a certain small percentage, which was given as from 3 to 5 per cent., of the total nitrogen which was combined to form the nitric oxide, escaped into the atmosphere. It had occurred to him that if that were so those wishing to work the process were not absolutely unrestricted as to the spot upon which a plant could be put down. Looking at the whole matter, it was probable that there was something to be said for the point of view that no one process would stand alone. The question of cost was important, and it is noticeable that Mr. Scott had given absolutely no basis whatever to go upon in attempting to compare this system with others. Could he give some approximate figures as to the cost of a plant for producing a certain quantity of nitric acid, and the amount of power required. Something also about the cost of labour and supervision would be an assistance to the same end. Nevertheless, he considered that Mr. Scott was deserving of all praise for the way in which he had pursued this matter for years, persistently and steadily.

Mr. F. SPROXTON said that, as a layman, he was a little bit puzzled why the yield of the new furnace was only 50 per cent. better than the old furnace. It appeared that the advantage should have been much greater. Was there any advantage in modifying the composition of the air by the admixture of oxygen to get nearer to the theoretical composition, say, four volumes of nitrogen to one of oxygen. Theoretically there should be two volumes of nitrogen to one of oxygen.

Mr. J. B. WEBB said the Moscicski absorption process had been attracting a great deal of attention, and as the author had pointed out, the important factor in the whole process was the oxidation of NO to NO_2. That seemed to depend on the actual time of traverse of the NO through the absorption towers, and hitherto the absorption was spoilt to a very large extent by the use of very fine packing, such as broken quartz. The packing in the towers must be of such a nature as to give both surface and free space, and he was rather at a loss to see how Prof. Moscicski's patent packing helped matters to any large extent. Broken quartz packing gave approximately 40 per cent. free space, but he did not know why there need be two chambers. Why not have one chamber and pack it with, say, ring packing, which gave approximately 75 to 80 per cent. free space, and at the same time a considerably greater surface than was obtained with broken quartz, unless the broken quartz was of the order of ¼ in. or less, in which case he would imagine the draft difficulties would be considerable. Even assuming there was the correct amount of free space and surface and that time was given for the NO to oxidise, there were a great number of factors entering into the operation. It was difficult, therefore, to see how alterations of packing, once the right thing was obtained, would solve the problem. He had understood that the packing question had been solved by the Swedish and Norwegian people. Could Mr. Scott enlighten them on this point? As to a comparison of the direct and indirect methods, he agreed with the previous speaker that it would have been very useful if Mr. Scott had been able to give some figures.

Mr. E. B. MASON called attention to the fact that there was an American process, known as the Rankin process, which had been commented upon favourably by Prof. Norton. It consisted of a cylinder and piston with two small electrodes in it. The air was compressed and the arc started. Then the arc was cut off, and the gas allowed to expand, and it was claimed that good results were obtained.

Mr. SCOTT, in reply, said the fact that Mr. Bower appreciated the absorption system carried a great deal of weight with him (the author), as Mr. Bower had made a considerable number of experiments. The President had mentioned that the Government were doing something at last, but it was three years late. In his speech to Parliament the other day Dr. Addison had mentioned that something was going to be done with the fixation of atmospheric nitrogen. He hoped the day would come when he would be able to publish the correspondence he had had

Digitized by Google

with various Government departments. If he could publish it he certainly would do so, but, of course, it could not be done now. Nevertheless, it was a disgraceful state of affairs. We had been held in a stranglehold by certain financial groups and political pools, who were apparently mixed up with the Chilian nitrate business. Perhaps he had better not say any more. He had not thought of electrolytic corrosion in the boiler, and it was a point he would look into. He very carefully earthed the boiler and alternating current, by reason of the current reversing, did not give the same electrolytic corrosion as direct current. Nevertheless, it was known that corrosion with alternating current did take place under certain conditions, but he did not think there was much danger in this case. There was some escape into the air with the system used abroad, but he had it in his mind to make a complete cycle by taking the air and after using it add oxygen to it, and not allow it to go out into the air again. By working through a complete cycle it would only need make-up oxygen. He did not believe a great deal in patent packings. The Norwegians had pinned their faith to quartz. It was impossible in all these fillings, to get rid of lime, and there was action on the lime; it was for this reason that quartz was better. He could not give the costs of the direct process because he did not know. He could only say that the cost of a complete plant was roughly about £8 per kilowatt. He had received a quotation with guarantees behind it from responsible people in Germany two years before the war to erect a complete nitric acid factory in this country for £6. 10s. per kilowatt of plant, and probably £8 was a safe figure now. As to the Rankin process, he had a very great regard for anything that Prof. Norton said, but he doubted some of the figures that had been given with regard to it. Nevertheless, he was quite prepared to believe on the strength of Prof. Norton's testimony that the Rankin system was producing good results.

LABOUR UNREST.

The Commission of Inquiry into Industrial Unrest has issued its report. For the purpose of the inquiry the country was divided into eight divisions, and a summary of the reports of the Commissioners, prepared by Mr. G. N. Barnes, M.P., has been issued.

Mr. Barnes states that a comparison of the reports shows that there is a strong feeling of patriotism on the part of employers and employed throughout the country, and they are determined to help the State in its present crisis. Feelings of a revolutionary character are not entertained by the bulk of the men. On the contrary, the majority of the workmen are sensible of the national difficulties, especially in the period of trial and stress through which we are now passing. Whilst the eight reports agree as to the main causes of industrial unrest, important differences appear in the emphasis laid by the various commissions upon specific causes. In order that the principal points of agreement and difference between the eight reports may be readily seen, Mr. Barnes submits the following brief summary of the Commissioners' findings and recommendations :—

1. High food prices in relation to wages, and unequal distribution of food.
2. Restriction of personal freedom and, in particular, the effects of the Munitions of War Acts. Workmen have been tied up to particular factories, and have been unable to obtain wages in relation to their skill. In many cases the skilled man's wage is less than the wage of the unskilled. Too much centralisation in London is reported.
3. Lack of confidence in the Government. This is due to the surrender of the trade union customs and the feeling that promises as regards their restoration will not be kept.
4. Delay in settlement of disputes. In some instances 10 weeks have elapsed without a settlement, and after a strike has taken place the matter has been put right within a few days.
5. Operation of the Military Service Acts.
6. Lack of housing in certain areas.
7. Restrictions on liquor. This is marked in some areas.
8. Industrial fatigue.
9. Lack of proper organisation amongst the unions.
10. Lack of communal sense.
11. Inconsiderate treatment of women, whose wages are sometimes as low as 13s.
12. Delay in granting pensions to soldiers.
13. Raising the limit of income tax exemption.
14. The Workmen's Compensation Act. The maximum of £1 weekly is now inadequate.

THE LEADING CAUSES.

Food Prices.—All the Commissioners put in the forefront, as the leading cause of unrest, the fact that the cost of living has increased disproportionately to the advance in wages, and that the distribution of food supplies is unequal. Commissioners are unanimous in regarding this as the most important of all causes of industrial unrest. Not only is it the leading cause of unrest in itself, but its existence in the minds of the workers colours many subsidiary causes, in regard to which in themselves, there might have been no serious complaint; and the feeling exists in men's minds that sections of the community are profiting by the increased prices.

Munitions of War Acts.—The operation of the Munitions of War Acts has undoubtedly been a serious cause of unrest, in particular the restriction upon a workman as regards the selection of his sphere of labour. If the leaving certificate restriction is removed the leading cause of dissatisfaction under this heading will cease to exist. There will still remain, however, the complaint that sufficient attention is not being paid by employers to Article 7 of Schedule II. of the 1915 Act. Changes of working conditions more especially the introduction of female labour have been made without consultation with the workpeople.

Military Service Acts.—The reports show generally that the irritation occasioned by the withdrawa of the trade card scheme within a few months of its initiation and without any previous intimation, has now subsided. At the same time much anxiety is occasioned by the working of the schedule of protected occupations. All the reports refer in general terms to what is called the want of co-ordination between Government departments dealing with labour. Apart from the suggestion that one central authority should be set up, the reports contain proposals for the formation of informal local boards to settle local disputes, or for the appointment of a local commissioner with technical knowledge to settle disputes other than those arising on questions of wages. A proposal which finds general favour is that workshop committees should be set up.

Other Causes.—The Commissioners give other causes of unrest, which are reported as acute in certain districts, including :—

1. The want of sufficient housing accommodation in congested areas.
2. The liquor restrictions, which operate as a cause of unrest in some districts, but not in others.
3. Industrial fatigue, which is not a universal cause of unrest. There is a general consensus of opinion that Sunday and overtime labour should be reduced to a minimum, that holidays should not be curtailed, and that the hours of work should not be such as to exclude opportunities for recreation and amusement.

Psychological Conditions.—The great majority of the causes of industrial unrest specified in the reports have their root in certain psychological conditions. Want of confidence is a fundamental cause, of which many of the causes given are merely manifestations. It shows itself in the feeling that there has been inequality of sacrifice, that the Government has broken solemn pledges, that the trade union officials are no longer to be relied upon, and that there is a woeful uncertainty as to the industrial future. The reports abound in instances of the prevailing feeling that pledges are no longer observed as they were in pre-war days. Allusions to "scraps of paper" are painfully numerous.

Special Local Causes.—It is noticeable that each of the eight reports has an individual character, and lays stress on one or other of the causes of unrest in varying degree. The reports reflect a great many minor causes of unrest, which are local in character, but these are too numerous to specify in detail.

Relations of Employers and Employed.—The reports bear a striking testimony to the value of the proposals made in the report of the Subcommittee of the Reconstruction Committee, dealing with the relations of employers and employed. Broadly speaking, the principles laid down appear to have met with general approval.

RECOMMENDATIONS.

The recommendations of the Commissioners are :—

1. *Food Prices.*—There should be an immediate reduction in price, the increased price of food being borne to some extent by the Government, and a better system of distribution is required.
2. *Industrial Councils, &c.*—The principle of the Whitley report should be adopted; each trade should have constitution.
3. Changes with a view to further increase of output should be made the subject of an authoritative statement by the Government.
4. Labour should take part in the affairs of the community as partners, rather than as servants.

The greatest publicity possible should be given to the abolition of leaving certificates.

6. The Government should make a statement as to the variation of pledges already given.
7. The £1 maximum under the Workmen's Compensation Act should be raised.
8. Announcements should be made of policy as regards housing.
9. A system should be inaugurated whereby skilled supervisors and others on day rates should receive a bonus.
10. Closer contact should be set up between employer and employed.
11. Pensions committees should have a larger discretion in their treatment of men discharged from the Army.
12. Agricultural wages in the western area, now as low as 14s. to 17s. a week, should be raised to 25s. a week.
13. Coloured labour should not be employed in the ports.
14. A higher taxation of wealth is urged by one commissioner.

In addition to the above recommendations the recruiting system is universally regarded as requiring most careful handling. The co-ordination of Government departments dealing with labour is reported as an urgent matter and an appeal for increase of publicity and fuller explanation of Government proposals is made in several of the reports. Further, it is recommended that when an agreement has been drawn up between representatives of employers' federations and trade unions, that agreement should be binding on all in the trade concerned. It is also represented that local arbitration tribunals for the settlement of local disputes on the spot could with advantage be set up.

The feeling in the minds of the workers that their conditions of work and destinies are being determined by a distant authority over which they have no influence requires to be taken into consideration, not only by the Government, but by the unions themselves. In conclusion, I desire to draw attention to two points—the practical unanimity of the reports and the remarkable promptitude with which they have been compiled. Had it not been for the whole-hearted co operation of the Commissioners and their local secretaries it would have been quite impossible for a comprehensive inquiry into the intricate subject of industrial unrest to have been completed within the time allotted.

Digitized by Google

CORRESPONDENCE.

PHASE LAG IN CURRENT TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The article on this subject by Messrs. Makower and Wust in your issue of the 13th inst. appears to contain an incorrect assumption and a statement which is certainly erroneous unless I have sadly misunderstood the paragraph in question. Two current transformers are described as being connected back to back; the errors in their ratios of transformation are expressed by the correcting constant λ, which is evidently assumed to have exactly the same value for both transformers. This identity of value would be realised only by chance in the case of transformers of a commercial type, and further, experience shows that the transformation ratio obtained with the instrument fed in on its primary side frequently differs from that obtained when it is fed in on its secondary side, this depending on the manner in which the circuit is closed on the side delivering current.

If, however, one could be justified in assuming the exact equality of the two ratio errors, then the actual combined ratio of transformation most certainly would not be λ^2, as stated, but in every case rigorously equal to unity.

There is apparently a serious inconsistency here. Will the authors oblige by kindly clearing it up?

There appears also to be a small error in equation (4), which no doubt should read as follows instead of in the form given on page 581:—

$$\tan\delta=\frac{a_1-a_2}{a_1\tan\varphi_2-a_2\tan\varphi_1}.$$

Referring to the abstract of Mr. A. E. Moore's paper given in the same issue, at the bottom of page 578 it is stated that

$$\sin\theta=d_2/k_2I_sI_m.$$

The necessary condition that d_1 (or in other words $k_1I_pI_m\cos\varphi_1$) be zero, is omitted.

Paris, July 18. E. W. HILL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Hill in his criticisms on the article on the above subject objects that the ratio of two transformers cannot be expected to be exactly the same. This is, of course, perfectly true, but it is common practice in many kinds of commercial tests to make such an assumption, and the results obtained in the manner indicated on a number of transformers tested in pairs would certainly give a reliable average. It may, however, be pointed out that the method described is in no manner affected by this question, as it is applicable to a single transformer. The device of connecting two transformers back to back was adopted, as explained in the article, solely for the purpose of using wattmeters of the same range so as to be able to calibrate them directly against each other with the greatest convenience and accuracy.

Furthermore, the two transformers would carry practically the same currents in their primary and secondary windings, and it is therefore unreasonable to claim that their characteristics would differ from the fact that they are fed from different sides.

It appears that Mr. Hill has confused the quantities denoted by t and λ. If the transformers have the same ratio of transformation t, their combined ratio of transformation would be 1, as stated by him and also in the article; but if there are voltage drops due to the load changing the ratio in the proportion 1 to λ, the effect of these voltage drops will not cancel in the two transformers, but will be cumulative. This is clear from a *reductio ad absurdum* by considering the case of two transformers each of ratio 1 to 1 connected back to back. According to your correspondent the primary and secondary voltages of the combination would be strictly unity on all loads, whatever voltage drops are introduced by each transformer as long as the voltage drops are the same for each transformer.

The change of sign suggested in equation (4) involves only a reversal of the sense in which the angle of lag δ is measured positively.—I am, &c.,

London, July 23. A. J. MAKOWER.

LEGAL INTELLIGENCE.

Gas Light & Coke Co. v. Hackney Borough Council.

The hearing of this case was concluded on Friday, when Mr. Justice Astbury decided to reserve his decision. On Wednesday judgment was given for defendants with costs.

In the course of his evidence Sir JOHN SNELL, Past-President of the Institution of Electrical Engineers, said that he had examined the accounts of the electric supply department of the defendants, and his conclusion was that a profit had been made on the private lighting, but a loss on the supply of power. After giving a definition of load factor and diversity factor, he said that, other things being equal, the higher the load factor the lower the cost of production, and the better the diversity factor the further could a power station owner go in the way of earning revenue, and, therefore, of course, the better it was for the authority. In 1913-14 the number of units sold was 8,584,332, the total cost was £49,523, and the revenue £55,413. The witness put in tables showing the units sold for public and private lighting and for power. The load factor of the power supply (with factory lighting) was 22·2 per cent., and of the domestic and private lighting 12·4 per cent. The witness gave evidence of the power and lighting loads on certain dates in 1913-14, and the charges made for the various classes of supply. The total demand for power was 3084 kw., and a reasonable diversity factor for that year in Hackney was 1·44; he obtained that figure by dividing 3,084 by 2,135, which was the power load minus the factory lighting. The cost (£49,523) should be apportioned as follows: £20,814 to private and domestic lighting, £2,755 to public lighting, and £25,954 to power and factory lighting. He made out that the profit on private lighting was £9,445 and on public lighting £782, while there was a loss of £4,337 upon power. He thought that the Council also took the same view of the matter, for in October, 1916, they raised the price of lighting by 20 per cent. in scale A and power by 30 per cent. He had also gone through the accounts for 1915-16, and the loss on power was increased very considerably. He had analysed the costs, and he put the running cost per unit sold at 0·348d., and the fixed charge per kilowatt demanded at the power station at £7·058. Under scale A (alternative No. 1) the fixed charge of £1 per quarter per kilowatt of maximum power demanded and ½d. per unit, which meant that a consumer who paid £4 per annum and ½d. per unit (at most), could not be profitable at the diversity factor in that year.

In cross-examination, Sir John Snell admitted it was a great advantage to electricity works to have a day load, because it increased the load factor and reduced the cost of production. The man who used energy for more hours per day was the best, provided the load was not too variable. The more diverse the trades the higher the diversity factor should be. The ordinary diversity factor for mixed factories was 2, but in Hackney there were 600 odd factories with an average power of about 11 H.P. Witness was next asked if he was aware that this year with 1,000,000 units less for lighting and 6,000,000 more for power, Hackney had wiped out her loss and carried forward £6,000 for the relief of rates. In reply, Sir John said he did not know that, as he had not had access to the accounts for this year, but if they had they had done very well.

Mr. WALTER said the cost of material including coal had much increased and the witness agreed. Sir John also agreed that the power consumer had a better load factor than the light consumer, and the former class had also a better diversity factor.

Then there is a further factor that, as a rule, the power user as a class used more electricity than the light consumer as a class?—As a rule.

All these factors, of course, are circumstances which are taken into consideration in fixing the price?—Certainly, that is why you charge twice as much for lighting as for power.

In so far as the power user has 20 per cent. of light his load factor is slightly worsened by that percentage?—If he has power alone, it is worsened.

As regards every municipal electrical undertaking, it must start at a loss?—No, I don't agree.

Do you suggest that when you start an electrical undertaking it ever starts at a profit?—Yes, I have known of such.

Until you have got a sufficient demand at the station it must be a question of loss?—Yes, until you have a sufficient demand, but I know a great many cases in which the first year has resulted in a profit. The profit of the undertaking will improve as it goes on.

Sir John was then cross-examined on the 1914 accounts of the electrical undertaking of the Council, these being the accounts which were placed before him for investigation.

On the 20th inst. Mr. WALTER, K.C. (for defendants), submitted that the action was entirely misconceived. It was founded on an entire misunderstanding of sec. 19 of the Electric Lighting Act, 1882, and of the Long Eaton Judgment, which, properly understood, was an authority directly in favour of the defendants. Plaintiffs came to court as the champions of light, though their real business was to sell gas.

His LORDSHIP pointed out that the point between plaintiffs and defendants was as to the relative profit made by defendants' undertaking during a particular period as between power and lighting. Sir John Snell thought the power was being supplied at a loss or, at all events, at a less advantageous rate than lighting.

Mr. WALTER said Mr. Merz, his witness, said the business was paying on power and the figures showed that in 1916, when the price of coal was up, defendants converted a loss of something like £8,000 into a profit of over £6,000, although the lighting load had gone down 1,000,000 units.

Mr. CHARLES H. MERZ, consulting engineer, gave evidence for defendants. He said the capital cost was a considerable item in all electrical

Digitized by Google

undertakings, and the plant must be sufficient to supply the maximum demand. The regularity of the supply was a most important factor in the cost of the production of the supply. As between a lighting load running only two hours a day and what was called the high load consumer the difference of cost might be several hundred per cent. on a municipal undertaking. Two hours a day was generally known to cover a very large number of lighting consumers. Power users for the purpose of their own businesses desired to have the highest possible load factor; it affected the wages bill and every other item in connection with factory cost, and the load factor was reflected back to the station. There had been a large number of power Acts passed by Parliament. The North East Coast group of power companies turned out about one-fifth of the total electricity of the country. Electrical energy was by the power Acts allowed to be supplied for power purposes, and it followed that it was also necessary to supply light for all factory purposes, and to allow 20 per cent. to be used for lighting. They supplied electrical energy and took no notice of whether it was supplied for power or light. The result was that in all power businesses a large undertaking must seek more and more to supply the manufacturer or factory owner, who would insist on being able to take his light or power from the one set of wires. With regard to the Hackney undertaking, he said the power business was undoubtedly paying in 1913-14. Witness produced two curves, one showing the actual cost of generating electricity in Hackney (0·348d. per unit), and the other the distribution between the different load factors and the figure for fixed charges, £8 odd per kilowatt. The latter curve expressed the actual costs per unit, as he had worked them out, and it showed that as the load factor went up the cost went down. In framing a tariff that was the primary consideration of a supply authority. The diversity factor for Hackney was the average figure of two. The power, plus factory lighting, which was being sold by the Council was paying in 1913-14, and was doing so now. The power was undoubtedly paying as the Council was charging £4 per kilowatt demanded per annum and ¼d. per unit, and the latter figure was more than the 0·348d. which he and Sir John Snell agreed was the extra cost of supplying each additional unit turned out. As the power demand was about 3,000 kw., and at £4 per kilowatt that represented £12,000 per annum in addition to the ¼d. per unit. Half the consumers were on the maximum demand scale, and half on the flat rate; at a load factor above 8·3 it would pay to put consumers on the former scale, but at Hackney the load factor of those on the maximum demand system was 14·46. Witness was examined at considerable length upon the demands of the various classes of consumers, the charges paid by them, their load factor, &c.

After Mr. Merz had been cross-examined by Mr. Colefax,

Mr. J. A. JENKINS, borough accountant of Hackney, was called to prove the accounts of the electric supply department. In 1916-17, he said, 1,829,075 units were sold for private lighting and domestic uses, and 12,465,635 units for power and factory lighting; in 1913-14 the private lighting units were 2,616,399, and the power supply in 1915-16 was 6,532,318. The total units sold in 1915-16 was 9,071,126, and in 1916-17 the figure was 15,302,372. Without allowing for employees serving with H.M. Forces, the profit last year was £6,918. 11s., and the war allowance to employees was £1,461. 19s. 7d. Witness gave particulars of the capital expenditure and of the sinking and reserve funds of the electricity department, and after cross-examination by Mr. Russell, K.C., defendants' case closed.

Mr. COLEFAX, K.C., summed up the case for plaintiffs, and his Lordship reserved judgment.

On Wednesday his Lordship delivered judgment. After reviewing the facts of the case at great length and referring to the decided cases (including the Melbourne and Long Eaton judgments) he held that plaintiffs had failed in their contention, and he gave judgment for the defendant Council with costs.

We propose to give a full report of the judgment in our next issue.

E. S. Co. (Ltd.) v. Tredegars (Ltd.)

Mr. Justice Ridley had this action before him last week. Plaintiffs claimed £263. 5s. 11d., the price of goods sold and delivered. Defendants admitted that they were indebted to plaintiffs for that sum, but counterclaimed for £193. 10s. 11d., goods supplied to plaintiffs, and paid the balance into Court.

Mr. C. HERBERT SMITH, opening the case on the counterclaim, said the action was originally brought for £263. 5s. for goods supplied. Defendants, who also dealt in electrical goods, claimed that they had a set off for £193. 10s. 11d., goods supplied to plaintiffs, and the defence to the counterclaim was that, although plaintiffs actually ordered the goods it was on condition that they were to be equal to sample and subject to the approval of a customer. Plaintiffs said the goods were not according to sample, and therefore there was no contract. Plaintiffs approached defendants with regard to the purchase of electrical switches, and defendants said they had 45 gross of Japanese switches, of which they would supply 30 gross at 10s. 9d. per dozen. Their manager (Mr. Summer) said he would like to see a sample, and then he would let them know definitely whether he would take the 30 gross. The next day he sent for the sample, and defendants eventually sold plaintiffs the switches as Japanese switches.

After hearing evidence, his Lordship gave judgment, and said he was of opinion that the contract was provisional and subject to an order from the Edison Swan Co., who, when the goods arrived, refused to accept them, as they did not comply with their order, because their order was for English and not Japanese switches. He had come to the conclusion that there was a conditional term upon which these goods were ordered. Plaintiffs succeeded on the claim, and defendants failed in their counterclaim, and there would be judgment for plaintiffs for the amount paid into Court, and for £193. 10s. 11d., the balance, together with costs.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

8,056 BARR, J. F. Electrical water heaters. (7/6/16.) (Cognate application 13,564/16.) 107,038.

8,178 RELAY AUTOMATIC TELEPHONE CO. & HERINK, H. J. Telephony. (9/6/16.) 107,041.

8,179 RELAY AUTOMATIC TELEPHONE CO. & HERINK, H. J. Telephone systems. (9/6/16.) 107,042.

8,245 SIEMENS BROS. & CO. & IRELAND, H. W. F. Electric ignition or sparking arrangements. (10/6/16.) 107,048.

8,305 PORTER, S. C. Telephone transmitter. (12/6/15.) 100,689.

8,547 BENNETT, A. E. Magneto-electric machines. (15/6/16.) 107,062.

8,474 RUTHS, J. C. Steam power plants particularly for use in electric generating systems. (14/6/15.) 100,693.

8,733 BEAVER, C. J. & CLAREMONT, E. A. Electric cables. (21/6/16.) 107,073.

8,810 OLDHAM, O. Miners' electric safety lamps. (22/6/16.) 107,074.

8,811 KRIBS, N. Electric battery lamps. (22/6/16.) 107,075.

9,766 B. T.-H. Co. (G. E. Co.). Regulators for polyphase transmission systems. (11/7/16.) (Cognate application 9,812/16.) 107,093.

This invention el tes to reg lation for controlling a phase balance for polyphase transmission systems. It has been proposed to connect a synchronous dynamo electricmachine to an auxiliary dynamo electric machine or booster in such a manner that the phase rotation of said machine is opposite, and means is provided for relatively changing the phase relation of the voltage of said machines, comprising a booster field winding having relatively displaced portions. When such a phase balancer is applied to a system where single phase loads are taken from more than one phase, this invention provides means for controlling the balancer so as to maintain equality of voltages, or equality of currents, in the phases of the system.

101,82 BIRKS, L. & TEMPLIN, J. R. Means for differentially metering electricity for lighting and heating purposes. (2/3/16.) 104,498.

11,043 B. T.-H. Co. (G. E. Co.) Electric motor control. (4/8/16.) 107,106.

This invention relates to locomotives of the type in which the locomotive may be supplied with current either from a storage battery or a trolly. In certain cases it is desirable to be able to run a locomotive normally supplied with current from a trolly beyond the limits of the trolly system, and to this end a storage battery may be provided upon the locomotive. Now the voltage of this battery may not be as large as that of the trolly system, and this invention provides means for automatically charging the battery, and for preventing the battery from supplying the motors at the same time as they are being supplied from the trolly in order that the battery may not be thrown directly in parallel with higher voltage source of supply.

12,685 CHIVERS, T. S. & MARTER, C. Electric insulating material resembling vulcanite. (7/9/16.) 107,122.

16,514 MASON, C. T. Timing in ignition dynamos. (19/6/15.) 102,267.

1917 SPECIFICATIONS.

1,279 KILBURN, B. E. D. (Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij). Automatic switching devices for thermic telephones (25/1/17.) 106,962.

2,191 SWITCHGEAR & COWANS & RODWAY, E. D. Automatic electric circuit-breakers (14/2/17.) 106,971.

2,912 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (Westinghouse Electric Mfg. Co.) Mercury rectifier distributing systems. (27/2/17.) 106,973.

The systen comprises an alternating-current supply circuit, a transformer having its primary winding connected thereto, a vapour electric rectifying device having its anodes connected to a secondary winding of the transformer, a distributing circuit for the rectified current which is connected to the rectifier cathode, and to an intermediate tap on said secondary winding, and an automatic double-pole circuit interrupter inserted between the anodes of the rectifier and the transformer secondary winding for protecting the rectifier and transformer against both internal short-circuits and overloads on the distributing circuit.

5,401 LGRAS, O. Transformers for alternating electric currents. (9/6/16.) 106,986.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Lieut.-Colonel C. B. CLAY, V.D., Commanding.

Orders for the Week.

Officer for the Week.—Platoon Commander P. Bowden.

Monday, July 30.—Technical Instruction (Searchlight) for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' Drill, 6.30.

Tuesday, July 31.—Lecture, 6.30. Physical Drill and Bayonet Fighting 7.30.

Wednesday, Aug. 1.—Drill and Elementary Bridge Construction, No. 1 Company, Left Half Company.

Thursday, Aug. 2.—Drill and Elementary Bridge Construction, No. 2 Company, Left Half Company. Ambulance Class.

Friday, Aug. 3.—Technical Instruction (Searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company. Right Half Company. Signalling Class. Recruits' Drill, 6.30.

Saturday, Aug. 4, to Monday, Aug. 13, Camp.—A camp will be held at Esher from Aug. 4 to 12. Billets will be provided at Claremont Park. Men will be provided with railway warrants and rations. This expense will be borne by the Government in the case of men in Sections A and B. Others will be required to pay cost price, but not exceeding 4s. 6d. per diem. Volunteers must take with them their own blankets and personal kit in a regulation kit-bag, marked with name, rank, company and regimental number. Also enamel mess plate and mug and knife, spoon and fork. An extra pair of boots is advisable. Parade at Waterloo, opposite No. 10 platform, on Saturday, Aug. 4, at 2 p.m.

Headquarters.—Headquarters at Balderton-street, closed Aug. 4 to 12. Headquarters will be transferred to Claremont Park, Esher, for that period.

Holiday Addresses.—These must be given in to the Orderly Room without fail.

Armlets.—These must be worn at all plain clothes parades.

Musketry.—For all Companies see notice at Headquarters.

Note.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton street, Oxford-street).

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

COMMERCIAL TOPICS.

The Consular Service. Last week a deputation from the Commercial Control Committee waited upon Lord Robert Cecil at the Foreign Office in order to make representations on the subject of the re-organisation of the British Consular Service. In reply, Lord Robert gave an assurance that the Committee would be consulted before any scheme for the improvement of the Consular Service, which is now the subject of negotiations between the Foreign Office and the Board of Trade, was finally approved. The subject has recently been considered by a Special Committee, but the majority and minority reports, though presented some time ago, have not yet been published by the Government.

* * * *

Exports to Neutral Countries. The Board of Trade suggest to British exporters engaged in sending goods to neutral European countries the desirability of concluding their contracts on a f.o.b. (instead of a c.i.f.) basis where the goods can only be exported under licence, having regard to the fact that it is frequently made a condition of the issue of such a licence that the goods must be carried in neutral vessels.

* * * *

The New Diplomacy. At the inaugural luncheon on Friday of the British-Italian Commercial Association, which has been formed to stimulate and encourage Anglo-Italian trade, Lord Robert Cecil, M.P., assured his hearers that the Foreign Office welcomed with pleasure and rejoiced in movements of that description. His presence emphasised that in future, even more than in the past, diplomacy and commerce must go hand in hand. In old days diplomacy was mainly concerned with the relations between one Government, one King very often, and another. That was no longer the case. Diplomacy if it was to be worthy of its true vocation must in the future be concerned mainly with the relations between one people and another.

Lord Robert said that all sections of the people had an equal claim upon its services, they were not to be satisfied in future by the mere friendliness of the actual Government; they had to promote also and much more a complete friendliness and co-operation of the various peoples. After the war they would have to repair the ravages of the war, to re-constitute all international relations to a great extent, and if they did not desire to do business with their enemies, they must take care that the business between the Allies was close and complete. During the time of the war it was inevitable that the Government of a belligerent country should undertake a number of duties which ordinarily were better left to individual effort. He had no desire to see war conditions carried on into the time of peace. The prosperity of a country depended upon the energy and enterprise of its population. The Foreign Office were considering how to improve the assistance which it might be able to give in that direction, and were, he hoped, taking adequate measures. The Government would do all they could to assist commercial organisations by seeing that they had a fair field, but more they could not do.

The Italian Ambassador and Sir Albert Stanley, President of the Board of Trade, also spoke, the latter emphasising the absence of any idea of indulging in "peaceful penetration" such as the Germans adopted, and announcing that they would in the future be able to establish an improved system of transport which would meet the very particular needs of Italy.

* * * *

B.T.-H. Report. From the report of the British Thomson Houston Co., which is given in another page, it will be seen that the company has made further progress during the past year. In 1915, which was a very good year for manufacturers, the company made a gross profit of £262,400, but last year the figure increased to £359,364. After appropriating £153,700 for depreciation and after taking into account the amount brought forward and the sum required to meet the excess profits duty and munitions levy, &c., for 1915, the balance carried forward is £163,923 (compared with £73,359), but the demand for excess profits duty for 1916 has not yet been met. The position is very much improved, but as there are arrears of preference dividends to be met it will not be possible to declare a dividend on the ordinary shares for some time.

Electricity in Brazil. The recent report of the directors of the Brazilian Traction, Light & Power Co. shows that the electric supply tramway and telephone undertakings owned or controlled by the company are making good progress, notwithstanding the increased price of materials and the transport and other difficulties. There is an especially good demand for energy for power and heating which augurs well for the future of electricity supply in Brazil.

The gross earnings of the Rio de Janeiro Tramway, Light & Power Co. were 59,009,971 milreis, an increase of 10·2 per cent., and the net earnings were 32,311,411 milreis, an increase of 4·2 per cent. There were substantial increases in both the gross and net earnings of all departments, except in the net earnings of the gas company. The tramway receipts created a record, and amounted to 13,710,912 milreis. There are 237·15 miles of track open, with 536 passenger cars and 441 trailers, 68 freight cars and 130 trailers, and 8 locomotives and service cars. The number of passengers carried was 198,677,975, and 24,667,154 car-miles were run. At the end of 1916 there were 8,759 public and 2,101 private arc lamps; and there were connected to the mains the equivalent of 97,858 H.P. in motors (against 93,892 H.P.), 836,269 private (50-watt) incandescent lamps and 1,126 public incandescent lamps. There were 47,864 light consumers (against 40,866), and 2,346 power consumers (against 2,208). Supply is given from the hydro-electric works at Lages, and the reserve steam plant has not been operated since September, 1914. Apart from street lighting, gas is now little used save for heating and fuel.

The telephone undertakings of the company now comprise those operated by the Brazilianische Electricitäts-Gesellschaft (serving the City and Federal District of Rio de Janeiro), the Interurban Telephone Co. of Brazil (serving the City of Nichteroy, the capital of the State of Rio de Janeiro, adjoining the Federal District, with which it is connected by a submarine cable, the City of Petropolis, and a number of smaller towns in the vicinity), the Companhia de Telephones Interestadoacs (serving the municipalities of Cataguazes, Sao Paulo de Muriahe and Palma in Minas Geraes, and of the Municipality of Santo Antonio de Padua), the Companhia Telephonica do Estado de Sao Paulo (serving the cities of Sao Paulo, Santos, and Campinas), and the Companhia Rede Telephonica Bragantina (serving about 100 of the most important municipalities of the State of Sao Paulo and that of several adjoining districts of the States of Minas Geraes and Rio de Janeiro). The Rio de Janeiro and Sao Paulo Telephone Co., which was recently formed, controls 95 per cent. of the capital of the above companies. Considerable work has been done at two of the exchanges at Rio de Janeiro by adding further sections and generally increasing their capacity. The four exchanges of the system, with the additional aerial and underground cable installed, now have a capacity of 20,840 lines. Until recently the Federal Government refused to allow telephone lines to cross from the territory of one state to another, but last year a law was passed removing this restriction, and the necessary licences have been granted permitting the systems of several companies to be connected across state boundaries. A toll line connecting the cities of Rio de Janeiro and Sao Paulo (about 300 miles apart) is under construction, and will be completed during the present year. It is also proposed to construct toll lines connecting the cities of Entre Rios, Sao Fidelis and Campos, &c. Other improvements have been carried out or are projected.

At Sao Paulo good progress was also made by the tramways and electric light and power departemnts of the local company. The equivalent of 332,392 50-watt incandescent lamps is connected for private lighting (against 272,905), and 40,491 H.P. (against 38,896 H.P.) in motors. There are 28,757 light consumers (against 22,414), and 1,494 power consumers (against 1,439). A new contract has been made with the state for public electric lighting, involving the substitution of the existing enclosed arcs by nitrogen filled lamps, and 350 additional lamps are being installed.

* * * *

Russian Trade and Industry. In a recent report by the Permanent Conference of Russo-Foreign Chambers of Commerce, a demand is made for a clear statement as to the future policy of the Government in regard to foreign trade and commerce.

The report states: "Being quite convinced that the pre-war commercial policy will not be that which will be adopted, we are, however, in complete ignorance of what may be our Customs tariff in the future; what will be the basis adopted in relation to it for our Allies, what for our enemies, and what for the neutral Powers; on what principles it is proposed in the future to build our trading relations. Is it contemplated to introduce any difference into the railway communications by differentiating in regard to the origin of goods? Is it proposed to establish any kind of measures, and what, to encourage export trade with Allied countries? The Chambers believe that the Provisional Government may find it possible in the organisation of their foreign trade to adopt certain guiding principles which will lead to the clearing away of the present condition of doubt and to the regular development of trading with the countries now allied with Russia.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Cardiff.—In view of the probable development of Cardiff and the fact that application had been received from the Windsor Slipway for a supply of electric power, the Council are recommended to extend the supply cables, at an estimated cost of between £6,000 and £7,000. The Windsor Slipway will require over 1,000 H.P., and their annual consumption will approach one million units.

Croydon.—The Lighting and Electricity Committee has been authorised to accept a tender for the construction of a garage at the electricity works.

Derby.—In consequent of a scheme for the establishment of a new industry in the town, considerable extension of the electricity supply undertaking will be necessary, and negotiations are proceeding between the Council and the promoters of the scheme.

Halifax.—The Council recently decided by a majority of one to purchase land at Copley for the purpose of erecting a new generating station. A special committee of 10 has been appointed to deal with the matter, and a report will be obtained from a consulting engineer on the suitability of the proposed site, &c.

Newport (Mon).—Last week the Electricity & Tramways Committee accepted tenders amounting to about £7,000 for extensions at the power station.

It was also decided to purchase six second-hand tramcars from the London County Council.

Poplar (London).—The Borough Council propose to erect a substation in High-street at a cost of £4,200. The work will be carried out by direct employment of labour under the borough surveyor.

GENERAL.

Board of Trade Electric Power Supply Committee.—In the House of Commons on Wednesday last the President of the Board of Trade was asked by Mr. Gilbert if he had received resolutions from the London municipal authorities owning electric supply undertakings asking for representation on the Departmental Committee on Electric Power Supply, and whether he proposed to appoint any representative on the committee to represent such London authorities.

In reply, Sir A. STANLEY said he had received copies of resolutions from certain of the authorities referred to, and, as he had already stated, he was of opinion that the Committee as at present constituted was sufficiently representative of all bodies owning electricity undertakings. He was not prepared to make any further additions to it.

Chesterfield.—The Rural Council has assented to the application by Sheffield Corporation for a provisional order for the district, and the Corporation has been asked to submit further particulars of their proposals.

Clayton.—The Urban Council has approved the proposed incorporation of the district in the area of supply of Bradford Corporation.

It has been arranged that Bradford Corporation will lay electric supply cables through Clayton, and give a supply of electricity on the same conditions and prices as at present prevail in Bradford. The construction of a tramway to Clayton will also be commenced within two years from the declaration of peace.

Crompton.—The Council have accepted the terms offered by Oldham Corporation for the supply of electricity in this district.

Croydon.—Owing to the increased cost of coal and other materials the Council have increased the charge for electric current by another 15 per cent., making 25 per cent. in all over pre-war rates.

Exeter.—The Council were recommended by the Electricity Committee to increase the salary of the borough electrical engineer (Mr. H. D. Munro) from £475 to £550 per annum, but after discussion at the meeting last week the recommendation was deleted from the Committee's report.

Huddersfield.—Notice has been served on the Urban District Councils of Kirkheaton, Marsden, Meltham, Kirkburton and Lepton of intention to apply for provisional orders authorising the Corporation to supply electricity.

Linking-up in South Wales.—At the meeting of the Cardiff Electrical and Tramways Committee on Friday the engineer and manager of the electric supply department (Mr. Arthur Ellis) made a report on the preliminary work done in construction with the linking-up movement in South Wales and Monmouthshire.

For the purpose of compiling information South Wales and Monmouth have been divided into three districts. The first includes Swansea Llanelly and Neath, the second Pontypridd and the Rhondda, and the third the areas supplied by Cardiff and Newport and the immediate vicinity supplied by the South Wales Electrical Power Distribution Co. In order that the work might be carried a stage further, Mr. Ellis asked to have the authority of the committee to go more closely into details with a view to preparing an estimate covering the cost of the cables necessary for linking up and other details relating to the advantages (if any) to be derived from the same.

Ald. ILLTYD THOMAS emphasised the importance of the subject, and on his proposition Mr. Ellis was empowered to proceed with the matter.

Llandudno.—Last week the Council was recommended to give notice to the Llandudno & Colwyn Bay Electric Railway, Ltd., of intention to terminate the existing agreement for the supply of electric current to the company. The Council, however, decided to refer the matter back, with instructions to obtain expert information on the technical and financial aspect of the question.

Municipal Board for Sheffield Area.—At a conference of representatives of Sheffield, Rotherham and Chesterfield Corporations, which was held at Sheffield on the 20th inst., a draft scheme for dealing with sewage in the water-beds of the Rivers Don and Rother was outlined.

The scheme involved the construction of a main arterial sewer which would conduct the sewage to the Humber. It would be necessary for a joint board to be formed for carrying out the work, and this board might control not only the question of sewage but also electricity, gas and water supply. It was thought that the Board could deal with these public services much more satisfactorily than the Councils of the respective areas interested.

The members agreed to lay the scheme before the various committees and it is probable that a small joint committee will be appointed for the purpose of making full enquiries into the matter.

Poplar (London).—The Council has sanctioned an increase of 10 per cent. on the charges for current for lighting as from Oct. 1 next.

Worcester.—In the annual report of the City electrical engineer (Mr. C. M. Shaw) it is advised that the water power of the Diglis Weir on the Severn could be utilised in the generation of electrical energy. About 1,500,000 units per annum could be generated in this way, and there would be a substantial profit if the price were ½d. per unit.

Wortley.—The Rural Council has refused its consent to the application of Sheffield Corporation for a provisional order for the district, as a proposed application of the Electrical Distribution of Yorkshire (Ltd.) had already been approved.

LIGHTING AND INDUSTRIAL POWER.

Bray (Ireland).—The Urban Council has acceded to a request for a supply of electric current for a motor to drive a gas compressor for the railway company.

Economy Exhibition.—At the National Welfare & Economy Exhibition, which was opened last week by Lady Rhondda at the Dewsbury Town Hall, there were exhibitions of electric cooking, heating and lighting by the electric supply department of the Corporation.

Electrolytic Production of Zinc.—At the recent meeting of the Venture Trust the chairman (Mr. A. A. Bauman) said that one of their main investments related to electrolytic zinc. Their object in going into the electrolytic zinc business was to start probative plant, which would prove the superiority of the Isherwood process of producing electrolytic zinc, and, at the same time, would have such an output as would give them a handsome return for their money.

That intention had been frustrated by the events of the war. The original capacity of the plant was intended to be 3 tons a day; their actual output at present was only ½ ton, but in two months' time they expected to be able to put out a ton, and before the war was over they hoped to be able to turn out 3 tons a day. It had been impossible to get the requisite skilled labour and plant. The Government had treated them exceedingly well, because they were anxious to get electrolytic zinc. It had been impossible to get an extractor and other plant necessary in order that the Isherwood process may work in its entirety. It was becoming recognised by experts that electrolytic processes on certain classes of ores, and worked in a favourable location, were likely to prove more advantageous than fire smelting. The results published by other companies making electrolytic zinc did not show an efficiency or economical working equal to that obtained during the trial of the Isherwood process in America.

Digitized by Google

ELECTRIC TRACTION.

Bolton.—The Corporation have decided to purchase an electrically propelled vehicle for the use of the electric supply department.

Bradford-Keighley Tramways.—In the annual report of the manager of the Keighley Corporation tramways the opinion is expressed that if there were through running between Keighley and Bradford, substantial benefits wou'd accrue to the Keighley tramways department.

The report states there are many instances in other parts of the country to show that a tramways system less than six miles in length—if an average be taken over a number of years—can never be made to pay. Immediately, however, it is increased to something approaching 12 miles, things automatically begin to adjust themselves on a paying basis.

Brighton.—The salary of the tramways engineer and general manager (Mr. Wm. Marsh) has been increased from £400 to £500 per annum.

Huddersfield.—The Corporation have authorised the doubling of the track on the Bradley tramway route.

Manchester Tramways Dispute.—A fresh award of the Committee of Production on the claim of the tramway employees of Manchester Corporation for an increase to 10s. of the war bonus conceded in many parts of Lancashire and Cheshire a month ago has been issued, and the committee has decided that "there is no reason for a departure from the award of June 11."

It will be remembered that the late award was ostensibly the cause of the trouble with the tramway employees in the Manchester and Salford district.

The Lancashire & Cheshire Council of the Tramway & Vehicle Workers Union have now decided to make a fresh application for an advance in wages of 7s. 6d. per week, making, with the 2s. 6d. granted under the recent award, 10s. per week, the amount originally claimed by the workers.

It has also been decided to support the employees of the Burnley Corporation tramways who were out on strike until Tuesday, when the employees decided to return to work pending negotiations between the parties.

Southend.—The Corporation have applied to the L.G. Board for permission to borrow £4,150 for the purchase of electric vehicles, motor generator, &c.

The electrical engineer (Mr. R. Birkett) has been instructed to fix on each of the tramcars a safety device for arresting the fall of trolly booms at an estimated cost of £3. 10s.

Mr. Birkett is to report as to the practicability of running a service of through cars from Leigh to Southchurch and to the Beach.

Wolverhampton.—The arbitrator appointed by the Chief Industrial Commissioner has awarded 5s. per week advance in wages to the tramway workers of 18 years and upwards and 2s. 6d. per week to workers under that age. The award will take effect as from April 1 last.

Time and a quarter is to be paid to members of the traffic staff for all hours worked on weekdays in excess of 10, and time and a half for Sunday work, for Sunday excursion and other special cars running outside and beyond the ordinary Sunday working hours.

FOREIGN NOTES.

Bolivia.—A consular report states that business in the Oruro district in 1916 was not seriously affected by the war, but exports of antimony and wolfram have decreased in the current year.

There are openings for British trade in electrical fittings, hardware and accessories for mining concerns.

Corea.—The acting British vice-consul at Seoul states that Corea produced about 12,700 tons of copper ore in 1916. New discoveries of copper deposits in South Chusei province are reported.

Since the outbreak of the war tungsten deposits have been discovered all over Corea, and about 510 tons were exported in 1916. It is stated that the mines in Kokai province, near Soctarie, contain at least a million tons of ore.

Portugal.—The Government has been authorised to grant, after public tender, to a Portuguese concern a 15 years' concession for the establishment and exclusive rights of working iron and steel works.

Russia.—The following are extracts from a report by the British vice-consul at Baku (Mr. McDonell) on the possibilities for trade in that district:—

There is a large demand for internal combustion engines of from 2½ H.P. to 100 H.P. for the oilfields, and the demand for Diesel type engines for running electrical plant is increasing. Electrical energy is being used on the oilfields more and more each year for drilling and baling, and the whole of the fields are lighted electrically. There is a good sale for electrically-driven pumps.

Salvador.—It is reported that a British subject has secured a 75 years' concession for operating electric street cars in San Salvador and suburbs. The track is to be about 11 miles in length, with the right to extend to 31 miles later. The State will subsidise the undertaking to the extent of about £375 per kilometre (£605 per mile) constructed.

Swedish Exports.—The Swedish Government have prohibited the export of all mica and manufactures thereof.

MISCELLANEOUS.

Advance of Prices.—The Electric Controller & Mfg. Co. (Cleveland, Ohio), notifies that owing to the increased cost of materials it has increased all its prices 10 per cent.

Alien Enemy Companies Wound Up.—Mr. Stanley F. Stephens, 12-14, Arthur-street, London, E.C., Controller of Greenwich Time (Ltd.), has applied to the Board of Trade for his release. Notice of objection to the Board, 55, Whitehall, London, S.W. 1, by Aug. 1.

Mr. G. W. Roberts, 133, Wool Exchange, Coleman-street, London, E.C., controller of Plutte, Scheele & Co. (Ltd.), has also applied for his release. Objections to the Board of Trade, 55, Whitehall, London, S.W. 1, by Aug. 1.

Interference With Colliery Electrical Apparatus.—At Chesterfield on Saturday a youth named Wm. Morris was fined £2 for interfering with the electrical apparatus at Pleasley Colliery.

It was stated that on July 12 defendant took off a globe from one of the lamp holders. He put it back, but proceeded to another, which he took off, and immediately the lights at the pit bottom went out. Considerable damage was done.

Iron Ore Mines Control.—In consequence of the Cumberland iron ore miners intention to strike the Government announce that they intend to control the whole of the ore mines in Cumberland and Lancashire.

London Coal Supply.—The original draft of the coal distribution scheme, prepared by the Coal Controller, has been modified, and the revised scheme (particulars of which will be available shortly) will come into operation on October 1, and not on Sept. 1, as originally announced.

Miners Federation.—At the annual conference of the Miners Federation of Great Britain, which was held at Glasgow on Tuesday, the president (Mr. R. Smillie) delivered his inaugural address and referred to the taking over by the Government of the mines of the country.

Mr. Smillie said he would very much rather have seen the mines taken over altogether, not merely for the period of the war, but for all time. If the Government were going to make sure that there would be something like a fair distribution of coal that was something devoutly to be looked forward to. As the Government had guaranteed the owners pre-war profits the miners, as the most important partners in the industry, were entitled to be placed in a position equal to the employers in that respect. The miners would prefer that the cost of living should go down rather than that wages should go up, but one of the two things must happen—either the cost of living must be reduced or the wages must go up. It had been said that the industrial unrest might be due to persons paid by German gold who were stirring up unnecessary strife. Some of them resented very much statements of that kind and in the recent summary by Mr. Barnes of the reports of the various industrial commissions they would find there was not even a suggestion that either the agitator or German gold was responsible for the unrest. The two main causes of high prices were the enormous increase in freight charges by shipowners and the profiteering by middlemen at home.

At the afternoon sitting the Conference instructed the Executive to form an immediate demand for a general increase of 25 per cent. on the present rate of wages for the whole Federation in order to meet the high cost of living.

Rate Aid by Trading Departments.—In November a special committee was appointed by Manchester Corporation in order to review the basis on which the electricity supply, tramways and gas departments had hitherto made annual contributions out of their profits in aid of the city rates.

The committee met in February last, but failed to come to a decision, and further information was obtained. It has now been decided to ask the Finance Committee to report on the matter.

Theft of Electrical Fittings.—At Acton police court last week Harry H. Sheppard, electrical engineer, was charged with stealing electrical fittings, &c., of the value of £70. 8s., the property of Messrs. C. A. Vandervell & Co.

Evidence was given by Mr. Blackburn, electrical superintendent to the prosecuting firm, who said defendant's wages and war bonus were £4 6s. a week.

Defendant pleaded guilty, and said he had never been in trouble before, but admitted taking the things for his small business. He was sentenced to four months imprisonment with hard labour.

Digitized by Google

TENDERS INVITED AND ACCEPTED.

Rotary or Motor Converters, Cable and Conduit.

ILFORD Urban District Council invite tenders for the supply of two Rotary or Motor Converters, 4,400 yds. 0·05 sq. in. three-core e.h.t. 6,600-volt cable and 3,600 yds. two-way stoneware conduit. Specifications and forms of tender from the engineer, Mr. Arthur H. Shaw, M.I.E.E., Electricity Works, Ilford, and tenders to the clerk, Mr. Adam Partington, Town Hall, Ilford, by noon, July 31.

Rotary Converter, Transformer, &c.

MELBOURNE City Council require tenders by noon on July 30 for supply and erection of a 2,000 kw. rotary converter, with transformer and accessories. (Specification No. 388.) Specification, &c., from Messrs. McIlwraith, McEacharn & Co., Pty. (Ltd.), Billiter Square-buildings, London, E.C. 3.

LEEDS.—The Corporation has accepted the tenders of J. Speight for tramway work and highway work, at £1,016. 17s. 6d. and £555. 16s. 8d. respectively, in Victoria-road, Headingley.

POPLAR (LONDON).—The following tenders have been accepted by the Borough Council :—

British Westinghouse Electric & Mfg. Co., switchgear for main station, £2,641. 10s.; British Thomson-Houston Co., substation switchgear; Western Electric Co., two 15 in. 3-core e.h.t. cables to new substation (3,700 yards) and l.t. feeders (500 yards), £4,782. 6s. 5d.; and Siemens Bros. & Co., 1,933 yards 15 in. 3-core e.h.t. cable, with Merz-Price pilot, £2,081.

SHOREDITCH (LONDON).—The Council have accepted the tender of the British Westinghouse Co. (at £26,538) for a turbo-alternator.

APPOINTMENTS VACANT AND FILLED.

A switchboard assistant is required by the Stepney (London) Borough Council for their electric supply department. Applications to the engineer and manager (Mr. W. C. P. Tapper), 27, Osborn-street, Whitechapel, E. 1, by July 31. *See an advertisement.*

A switchboard and battery attendant is required at the St. Anne's-on-Sea electricity works. Applications to the Engineer and Manager, Mr. J. H. Clothier.

The Walthamstow Educational Committee invite applications for positions as assistants in their engineering and trade schools, to commence duties on Sept. 1 next. Assistants are required for experimental science, practical mathematics, engineering workshop practice and in mechanical drawing, &c. Commencing salary £160 per annum. Candidates must be ineligible for military service, and application forms (which must be returned by July 31) from Mr. R. Dempsey, 2, Tower-chambers, Hoe-street Bridge, Walthamstow, E. 17.

A lecturer in electrical engineering will be required in September at the University College, Nottingham. Particulars from the Acting Registrar.

A lecturer in electrical engineering will be required in September for the Liverpool Central Municipal Technical School. Commencing salary £250. Particulars from the Director of Education, 14, Sir Thomas-street, Liverpool.

EDUCATIONAL.

University of London.—The degree of D.Sc. in Physics has been conferred upon Mr. Wm. Wilson, of King's College, for a thesis on "The Complete Photo-Electric Emission and the Emission of Electrons from Hot Bodies."

Science Teaching.—At the recent general meeting of the Association of Science on the 11th inst. the following resolution was unanimously passed :—

(1) That a liberal education should in all cases include sound elementary instruction in biology, botany, chemistry and physics; (2) that the status of science masters and teachers should be substantially improved; (3) that the position and payment of scientific workers are, at present, in general, inadequate and ought to be raised; (4) that increased opportunities and incentives for scientific studies and research should be provided for persons above school age, so as to be available for those who are employed during the greater part of the day in various avocations.

Institute of Chemistry.—The results of the examinations recently held in London, Dublin and Johannesburg have now been published.

Four candidates passed the intermediate examination, viz. :—E. R. Baines, (Miss) Ella Caird, W. H. Craven, B.Sc., and A. J. Dando. Four candidates passed the final (A.I.C.) examination, viz. :—H. J. Hegan, B.Sc., in Mineral Chemistry; A. J. Hall, B.Sc., and S. J. Rogers, B.Sc., in Organic Chemistry; and H. Jephcott, B.Sc., in the Chemistry (and Microscopy) of Food and Drugs, Fertilisers and Feeding Stuffs, Soils and Water. Two candidates passed the final examination for the Fellowship, viz. :—H. R. Adam, B.Sc., in Metallurgical Chemistry; and George Taylor, in the Chemistry of Food and Drugs, &c.

BUSINESS ITEMS.

The offices of the Department of Scientific and Industrial Research (including the Fuel Research Board) have been transferred to 15, Great George-street, Westminster, S.W. (nearly opposite the Department's present offices). The telegraphic address remains "Resciendus, Parl., London," and the official telephone number will be, as before, Victoria 7940 (2 lines).

Mr. F. H. Morley, Star Buildings, Northumberland-street, Newcastle-on-Tyne, has been appointed representative for the Newcastle district, for the sale of the switchgear and apparatus of the New Switchgear Construction Co., Ltd.

Plant for Sale.—The Victoria Electric Plant Co., Spencer-street, Westminster, S.W. 1, advertise for sale a bi-polar motor-generator.

LIQUIDATION.

A meeting of creditors of Korting Brothers (Ltd.) will be held on Aug. 7 at the offices of the liquidator, Mr. Alex. G. Parker (2, Coleman-street, London, E.C.), to whom claims should be sent at once.

CATALOGUES, &c.

STATIC TRANSFORMERS.—Messrs. Ferranti, Ltd., Central House, Kingsway, London, W.C., and Hollinwood, Lancs, have just issued a pamphlet (Tal 79), which gives instructions for the use of the firm's oil immersed static transformers.

ELECTRIC COOKING AND HEATING.—From the British Electric Transformer Co., of Hayes, Middlesex, we have received an illustrated pamphlet of some 60 pages, which give interesting extracts from a Paper on "Electric Cooking and Heating," read by Mr. A. F. Berry before the Association of Supervising Electricians. In these days economy in the cooking and use of food is of vital importance, and the facts and figures given by Mr. Berry should be perused by all interested in improved and economical methods of cooking and heating. Among the subjects dealt with are "Some Tricity Cooker Economies," meat roasting and saving, jam making and sugar economy, relative figures as to cost, &c. Copies of the book will be sent post free on application to the company.

MERCURY VAPOUR CONVERTERS.—The Westinghouse Cooper-Hewitt Co. has sent us a copy of their list No. 75B, dealing with mercury vapour converters. The company is now manufacturing a special series of rectifiers for the charging of telephone batteries.

TRADE BILL-HEADS.—From the "Z" Electric Lamp Mfg. Co. we have received a specimen of a post card and bill-head which it has designed for the use of the trade.

On the bill-heads, which are done up in pads of 100 each, is a striking representation of the "Z" lamp, while the names and addresses of customers are printed free of charge. In view of the present restrictions on trade catalogues this method of publicity should prove useful to traders.

MOTOR CONTROL GEAR.—From Messrs. George Ellison, Birmingham, we have received a copy of a pamphlet entitled "Hints on Rectifying Faults in Motor Control Gear," which should be of assistance to engineers in charge of electrical plant. It contains suggestions as to the selection of protective switchgear and sets out a number of common sources of trouble.

AIR COMPRESSORS.—The Chicago Pneumatic Tool Co. has sent us a copy of Bulletin 347 on gas and gasoline driven air compressors.

PORTABLE TESTING SETS.—From the Leeds & Northrup Co., Philadelphia, Pa., we have received a copy of catalogue No. 50, dealing with portable testing sets, cable testing apparatus, &c.

"PULLEYSTONE" AND "PERMANITE."—The National Chemical Works (Ltd.), of South Acton, have sent us leaflets giving particulars of "Pulleystone" and "Permanite" supplied by them.

Pulleystone is a pink paste put on pulleys; it sets hard and forms part of the pulley itself. Among the advantages claimed for it are that the adhesion of a pulley coated with the paste is 38 per cent., compared with 18 per cent. for an ordinary metal pulley; that as a result of the increased adhesion of the pulley surface the belt will have a better grip, and the loss of power is largely reduced. Among users of "pulleystone" are a number of engineering, iron and steel works, electric supply undertakings, &c.

Permanite is an adhesive cement, and is applied like an ointment ⅛ in. thick. It sets hard and when hard it will resist petrol, benzine and turpentine, and the action of acid, chemical fumes, &c. It is stated that it does not expand or contract, and it can be used for a variety of purposes. Both compositions have been used with success by the British Westinghouse Co. and other engineering firms.

SCHOLEY'S MAGAZINE.—This magazine, which was suspended at the outbreak of the War, is now being reissued.

The June number, which is largely devoted to questions of industrial efficiency and progress, contains several items of interest to the steam raiser. Among these are an abstract of an article on "Regulation of Water Level in Boiler" (from the "Electrical World"), "Illustrated Notes on the Cope's Feed Water Regulator" and the Taylor mechanical stoker, the use of the electric suction cleaner for industrial purposes, and some tool steel records.

Digitized by Google

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Chili Telephone Co. (Ltd.)

The twenty-eighth ordinary general meeting was held on July 19,1917, under the presidency of Mr. CHARLES W. PARISH, the Chairman of the Company.

The SECRETARY (Mr. W. G. MARE) having read the notice calling the meeting and the auditors' certificate,

The CHAIRMAN, after making a feeling reference to the death of Mr. Geo. Keith, said: Gentlemen, considering all things, the report and accounts show a satisfactory result for the year's working. Our gross receipts in Chili were £150,759, compared with £120,969 the previous twelve months, an increase of £29,790, or nearly 25 per cent. With interest, &c., we have a total revenue of £152,182, giving an increase for this financial year as compared with the last of £30,209. On the other hand, however, our expenses have considerably increased, owing, as you will readily understand, to the higher cost of materials and labour, and to the general effects of the war. The percentage of working expenses on the receipts in Chili is just under 60, compared with 52 last year. I might mention that a considerable expenditure had to be met for changing the position of some of our lines and relaying them underground, which naturally fell upon revenue. Similar expenses must occur from time to time. The expenses in London show a small decrease, and when the total expenditure is taken into account, our net revenue from all sources shows an increase of £3,535. After deducting the heavy charge of £11,103 for income-tax and adding the amount brought in from last year, there remains an available balance of £52,784. Of this amount £2,796 has been expended on replacements of plant, and after transferring £16,386 to general reserve account (which now stands at £138,000) and £2,000 to the reserve against depreciation on investments, your Directors have pleasure in recommending a final dividend of 5s. per share, free of income-tax, making, with the interim dividend paid in January last, 8 per cent. for the year, leaving a balance to be carried forward of £5,202, compared with £4,302 brought in. Of £12,351 expended during the year on capital account, £5,360 represents the cost of land and buildings which we have acquired for our exchanges in various towns in Chili. These properties constitute a valuable asset, as real estate in Chili is undoubtedly appreciating in value. An important new building is in course of construction to meet our increasing requirements at Valparaiso, and will, we hope, be completed during this year. We were able to acquire during the year a small telephone business at Constitucion, a port some 60 miles from Talca. The business consisted of an up-to-date plant, a trunk line to Talca and a plot of land in the town of Constitucion suitable for the erection of an office. We consider this purchase a most desirable acquisition, as it consolidates our business, and enables us to give a more efficient and, therefore, more valuable, service at Talca, where we have an important office. The remainder of the capital expenditure is made up of new trunk lines and the usual extensions of our plant in various parts of Chili. You will have been pleased to observe that our subscribers increased during the year by 936, bringing the total to 14,243. Our numbers fell off considerably during the first year of the war, but I am happy to say that we have now more than recovered our position, and, judging from the latest advices we have received from Chili, there appears to be every prospect of the number of our subscribers steadily increasing. The rate of exchange has also improved considerably; this factor will favourably influence our results in sterling. In common with other English companies operating in South America and elsewhere, one of the greatest troubles we have to contend with is to obtain an adequate supply of materials for the maintenance and development of our business. We are doing our best to overcome this difficulty, as it is most desirable that we should be in a position to benefit fully by the prosperous state of the country. Chili is at the present time enjoying a wave of prosperity, owing to the output of nitrate and to her general mining development. The country is wisely governed, for her public men are paying every attention to economy and endeavouring to take advantage of the situation. Our late Chairman, Mr. Keith, had a very high opinion of the future of Chili and the important development of this Company. During the last months of his life he had made arrangements for the formation of Local Advisory Committee. This was done with the concurrence of Senor Huneeus (our General Representative) and Mr. Johnston (our General Superintendent), who strongly recommended as their colleagues Senor German Riesco, an ex-President of the Republic, and Senor Pedro Torres, managing director of the Bank of Chili. Unfortunately Senor Riesco died shortly after he joined us, and was replaced by Admiral Sir George Montt, also an ex-President of the Republic. This gentleman, however, has, to our great regret, found it necessary to retire temporarily from our Committee, owing to the position he holds as Mayor of Valparaiso, but we have every hope that he will rejoin us when his term of office expires. After thanking Senor Huneeus and his colleagues on the committee, and Mr. Johnston, the General Superintendent (also a member of the Committee), and the staff generally for the service rendered to the Company, he concluded by moving the adoption of the report.

The motion was seconded by Capt. the Hon. E. B. Butler-Henderson and carried unanimously. Mr. C. W. Parish was re-elected a director and Messrs. Welton & Bond were also re-elected auditors. A vote of thanks to the Board and staff terminated the proceedings.

West African Telegraph Co. (Ltd.)

The 32nd ordinary general meeting was held on July 18, Sir JOHN DENISON-PENDER, K.C.M.G., Chairman and Managing Director of the Company, presiding.

The SECRETARY (Mr. John Cambrook) having read the notice convening the meeting and the Auditors' report,

The CHAIRMAN said: Gentlemen, we usually hold our general meeting, as you know, in the month of May. The war imposes upon us conditions which greatly interfere with the normal working of the Company, being short-handed in office work, and we have had to wait much beyond the usual date for our accounts; it is for this latter reason that we have been unable to call a meeting earlier. The gross revenue for the year amounted to £53,214, against £55,389 for 1915, or a decrease of £2,175. So far as actual message receipts are concerned, there has been practically no variation, but the net message receipts were somewhat adversely affected by the course of exchange, while interest and dividends on investments show a reduction of £475 when compared with the preceding year, which is caused by the additional income tax payable. The total expenses for the year amounted to £41,485, while for the preceding year they amounted to £30,675, or an increase of £10,810. So far as the ordinary expenses are concerned, these have varied but slightly, and there has, in fact, been a small reduction in the total this year as compared with 1915; the expenses attending maintenance of cables, however, were £12,500 more in 1916 than they were in the preceding year. As I have emphasised at our meetings on previous occasions, this item of expenditure is liable to extreme fluctuations at all times, depending as it does upon the number and extent of the repairs necessary to maintain communication, and I may point out that during the year with which we are dealing, several repairs were carried out to our San Thomé-Loanda cable alone. These and other repairs necessitated a total expenditure of over 27 knots of cable, costing £7,230, against 9 knots expended in 1915, at a cost of £1,717. Your cables are getting older, gentlemen, and this means more frequent and more costly repairs. In addition to this the daily charge for the hire of the repairing ships engaged upon our work and our contribution towards the maintenance of the ship stationed on the West Coast for the purpose of attending to the cables in that locality are heavier than formerly, consequent upon the increase in the expenses caused by the war. The result of the year's business is, therefore, a net profit of £11,729, and after providing for income tax and adjusting excess profit duty, we pay a dividend the same as in former years, still adding to the reserve. This reserve fund now stands at about £328,000, and as the interest received on its investments amounted to £10,538, we are again not only able to pay the dividend without taking from the reserve, but are able to add to the latter the sum of £2,000. The Chairman concluded by moving the adoption of report and accounts.

Sir HENRY C. MANCE, C.I.E., M Inst.C.E., seconded the motion, which was unanimously agreed to. Mr. J. C. Denison-Pender, M.P., was unanimously re-elected a Director, and Messrs. Deloitte, Plender, Griffiths & Co. were also re-elected auditors. A vote of thanks to the Chairman, the Directors and the staff concluded the proceedings.

BRITISH THOMSON-HOUSTON CO. (LTD.).—The directors' report for the year 1916 states that the buildings and machinery of the company at the works at Rugby, Coventry and Willesden have been maintained in good condition throughout the year. A canteen and an extension of the works at Willesden have been completed, and a canteen at the Rugby works is approaching completion. On account of further dilution of labour and the absence of employees who were familiar with the stocks, it was not possible to take an inventory at Willesden and the Rugby main factory, but a complete inventory was taken at the other factories and branch offices. The profits for the year, after deducting all expenses and charges other than interest on debentures and loans, are £359,364. The amount brought forward was £73,359, and the amount required for excess profit duty and munitions levy and for increased depreciation to end of 1915 is £70,000, leaving a balance of £3,359. The reserve for raw materials made at Dec. 31, 1915, not required and written back is £25,000, making a total of £387,723. The amount paid for interest on debentures and loans during the year was £70,100, and of the balance of £317,623, the directors recommend that £153,700 be appropriated for depreciation, and that the balance (£163,923) be carried forward, subject to deduction of munitions levy for 1916, the amount of which has not yet been ascertained. The directors regret to announce that during the year they have lost by death Sir Geo. Franklin (a member of the board for 18 years), and by resignation Mr. J. F. Nauheim (chairman), a director for 20 years; while Mr. E. Thurnauer (who for 21 years has represented the French shareholders) retires, and does not offer himself for re-election. Mr. H. C. Levis, the managing director, has been appointed chairman!

Digitized by Google

The extraordinary business conditions during the past year imposed most exacting demands upon the employees in all departments. Their loyal and efficient co-operation has been of the most gratifying nature, and the directors desire to record their hearty appreciation of their services. The directors also desire to record the splendid response made by the employees in joining his Majesty's Forces on sea and land. 152 have fallen in the service of their country; 138 have been wounded; 102 have received commissions; 27 have won special honours; 9 have been mentioned in despatches; and 11 have been specially commended for service in the field. It is proposed at the end of the war to erect a suitable memorial tablet containing the names of those who have died on active service, as a permanent record of their noble sacrifice.

CROMPTON & CO. (LTD.)—The report states that the directors have found it necessary to postpone the issue of the accounts for the year ended March 31 last, pending the settlement with the Ministry of Munitions of various matters connected with the "Control" of the business under the Ministry of Munitions Act. The works continue to be fully employed on orders of national importance. In the opinion of the directors, the profits for the year justify the recommendation of the following dividends for the year:—A dividend at rate of 7 per cent. per annum on the preference shares and a dividend at rate of 5 per cent. per annum on the ordinary shares.

EDMUNDSONS' ELECTRICITY CORPN. (LTD.)—Mr. P. Debell Tuckett, who presided over the annual general meeting last week, said the accounts were much better than they feared would be the case when they decided to withhold payment of the interim preference dividend. General conditions had been decidedly worse than ever before, so that, in the circumstances, they could congratulate themselves on the results. Their lighting revenue had suffered severely from the Summer Time Act, the drastic lighting conditions and the greater economy exercised by their customers. From those three causes alone there had been a reduction in revenue of £20,000, and, simultaneously, costs of every description had increased. In these circumstances they would have expected to find a reduction of something like £50,000 in the profits of their subsidiary companies, but, thanks to the increased rates charged, and to the marked increase of 4,000,000 units in their power output, the actual reduction (excluding the Lancashire Power Co.) had been only £9,800. The increased demand for power had been one of the outstanding features of the war period. The Lancashire company itself had shown an increase of 5,000,000 units. It was the misfortune of the company that a large proportion of the towns served were holiday resorts, offering a very limited, or no particular, scope for the development of an industrial output. So far they had fairly held their own this year, but until they had the accounts for the last quarter covering the period of the extra six weeks of summer time, they could not speak with certainty.

GREENWOOD & BATLEY (LTD.)—After providing for interest on debentures, expenses of management, doubtful debts, the writing down of War capital expenditure and the company's anticipated liability under the Finance Acts, &c., the accounts from July 12, 1915, to March 31 1917, show a profit of £119,242 and with £7,906 brought forward the total is £127,148. Dividends already paid absorbed £26,017, leaving £101,131. Of this sum the directors have appropriated £45,000 for depreciation and £13,000 to reserve account, and they recommend the declaration of a final dividend for the year to March 31, 1917, on the paid-up preference share capital of 3½ per cent., making with 3½ per cent. paid in February last, the full 7 per cent. for that year; and the declaration of a final dividend on the paid-up ordinary share capital of 15 per cent.

PERNAMBUCO TRAMWAYS & POWER CO.—The net receipts for 1916 amounted to £65,513, and after meeting debenture interest (£51,148) and placing £10,230 to capital reserve account, and appropriating £3,454 for other purposes the balance was £681, making, with £14,770 brought forward, a total of £15,459 to be carried forward.

SOUTH BRAZILIAN RAILWAYS CO. (LTD.)—The report for the year Sept. 30, 1916, states that raw materials had increased in price without any corresponding rise in the tramway and electricity tariffs. The gross earnings from tramways amounted to £20,528 and operating expenses at Curityba £19,081. The general expenses in Europe were £1,656 and interest £2,647, leaving a loss of £2,856. Light and power earnings were £42,090 and operating expenses £22,206, the profit being £19,823. After deducting general expenses in Europe, &c., the net profit is £12,473, and after taking into account the loss on tramways the net earnings are £9,617. The distribution to the debenture holders shows an increase of nearly 20 per cent. compared with the previous 18 months.

NEW COMPANIES.

BRITISH TESTING APPARATUS ASSOCIATION (LTD.) (148,001.)—Private company; reg. July 18 by A. R. Monks as a company limited by guarantee, with not more than 50 members, each liable for £1 in the event of winding up. Objects: To promote and protect the interests of manufacturers of ignition apparatus in the United Kingdom, to conduct and assist in experiments, to promote the standardisation of quality and form of ignition apparatus and the adoption of equitable forms of contracts &c. Reg. office, 39-34, Mansion House-chambers, E.C.

E.M.P. ENGINEERING CO. (LTD.) (148,004.)—Private company reg. July 18, capital £18,000 in 8,000 ordinary shares of £1 each and 40,000 deferred shares of 1s. each. Mechanical, electrical and power engineers, motor car manufacturers, &c. First directors are E. A. Enever and G. E. Bunbury. Reg. office, 50-52, Draycott-avenue, S.W.

K. W. P. ENGINEERING CO. (LTD.) (147,896).—Private company, reg. July 6, capital £5,000 in £1 shares, to take over the business carried on as the "K. W. P. Engineering Co." and to carry on the business of mechanical and electrical engineers, manufacturers of aircraft, automobiles, &c. Permanent directors:—W. Knight and G. S. Warin (ch.).

MOTOR GEAR & ENGINEERING CO. (LTD.) (147,929.)—Private company; reg. July 10, capital £5,000 in £1 shares; motor, electrical aircraft and general engineers. First directors are A. S. F. Morris and F. J. Gordon (both permanent). Reg. office, 75, Curtain-road, E.C.

NATIONAL UNION OF MANUFACTURERS (INC.) (147,967).—Reg. July 13, as a company limited by guarantee, not formed for purpose of profit. The word "Limited" is omitted from the title by licence of the Board of Trade. The number of members is unlimited, and each member is liable for five guineas in the event of winding up. Objects: To undertake all or any of the liabilities and assets of an unincorporated association known as the "British Manufacturers' Association, 1915," to promote the home, colonial and foreign trades and industries of the United Kingdom, to encourage free intercourse between masters and workmen, to render pecuniary, legal and other assistance to small essential industries in case of need, to collect and disseminate statistical and other information, &c. The management is vested in an Executive Council, the first members of which include:—President: G. Terrell, M.P. (Tyler & Co.); Deputy-Chairman: R. L. Mathews (W. J. Turney & Co.); Treasurer: J. Walker (John Walker & Co.); E. R. Arnold (Arnold & Sons), W. T. Bell (Robey & Co.), E. Berkeley (Berkeley & Young), A. Johnston (North British Rubber Co.), D. D. Macpherson (Gandy Belt Mfg. Co.), T. C. Pullinger (Arrol-Johnston) and F. C. Pulsford (Ashwell & Nesbit); Secretary: G. W. Cheesman. Reg. office: 11, Paternoster-sq, E.C.

ROTARY IGNITION (LTD.) (147,978).—Private company, reg. July 14 capital £10,000 in £1 shares. Ignition specialists, manufacturers of and dealers in parts, accessories, engines, motor cars, &c. First directors are: F. Price Handkrik and H. G. Atkinson. Reg. office: 30-32, Ludgate-hill, E.C.4.

CITY NOTES.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended June 30 of 15s. per cent. on the ordinary stock and £1. 10s. on the preferred stock, less tax.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—The directors have declared an interim dividend on the ordinary shares, at the rate of 5 per cent. per annum (less tax) for the half-year ended June 30.

CENTRAL LONDON RAILWAY CO.—The directors have declared interim dividends for the six months ended June 30 on the undivided ordinary stock of 1¾ per cent. and on the preferred ordinary stock of 2 per cent.

CITY & SOUTH LONDON RAILWAY CO.—The directors have declared dividends of 2½ per cent. on the 5 per cent. preference stocks 1891, 1896, 1901 and 1903, and ¾ per cent. on the ordinary stock for the six months ended June.

EASTERN TELEGRAPH CO. (LTD.)—Mr. Robert Molesworth Kindersley has joined the Board of this company.

ELECTRICAL UTILITIES CO. (LTD.)—A dividend of 1¼ per cent. has been declared on the preferred stock.

KAMINISTIQUIA POWER CO.—A dividend at the rate of 7 per cent. per annum has been declared for the quarter ended July 31.

LIVERPOOL OVERHEAD RAILWAY CO.—The directors have declared an interim dividend for the half year ended June 30, on account of the year ending Dec. 31, 1917, at the rate of 5 per cent. per annum on the preference shares and 2½ per cent. per annum on ordinary shares, less tax

LONDON ELECTRIC RAILWAY CO.—The directors have decided to pay a dividend for the past half-year at the rate of 2 per cent. on the 4 per cent. preference stock and ¾ per cent. on the ordinary shares, being the same rates as in 1916.

METROPOLITAN DISTRICT RAILWAY CO.—The directors have declared interim dividends for the six months ended June 30 on the 4 per cent. guaranteed stock of 2 per cent., on the first preference stock of 2½ per cent., and on the second preference stock of 1¼ per cent.

MOND NICKEL CO. (LTD.)—The directors recommend a dividend of 20 per cent. for the year ended April 30.

NAIROBI ELECTRIC POWER & LIGHTING CORPN. (LTD.)—An interim dividend at the rate of 6 per cent. per annum has been declared on the shares of this company for the half-year ended June 30.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The directors have declared an interim dividend at the rate of 7 per cent. per annum on the ordinary shares for the half-year ended June 30.

The share transfer books are closed from the 26th inst. to Aug 8 inclusive, preparatory to payment of dividends for half year ended June 30.

SOUTH AMERICAN LIGHT & POWER CO. (LTD.)—A dividend of 5 per cent. has been declared for the past year, after writing £2,000 off discount on debentures and £3,695 has been carried forward.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—The directors announce that interest on the 6 per cent. first cumulative income debenture stock will be paid on Sept. 1 (less tax) at 3 per cent., and coupon No. 19 off the 6 per cent. income bonds will also be paid (tax free) at 2 per cent.

UNITED ALKALI CO. (LTD.)—An interim dividend of 1s. per share has been declared on the ordinary shares.

Digitized by Google

THE ROUND TABLE.

By "KVA."

BON MOT OF THE WEEK.—"It will presently be found that the generation of cheap and plentiful electrical energy is interwoven at the roots with the welfare of the people."—"Electrical Times."

* * * *

A writer in the "Lady's Pictorial" is guilty of about the biggest taradiddle that I have seen in print for a very long time.

"Of all the oils on the wheels of modern life there is none more effective than His Majesty's Telephone Service."

I'd like the writer (she's a lady, of course) to try some of her oil in my office, especially on a Saturday morning!

* * * *

"Poplar Council propose to erect new electricity sub-buildings in High-street, at a cost of £4,200, the work to be carried out under the direction of the surveyor, without the intervention of a contractor."

Quite so; the contractors are all too busy profiteering on huts and other little war side lines!

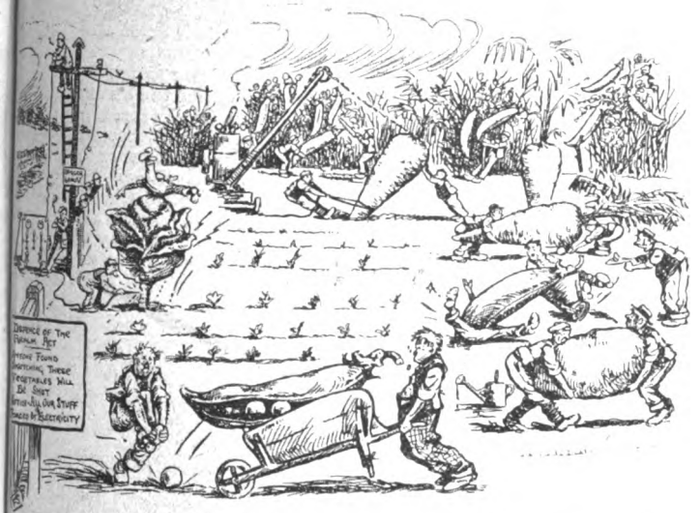
* * * *

The "Yorkshire Observer" says:—

"Lady Rhondda, the wife of the Food Controller, visited Halifax yesterday for the double purpose of starting a new turbo-generator at the Halifax Electricity Station and of addressing a public meeting at Bankfield in support of the food economy campaign."

After this official send-off the cause of electric cooking in Halifax ought not to look back.

* * * *



THE EFFECTS OF ELECTRO CULTURE ON THE ALLOTMENT ACCORDING TO "GLOVER'S ALMANAC."

* * * *

A Manchester correspondent calls my attention to the following cutting from the "Manchester Guardian" under the heading "Manchester 100 Years Ago."

"We understand a patent has been obtained by two gentlemen of Salford for a new method of lighting up houses, warehouses, shops, workshops, &c., with gas. The principle appears to be of the most simple yet commodious nature possible. A retort is placed by a common kitchen fire, and without the least additional expense (except the first fixing of the tubes) a brilliant light is instantly communicated to any or every part of the premises."

I can imagine that the brilliance referred to would on occasions be similar to that produced by an exploding H. E. shell.

According to "a special correspondent lately in America" in the "Manchester Guardian" the European War stopped emigration to the United States, and as a result the negro population of the South is flocking North into industry, commerce and agriculture. The South is confronted with a grave labour shortage, and I suggest that it turns to hydro-electric power for a solution of its problems. Let the place of the departing black man be taken by La Houille Blanche! White coal, as the French have so aptly dubbed hydro-electricity, is as plentiful in the Southern States as black diamonds used to be!

* * * *

The air raids on London are bringing home to roost the chickens hatched out by the enthusiasts on street lighting by gas. During night raids the gas lights cannot be turned out and during daylight raids the electric lights, which are not there, cannot be turned on!

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, July 24, 1880.]

THERMO-ELECTRICITY.—It is stated that a thermo-electric battery has been constructed in America by Prof. Langley, with one of its elements constituted by sheets of iron of such extreme tenuity that ten or twelve thousand of them, superposed, do not exceed an inch in thickness. We have, however, no details as to the method of construction.

CONSERVATION OF ENERGY.—Experiments have shown that not only may one kind or form of energy be translated into another, but also that in the translation nothing is lost, and that there is every reason to believe that the destruction of energy is equally with that of matter, impossible. There is throughout the Universe nothing but the transformation of energies; no loss of energy is possible. Its disappearance in one form is owing to its change or conversion into another; and had we a machine or engine capable of conversion, like the simple pendulum, for kinetic and potential energy, we might see the oscillation of energy between the two forms of mechanical and heat energy; for example, just as we do that of the pendulum between kinetic and potential. There may be an ebb and flow between the relative amounts of the various energies, but the sum of them is all constant and invariable throughout the Universe.

Patent Law Amendment.—In the House of Commons last week the Parliamentary Secretary to the Board of Trade announced that it was hoped to be able to introduce at an early date the Patents and Designs Bill for the amendment of the law relating to patents.

Metallurgical Research in Germany.—It is reported that an assembly of representatives of the iron and steel industries at Dusseldorf recently decided to found a special scientific institute in the Rhenish Westphalian industrial district for the furtherance of the science of iron metallurgy.

The Electric Taxicab in the U.S.A.—The introduction of electric taxicabs, which met with such phenomenal success in Detroit, has been followed by the appearance of six cars in St. Louis.

The clean, silent, smooth running attractive electric taxicab has made a strong and immediate appeal, and has proved itself to be extremely well fitted for this service, especially because of its low operating cost and its simplicity of operation through congested streets, insuring safety, to its occupants. The mileage of these "electrics" is practically unlimited, as facilities for curb "boosting" are situated in various parts of the city, so that the cab may be charged while it is waiting, even though it may be only a few minutes.

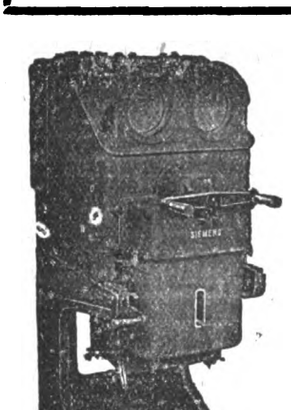
The Electric Vehicle Section of the National Electric Light Association is advised that an electric taxicab company is now being organised in Mexico City, and it is interesting to note that whereas the electric taxicab met its first success in Detroit, the home of the petrol car, it is now to compete with the gas car in the habitat of hundreds of oil wells. Apart from the generally appreciated virtues of the electric taxicab, it is cosmopolitan, for it is found in successful operation in Shanghai, China, where it has to a great extent replaced the quaint and quite inexpensive jinrickshaw. Progress is being made in the matter of the initial fleet of about 500 electric taxicabs of the most advanced type, which it is intended to install in New York City.

L.P.S. INSULATING SLEEVING.
BRITISH MADE & ALWAYS IN STOCK.
A most efficient insulation for all internal connections in electrical apparatus.
An excellent substitute for perishable rubber tubing.
Very flexible, water and oil proof; and of high dialectric strength.
Write for Particulars:—
THE L.P.S. ELECTRICAL COMPANY, 14, Howick Place, Westminster, S.W.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

Digitized by Google

SIEMENS



IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars
Distribution Boards
Main Switchboards

Write for particulars to —

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350 Telegrams: "SIEMOTOR, CENT., LONDON."

HOME BRANCH ADDRESSES:

BIRMINGHAM—Central Ho., New St.
BRISTOL—30, Bridge Street.
CARDIFF—89, St. Mary Street.
GLASGOW—66, Waterloo Street.
MANCHESTER—196, Deansgate.
NEWCASTLE—64-68, Collingwood Bldgs.
SHEFFIELD—22, High St.
SOUTHAMPTON—46, High Street.

Branches in Principal Towns Abroad.

FOR

High and Low Tension SWITCHGEAR

THE

NEW SWITCHGEAR CONSTRUCTION CO., Ltd.

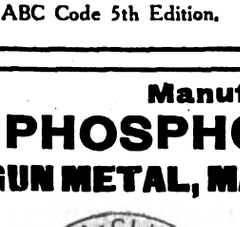
SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

Manufacturers of

PHOSPHOR BRONZE, GUN METAL, MANGANESE BRONZE

TRADE MARK.



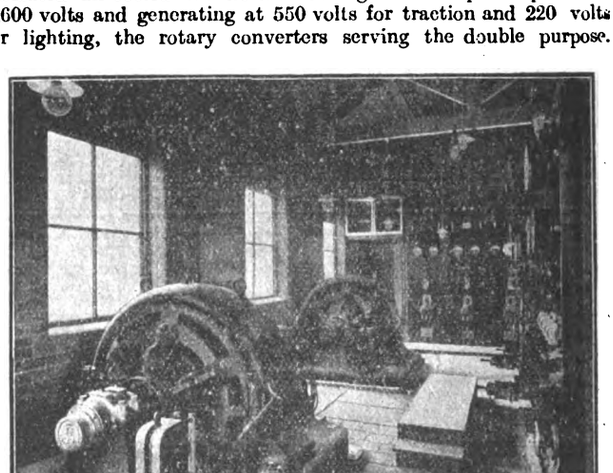
Brass & Copper Tubes and Sheets.

BRASS CONDENSER TUBES FOR STANDARD SHIPS, &c.

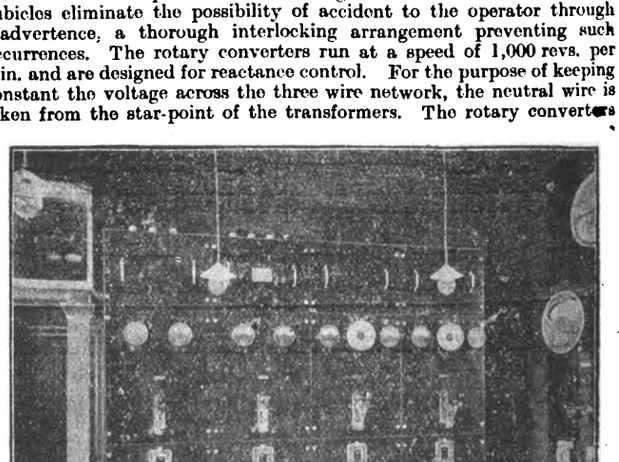
CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.

THE HALIFAX CORPORATION SUB-STATIONS.

In order to afford a supply of continuous current to the outlying areas of Hebden Bridge and Hipperholme, the Halifax Corporation have recently laid down two converting stations in these districts. For the electrical equipments of these sub-stations the contract was entrusted to the General Electric Co., of Witton, Birmingham, and Queen Victoria-street, London. The converting unit chosen was the 250-kw. "Witton" rotary converter, together with an oil insulated air-cooled transformer taking in three-phase power at 6,600 volts and generating at 550 volts for traction and 220 volts for lighting, the rotary converters serving the double purpose.



The incoming feeders are controlled in each sub-station by mistake-proof switchboards. The Hipperholme sub-station having two converting units has two incoming feeder panels on the high-tension board and two machine panels. That at the Hebden Bridge has but one machine panel. These installations exhibit excellently the compactness of the "Witton" bolier-plate cubicle arrangement for sub-stations The cubicles eliminate the possibility of accident to the operator through inadvertence, a thorough interlocking arrangement preventing such occurrences. The rotary converters run at a speed of 1,000 revs. per min. and are designed for reactance control. For the purpose of keeping constant the voltage across the three wire network, the neutral wire is taken from the star-point of the transformers. The rotary converters



are of the self-synchronising pattern, being run up to the speed by a starting motor and switched in through choking coils. They fall into step easily without any synchronising and without any reversal of polarity. The l.t. boards include both traction and lighting panels and a simple arrangement of interlocks between the liquid starter for the motor, the circuit breaker and the short-circuiting switch for the liquid starter precludes any possibility of error in the sequence of the operations. Change-over switches are also included on the board for applying the machines either to lighting or traction and these switches make provision for the opening of the neutral connection when the machines are required for the latter purpose. The illustrations show the two rotary converters and mistake-proof switchboard at Hipperholme. We are indebted to Mr. W. M. Rogerson, M.I.E.E., Borough Electrical Engineer of Halifax, for permission to take photographs shown and to publish this description.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

GOOD WINE NEEDS NO BUSH.

Many, being perplexed at this dark saying, referred it to the Wise Men, who expounded it thus, and thus, or sometimes, thus, so that there were many opinions; but all men agreed, after seeking inspiration in the wine itself, that it was so.

Then One, Greatly Learned, pointed out that the necessity of using a Bush to reduce friction in the case of the aforesaid wine, was wholly unthinkable, while for Trolley Wheels the use of the

PRESCOT GRAPHITE BUSH

was essential to secure long life, good current collection, and smooth running, and all agreed that it was so, too, By Gum!

BRITISH INSULATED & HELSBY CABLES. LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

QUARANTEED SECOND HAND

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.

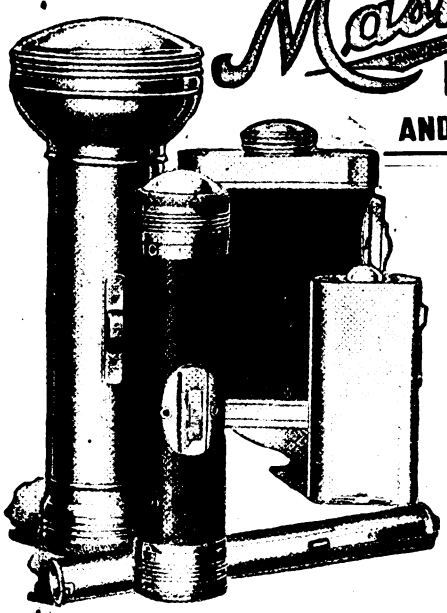
Phone: Victoria 4026 Grams: Victimaster, Sowest London

PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh. *See our Illustrated Advt. next week.*

Digitized by Google



Master BATTERIES AND FLASHLIGHTS.

Build up a better battery business by stocking the MASTER Line for Fall. Flashlight Cases are unique and beautiful.

MASTER Tungsten-Light Batteries are made in every standard size, to fit foreign or domestic cases.

Each battery guaranteed not to depreciate over 10 per cent. in a specified number of months and then to give a certain number of hours' burning-service. Request our catalogue and attractive quotations on direct importations from the U.S. or delivery from large London stock.

THE RIVER PLATE COMMERCIAL COMPANY
EXPORT ORDER DEPARTMENT,
UNITED BATTERY CORPORATION.
MANSION HOUSE—15, GEORGE ST.—LONDON, E.C.

LEWIS'S SCIENTIFIC CIRCULATING LIBRARY.

ELECTRICAL, MECHANICAL & GENERAL ENGINEERING TEXT BOOKS & TECHNICAL WORKS.

New Works and New Editions can be had from the Library immediately on Publication. Telephone: MUSEUM 1672.

SUBSCRIPTION, Town or Country, from ONE GUINEA.
READING ROOM open Daily to SUBSCRIBERS.

H. K. LEWIS & Co. Ltd.,
136, GOWER STREET, and 24, GOWER PLACE,
LONDON, W.C.

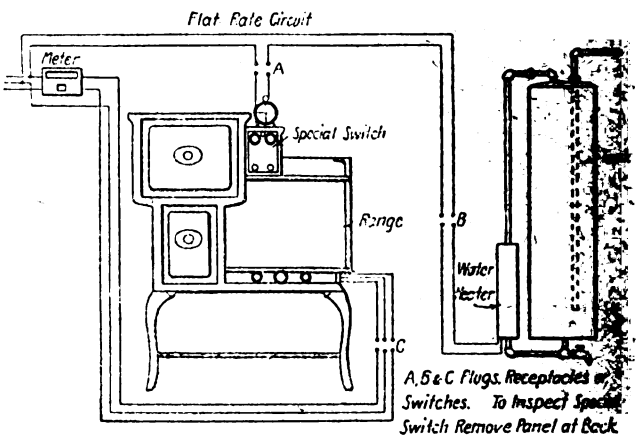
GENUINE
M & M VULCANISED FIBRE.
MOSSES & MITCHELL, 122 & 124, GOLDEN LANE, LONDON, E.C.

INSULATION BEADS
...satisfactory substitute for ...wire also for flexible ...AMPLE STOCKS ...
...HOLDER-HARRIDEN, LTD., 35/37, ... LONDON, E.C.

ELECTRIC RANGES AND HEATERS IN AMERICA.

Supply companies in the United States are conducting vigorous campaigns in favour of the extension of the use of electric ranges, electric heaters, and other domestic appliances. Various methods are adopted for stimulating the interest of lighting consumers in electric cooking and heating; public demonstrations are given, hire purchase and easy payment schemes have been introduced with very satisfactory results in most cases. For instance, the Washington Water Power Co. sold during the first five months of 1917 over 400 electric ranges in Spokane and its vicinity. In practically all cases the electric range displaced a gas, petrol or coal range. Equal success is claimed to have been achieved by the company in the introduction of the electric water heater, about 500 of these having also been disposed of in the first five months of the year.

The company started selling electric ranges in 1912, but only within the last two or three years has the sale on a large scale developed. At present only three standard makes of ranges are supplied to consumers, the idea being to keep the variety as small as possible, and thus to make the stock problems simpler. A vigorous campaign is being conducted among the residential lighting customers, in order to popularise the company's ranges and heaters. In order to make it possible to sell additional ranges it is found necessary that ranges already sold be given the greatest attention, and a range is not considered sold until an expression of satisfaction has been secured from the consumer. For this purpose a routing sheet is used, which is kept in a live file until a report by the "home economist," employed by the company, who visits the customer in order to instruct her in the proper use of the range, shows that the consumer is satisfied. According to the "Electrical Review and Western Electrician," large



WIRING DIAGRAM FOR ELECTRIC RANGE AND HEATER.

demonstrations are found to be no longer necessary, and the only demonstrations are those conducted in the company's own electric kitchen or in the range-display room of the company, or in the customer's own home after a range has been placed in service. It is not found necessary to sell ranges on approval, but ranges are sold with the guarantee that they will be satisfactory.

The problem of water heating has received special attention in the company's territory, as it is found impossible to make a consumer's kitchen electric in the fullest sense unless the coal or gas range is removed. For this purpose a circulating water heater on a flat rate is used to heat the water in the range boiler. This boiler is lagged to prevent excessive radiation. In order to prevent the water heater from coming on the range peak, it is placed on a double-throw switch which prevents the heater being used simultaneously with the range oven. The water heater circuit is wired ahead of the meter, a special switch controlling it. The flat rate on this style of water heater is $3 per kilowatt-month, and it has been found that 60 per cent. of the ranges to date have been so equipped, the consumer frequently finding the water heater a source of even greater satisfaction than the range. The illustration given above shows the wiring diagram for range and heater.

THE MOTOR INDUSTRY AFTER THE WAR.

Mr. C. A. Vandervell, of the well-known firm of Messrs. C. A. Vandervell & Co. (Ltd.), Acton, was recently interviewed by a representative of the "Financial Times" as to the position of the motor industry after the war.

In the course of the interview Mr. Vandervell said that everyone in the motor trade seemed to hold the view that the industry would be benefited by a protective duty. To his mind the strongest point of all was that as soon as the workman found out that his very livelihood was going to depend upon a tariff there would be a change of sentiment. Everyone had the right to work and to live, and it should be the duty of the State to see that no willing worker lacked employment, and the only way to do that was to keep the home factories going.

With regard to the relations between capital and labour, Mr. Vandervell

Digitized by Google

If proof were needed that——

C.A.V. Commercial Vehicle LIGHTING SETS

are the most reliable in the world this extract from the "Motor" should convince the most sceptical.

THE LIGHTING SET WAS INTACT!

When the Mex Motor spirit lorry through skidding ran into the bridge at Bransford, near Worcester, at midday on 27th Nov., and was precipitated into 16 feet of water, it was not until five in the evening of 1st Dec. that it was got on to the bridge again. The engineer in charge of the operations turned on the switch, and found the lighting set intact and in perfect working order, nor has it required any attention since, although it has remained in frequent use. This is striking evidence of the excellence, design, and workmanship of the C.A.V. Lighting Set for heavy vehicles, and shows that the waterproof qualities and insulation of this famous system are practically perfect.

The "Motor."

Our Commercial Vehicle Dept. will be pleased to send you particulars of the Lighting and Starting Sets that are constructed to give faultless service under the most extreme conditions.

C.A. Vandervell & Co. Ltd.
ACTON LONDON W.

Telephone Chiswick, 2000 (eight lines).
Birmingham. Manchester.

FERRY

FERROZOID

CONSTANTAN

CHRONIC

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:

HENRY WIGGIN & CO., Ltd.
George Street, Birmingham.

TELEPHONE: 6400 CENTRAL
GRAMS: "WIGGIN BIRMINGHAM."

AGENT:

LIONEL ROBINSON,
3, Staple Inn, London, W.C.

TELEPHONE: 6328 HOLBORN.
GRAMS: "FERRYDOM, LONDON."

Digitized by Google

Co-efficients of Friction.

Hard Oak on Oak .19 to .48. Metal to Metal .14 to .30
Leather on Metal .15 to .46. Hemp on Oak .35 to .53
FERODO FIBRE .4 to 8.
FERODO BONDED ASBESTOS .3

Ferodo Fabric and Ferodo Bonded Asbestos not only possess a higher co-efficient of friction than hard oak, leather, cast iron, hemp, or *any* other practical friction surface, but they are infinitely more durable. They save power by giving maximum acceleration and deceleration, and absorbing more pounds of energy per square inch than any other friction surface.

FERODO FRICTION SURFACES—give equally good results when brand new and when worn to the thickness of a sheet of paper.

—cannot spark—cannot char—cannot throw off metal dust—cannot seize.

—are always reliable. Each weaving is thoroughly tested by experts before leaving our works.

Write for Lists to—

The Herbert Frood Co. Ltd.

Works: Chapel-en-le-Frith.

Contractors to the War Office and Admiralty, London General Omnibus Company, and Underground Electric Railways of London and Paris.

Depots at London, Birmingham, Belfast, Bristol, Cardiff, Edinburgh, Glasgow, Liverpool, Manchester, and Newcastle.

FERODO
Friction Surfaces.

Theory of the Submarine Cable.

BY

H. W. MALCOLM,

M.A., Ph.D., D.Sc.

Price 18/- net. (By post 18/6).

600 Pages. **200** Illustrations.

CONTENTS.

PART I.—Introduction.—Mathematical Recapitulation.—The Fundamental Cable Constants.—Transient and Periodic Phenomena.

PART II.—Purely Periodic Phenomena.—The Telephone Cable.—The Telegraphic Equation and its Periodic Solution.—The Methods of Loading Cables.—Discontinuance and Reflexions.—Alternating Current Measurements.

PART III.—Purely Transient Phenomena.—The Telegraph Cable.—The Telegraphic Equation and its Transient Solution.—The Part Played by the Signalling Apparatus.—Sending Phenomena and the Influence of Leaks.

PART IV.—The Methods of Telegraphic Transmission.—Signalling by Inverse Currents.—Sine Wave Transmission.

PART V.—The Future Progress of Cable Telegraphy.—Distortion and How it is Produced.—Present-day Methods of Overcoming Distortion.—The Duplexed Cable.—The Loaded Telegraph Cable.—Conclusion.

APPENDICES.
INDEX.

"THE ELECTRICIAN" OFFICES,
8, Bouverie Street, London, E.C. 4.

remarked that, in spite of numerous strikes that had occurred, he could not help feeling that they were coming together a little more. But to his mind they never would be properly united until the Socialistic element had been eliminated. Honest labour should work hand in hand with capital; the one could not do without the other. Although the co-operative system had been successfully introduced in some factories, he did not think it possible in a general way; labour was bound to be migratory, and for that reason it made the success of any profit-sharing scheme doubtful. A workman should certainly have some inducement offered him to work hard, and he ventured to say that a good fat bonus every pay-day would appeal to him more than waiting for the yearly balance-sheet. Undoubtedly trade unions would have to take a new point of view. It should be the policy of labour organisations to induce their members to work to the best of their ability—high wages constituted no drawback to an employer, provided that the rates were general and the industry protected. He believed a workman would rather have higher wages even though the cost of living be higher than low wages, cheaper living and doubtful employment. As a manufacturer, he would cordially welcome the day when capital and labour really worked hand in hand, but that could never happen through advances made by the capitalist alone; the workman, too, had just as important a part to play; and until he came forward on his side one could not look for any immediate improvement.

As to trade after the war, Mr. Vandervell said much reconstruction would have to be done, and business ought to be brisk. Naturally, the workers would want to continue earning good wages. The only way in which that could be accomplished was to keep all our factories fully occupied. English manufacturers were enterprising enough if there was any work to be done. If after the war there should be a slump in work a slump in wages would necessarily follow, and much unemployment would be witnessed. Without doubt the Government, instead of taxing thrift as at present, should seek to raise revenue in a manner beneficial to the industrial interests of the country. To attract capital a business must be reasonably remunerative, just as to attract the workman wages must be good and surroundings pleasant. The motor trade, provided the war did not last too long, had a hopeful outlook. The British magneto was going to hold its own. He was quite certain it would if the foreign article was kept out of the country until the industry was properly established. He did not think manufacturers would again be in a hurry to lay out money in a business that would be liable to cut-throat competition from foreigners. It was the duty of the State to help foster home industry and to improve the manufacturing status of the country. If that policy was applied to all industries, and taxation was kept within reasonable bounds, he saw no reason why the future should not be prosperous.

MOTORS FOR NEW YORK CITY STREET CLEANING.

The report of the New York City Department of Street Cleaning for 1916, which was recently issued, states that improved equipment involving the partial replacement of horses and carts by motor-driven vehicles resulted in considerable improvements and economies being effected.

Commissioner John T. Fetherston, who has been in charge of the City Department of Street Cleaning for the past three years, states that in the three boroughs of Manhattan, Bronx and Brooklyn there were 101,173 horses and 89,122 automobiles (commercial and pleasure) in 1916, the increase in the number of automobiles over 1915 being 26,217 (or more than 40 per cent.) and the increase in commercial motor vehicles 37 per cent. Having decided that the time had arrived when the department should discard its inadequate equipment and adopt modern up-to-date machinery, a sum of $250,000 was appropriated for a district of Manhattan which was selected for the experiment. After investigating and testing apparatus supposed to be suitable for the purpose in view it was found that none covered the requirementss of the department, and a petrol electric tractor was then designed by the engineering branch of the department. During 1915 12 of these tractors were completed (at a cost of $4,166 each) and also 11 trailers, suitable for the collection of the four classes of material (ashes, street sweepings, garbage and rubbish) on the same trip. Under the old system the horse-drawn vehicle made three distinct trips when on this work. The trailers cost $810 each. During 1916-17 seven additional tractors and six trailers were added, but as three tractors constructed in 1915 were transferred to other districts there were only 16 tractors and 18 trailers for the model district service at the end of the year. In 1916 a motor-driven combination flush and sweeper was introduced, and locomotive cranes were installed for transferring the trailer loads to scows. It is estimated that the city saved approximately $68,000 by the modern equipment in 1916 as compared with the figures for 1914, the last year in which horses were exclusively used. Commissioner Fetherston states that, though not yet complete, the motor equipment and the accompanying improved methods gave an enhanced service at a reduced cost, and in consequence of this the Board of Estimates and Apportionment has adopted estimates amounting to $593,500 for the introduction of motor vehicles in two more districts and of motor flushing machines in Brooklyn and Bronx.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,046. [Vol. LXXIX. No. 18] FRIDAY, AUGUST 3, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES	689
Arrangements for the Week	691
Experimental Researches on the Skin Effect in Steel Rails. By A. E. Kennelly, F. H. Achard and A. S. Dana. Illustrated..	692
Notes on the Design of Electromagnetic Machines. By Stanley Parker Smith, D.Sc. Illustrated.—*Continued*	696
Siemens Rotary Converters. Illustrated	699
EDUCATION OF APPRENTICES	702
REVIEW	702
British Trade in Foreign Countries	705
Education of Apprentices	707
LEGAL INTELLIGENCE	709
Patent Record	710
Volunteer Notices	710
COMMERCIAL AND INDUSTRIAL SECTION	713
Electricity Supply	714
Tenders Invited and Accepted	716
Financial Matters	717

NOTES.

British Trade in Foreign Countries.

IT is a little disquieting that nothing has yet been heard of the reform of the Consular Service, at least of a positive character. So far all that has been done is that a Government Committee has heard recommendations from the Federation of British Industries and from the Chambers of Commerce. These recommendations have been mainly on the same lines. After hearing this and further evidence, the Committee drew up majority and minority reports; but so far the Government has refused to publish these reports. Considering the importance of being prepared for peace conditions, and the fact that any serious alteration of our existing organisation must take a very considerable time, it is essential that prompt steps should be taken to put our house in order. Great Britain's ability to pay her debts will undoubtedly depend on efficiency in production at home and on ability to send her products abroad in the face of highly organised competition. Having regard to the importance of the subject, we are glad to note that the Federation of British Industries has issued a statement of its views and recommendations, which have been submitted to the Government. These are of a comprehensive and sweeping character, as befits the case. The view is taken that any attempt to impose detailed reform or additions upon the existing Government organisation would be doomed to failure, and that the only chance of success lies in a fundamental reconstruction of the present administration. Consequently it is suggested that control can only be obtained by the concentration of the entire responsibility in the hands of a single department, and that this department should be a branch of the Foreign Office. It is pointed out that there will be large questions involved by railway, loan, dock and similar projects and schemes for the development of natural resources in foreign countries. There will not only be political elements, but direct negotiations with Governments of foreign countries. Thus there will be a large range of problems of a nature partly political and partly commercial, such as those raised by the resolutions of the Paris Conference, and it is most important that the department concerned should be in the most intimate and direct touch with industrial and commercial opinion if disastrous consequences are to be avoided.

Some Points Emphasised by the F.B.I.

WE have become accustomed to the German method of backing schemes, which method includes the proviso that the plant for the contemplated scheme shall be made by German firms. It is, therefore, interesting to note the suggestion that the issue of foreign loans in the United Kingdom should be subject to the approval of the Government, and that a necessary condition of such approval should be the purchase of a larger portion of the goods or services from British sources. One of the needs which has been keenly felt in the past has been up-to-date commercial information, readily accessible, and published as soon as obtained, instead of after the lapse of one or two years, when the information has become of little value. A point is made of the need for having commercial intelligence immediately accessible to other Government departments. This would certainly be an innovation, for one of the most difficult matters is to obtain information through one Government department which has been obtained by some other department; there ought, in fact, to be a sort of inter-departmental clearing house for such matters. Naturally, a programme of this kind, if it is to be carried out effectively, will mean a very considerable expenditure of money. This is realised, and the opinion is expressed that expenditure on the Foreign Commercial Service is as necessary as adequate expenditure on national defence. With this sentiment we fully agree. It is surely insufficient to secure the national defence of the country by means of warships and armaments if there is no corresponding defence to maintain our commercial position; but this will be a new sentiment to many Government officials.

The F.B.I. Scheme.

As will be seen by reference to another page, the scheme outlined is to create a commercial branch whose officers shall be in touch with British industries, and who will be available for personal interviews with British subjects wishing to discuss foreign trade questions. Such officials, it is suggested, should pay frequent visits to industrial centres, and should possess sufficient knowledge and practical experience to enable them to judge the value and importance of commercial factors in any large problem with which they may be dealing. In foreign countries it is proposed that there should be Commercial Counsellors, whose importance would be second only to His Majesty's representative in the particular country, and to whom he would be responsible. The Commercial Counsellors would be given opportunities of paying frequent visits to the United Kingdom in order to consult commercial interests and to keep in touch with the latest developments in industry and commerce. Lastly, there is the most important question of stimulus in the work; in other words, the elimination of that policy of *laissez-faire* which is so noticeable in the average civil servant. It is desirable that officials in this class of work should be just as alive as they would be in private affairs, and it is proposed to gain this end, not by giving rewards, but by having a promotion board, which would have the power to postpone promotion, or even to require resignation, in the case of officers who fail to reach a required high standard. It

Digitized by Google

appears to us that this scheme has many excellent points, and the only one with which we are inclined to disagr . is that the new department should be part of the Foreign Office. Officials of the Foreign Office are so absolutely out of touch with anything in the nature of commerce, probably regarding it as a matter which should be left severely alone, that the success of a department such as is contemplated might be jeopardised. We suggest that it might be better to form a Ministry of Commerce, which would be in close touch with the Foreign Office; but if eventually it is decided to form a department as suggested, then we feel that adequate safeguards should be adopted to render the department independent of the influence of those to whom commerce is distasteful.

The Cost of Industrial Power.

IN a recent Report of the Central Station Power Committee of the Association of Iron and Steel Works Electrical Engineers it is recommended that rate schedules should be as simple as possible, and that complicated systems of rates and discounts for various load factors and consumptions be avoided. Such systems have done considerable harm to the development of the power load at home, and every central station engineer knows that what the power consumer wants is a flat rate of so much per unit, with, perhaps, discounts for large consumers. The Committee's idea of "simplicity" is one with which we do not agree. In the report it is recommended that in negotiations for power supply, and in order to obtain most favourable rates to the purchaser, it be insisted that the rate schedule be divided into demand charges and energy charges; that the demand be the average or integrated peak of 15 to 30 minutes' duration; that the power factor be 80 per cent., with decrease or increase in the demand to be charged for accordingly as the power factor is above or below 80 per cent.; that the demand charges per kilowatt be in two or more steps; that the energy charges per kilowatt-hour be in two or more steps; that any excess demand occurring at other than the peak period of the power company's plant be charged at only one-half the demand charge normally applying to such excess if occurring on the power company's peak period. If this is a simple system of charging we should like to know what the Committee regards as a complicated system. The consumer knows nothing, nor can he be expected to know anything, about demands, integrated peaks, power factors, multi-step demand and energy charges and the like. What he would like to know is that by multiplying his meter reading by a constant he obtains the amount which he owes, and beyond question this is the ideal which power supply authorities should keep before them. When public opinion is such as to compel a large proportion of the existing power stations to shut down in favour of a few well-placed stations, we shall be appreciably nearer to a commercial system of charging for industrial power.

The Training and Work of the Chemical Engineer.—A general discussion on this subject was held by the Faraday Society on March 6. This has now been issued in the form of a pamphlet, together with contributions by a number of engineers who were not able to be present on that occasion.

Electrical Standardisation in France.—The French Electrotechnical Committee has decided on various measures for the standardisation of electrical machinery, &c., some of which are mentioned in the "Revue Générale de l'Electricité." On many of the points publication is not permissible at present, but it is understood that the steps proposed refer to insulated cables and the standardisation of the production and transmission of energy and of electric machinery. The measures will be considered with regard to similar steps being taken in Great Britain, Italy and the United States.

British Engineers' Association.—At the fifth annual general meeting last week the result of the ballot for the election of the new council under the revised articles of association was declared. At the first meeting of the council, held the same day, Mr. Wilfrid Stokes was re-elected president. Arrangements were made for an extended programme of usefulness to be carried on.

A Physical Laboratory for Birmingham.—The Birmingham Chamber of Commerce has decided to convene a public meeting of manufacturers for the purpose of hearing an address by Prof Burstall on his proposal to set up in Birmingham a laboratory on the lines of the National Physical Laboratory for the purpose of issuing certificates of length measurements, &c. It is considered that after the war such a laboratory will be of great use to the trades in Birmingham and district.

Analyses of Coals.—A useful bulletin, No. 119, by G. S. Pope, issued by the Bureau of Mines (U.S.A.), summarises the results of analyses of coals carried out for the department during the years 1908-1915. The tests include particulars of moisture present, ash in dry coal, and calorific values from coal respectively, as received, dry, and free from moisture and ash. The coals studied are mainly American, but some samples from Australia and Canada are included. It is estimated that the United States Government expends annually about eight million dollars on coal, so that the value of periodical analysis is evident.

World's Largest Telephone Cable.—The "Electrical News" of Canada announces that the largest submarine cable in the world has just been completed across Raritan Bay between Eltingville, Staten Island and Keansburg, N.J., by the New York Telephone Co. It is nearly 5½ miles long, and contains 74 pairs of wires. The new cable does away with 3,000 miles of open wires and 13,000 cross-arms used on the old land route. There are longer cables in existence across the English Channel and the Pacific Coast, but these carry only up to 16 pairs of wires.

Coal Mine Breathing Apparatus.—The Committee of the Privy Council for Scientific and Industrial Research, on the recommendation of their Advisory Council and at the request of the Home Office, have sanctioned the appointment of a Committee with the following terms of reference:—

"To inquire into the types of breathing apparatus used in coal mines, and by experiment to determine the advantages, limitations and defects of the several types of apparatus, what improvements in them are possible, whether it is advisable that the types used in mines should be standardised, and to collect evidence bearing on these points."

The Committee is composed as follows: Mr. William Walker, Acting Chief Inspector of Mines under the Home Office (*chairman*); Mr. John Haldane, LL.D., F.R.S.; and Mr. H. Briggs, D.Sc., of the Heriot-Watt College. Mr. A. Richardson has been appointed secretary to the Committee, and Dr. Henry Briggs has been constituted director of the inquiry.

Fixation of Nitrogen.—Last year a report was prepared by the South African Institute of Electrical Engineers upon Electro Chemical Industries, more particularly in regard to the possibility of producing calcium carbide and other nitrogen products in South Africa so as to avoid the importation of such materials. This report has now been issued as a separate document. The conclusion is reached that such products can be profitably manufactured in South Africa and that an early investigaiton of the matter is of the greatest possible importance. An estimate of the cost of manufacturing calcium carbide is given. This ranges from £13. 16s. per ton for an output of 2,600 tons per annum down to £10. 10s. per ton for an output of 10,000 tons per annum. The cost of manufacturing calicum cyanamide is estimated at £9 per ton with an output of 4,000 tons per annum. The cost of electric power is taken at 0·35d. per kw.-hour.

The Influence of Organisation on History.—In an address on the above subject before the British Empire Producers' Organisation, Mr. Jan. D. Colvin recently sketched in some detail the activities of the Hanseatic League in British commercial history. According to Mr. Colvin the influence of this league was so powerful that they paid lower duties in this

Digitized by Google

country than Englishmen themselves, were free from local and domestic taxation and had many other special privileges. It established a practical monopoly. When the league fell to pieces, the bits were picked up mainly by the Dutch. In England such bodies as the Merchant Adventurers were formed to combat the League, with some success, and Simon de Montfort is mentioned as one of its chief opponents. Mr. Colvin's contention appears to be that such wide achievements are impossible without organisation, and that this is the great need in British industry to-day.

Scientific Work in Russia.—A correspondent from Petrograd to "Nature" gives a distinctly gloomy account of the difficulties of carrying on scientific work or publications in Russia at the present time. It is almost impossible, he says, to print scientific works having small circulations and having small calculations, as prices demanded by compositors, printers, paper makers, &c., are 200 to 300 per cent. higher than before the Revolution. Scientific work and teaching is likewise interfered with by the fact of many of the institutes and universities having been "requisitioned" by irresponsible revolutionary organisations and troops. Thus, the Polytechnic has been occupied by 2,500 soldiers since March 5th, and all efforts to eject these unwelcome guests have proved abortive. Many of the students take a great part in these revolutionary organisations, and also make demands to have the direction and control of all affairs in universities and institutes. In these circumstances the future of seats of learning is naturally considered precarious.

Coal Concreted from Dusts or Ashes.—At the Society of Architects last week a second Paper was read by Mr. R. G. Lovell upon this subject, and demonstrations were given of the process on a small scale. Three processes were shown. In the first the ashes or dust is sifted, dried and sprinkled with special sugar waste solution, and then dried again, and in some cases a small quantity of creosote oil is added. The mixture is turned into moulds and allowed to concrete, the time varying with the amount of heat available. The fuel when cold is emptied out of the moulds, broken up and hardened by exposure to the atmosphere. The second process is similar to the first, but the creosote is placed in a boiler and the mixture is stirred until a temperature of about 120°F. is obtained, when it is turned into a mould. When cold it is broken up and allowed to harden. In the third process the aggregates are mixed with a different matrix mixture and moistened with a solution. A table of analyses was given showing results obtained with various coal dusts, ashes and coke. The amount of raw material used was generally over 95 per cent., and consequently the calorific value was not far different from that of the fuel in the first instance.

Mine Fatalities in the United States.—Several publications issued by the Bureau of Mines, U.S.A., contain some statistics on accidents in coal mines in the United States. The monthly statements for 1916, as compared with 1915, show that the number of fatalities reported were respectively 2,225 and 2,269—a decrease of about 2 per cent., whereas the production of coal has risen about 12 per cent. The accidents, together with the chief causes, are tabulated month by month for the two years, from which it appears that falls of roof and coal, and mine cars and locomotives are chiefly responsible; gas and other explosions coming next. The bulletins also contain notes on approved permissible explosives, lamps and mining equipment, and a circular by Messrs. W. A. Lynott and D. Hanington is devoted to "Elementary First Aid for the Miner." Separate data are also given for accidents in metallurgical works, where the number of fatalities is relatively low, but the number of injuries in ore-dressing works and smelters is considerable, and shows a progressive increase during 1913-15, no doubt owing to the larger number of men employed.

Electrically-Heated Moulding Presses.—According to the "Electrical World," the Westinghouse Co., of Pittsburg, has adopted electric heating for 23 presses used in the manufacture of moulded insulating material. These presses were formerly heated by steam, but a trial of an electrically-heated press proved so satisfactory that the entire set of presses is now being modified for equipping with electric heaters. The heat is furnished by means of two plates 1 ft. square by $3\frac{1}{2}$ in. thick, covered on their exposed surfaces with magnesia to reduce the radiation losses. The upper plate is stationary and is in contact with a thermometer. The lower plate is movable vertically. Each plate is made in two parts, in each of which are two grooves holding the heating units. Thus there are four heating units per plate, or eight per press. Each unit is 12 in. long by $2\frac{1}{4}$ in. wide by $\frac{3}{16}$ in. thick, and is rated at 300 watts. These units consist of a flat ribbon resistor assembled in a mica sheath and enclosed in a steel casing. The presses are arranged in sets of four. Current is supplied to each set through a multi-tap transformer and a 15-point dial face plate. The voltage may be varied from a maximum of 220 to a minimum of 150 volts, with relative inputs for each set of heaters of from 2,400 watts maximum to 1,200 watts minimum. This arrangement provides for an input of high value for quick heating when the press is cold, and it is desired to heat it rapidly; one of low value when the press is not to be used, but it is desired to keep it hot for later use, and several intermediate inputs when it is desired to keep the press hot while in steady use on work having different heat requirements. Tests show that from one to $1\frac{1}{4}$ hours are required to heat the plates, starting cold, and that 1,800 watts will keep the press hot while in steady use for work requiring a temperature of 190°C.

German Iron and Steel Institute.—From a report of the meeting of the Verein Deutscher Eisenhüttenleute (the German Iron and Steel Institute), which has been translated by Sir Robert Hadfield, F.R.S., we note that the feeling for closer co-operation among the German technical societies has been emphasised. It is pointed out that after the war Germany will have to depend on its own strength, and that accordingly the demands of the country will be enormous. Co-ordination between metallurgical practice and metallurgical research will in future be imperatively needed. Among the problems to which reference was made was the extraction of manganese from the Thomas slag. It was pointed out by Captain Thiele that each year 300,000 tons of iron and 150,000 tons of manganese, in the form of their oxides, were being scattered on fields and meadows of foreign countries. It is an interesting fact that Dr. Beumer, in an after-dinner speech, called attention to the fact that over-organisation was causing grave anxiety. The "water-tight compartment" attitude of the official mind was playing an ominous rôle, as to which Bismarck had said that a regular "departmental patriot" always looked upon any other state department as "foreign country." Each newly created office commenced with enquiries, notwithstanding the fact that similar enquiries had already been instituted before by existing departments, the results of which had been quietly shelved. In his opinion, Martin Luther and others, if alive to-day, would be preaching against the "departmental devil," the "ink devil," the "writing devil" and the "statistical devil," instead of against the devils of dancing, of pride and of finery. Evidently some of our own troubles are not unknown in Germany.

PERSONAL.

Mr. A. P. Trotter, after 21 years' Government service, is returning to professional practice as a consulting engineer and is joining Messrs. Handcock & Dykes, as partner in the firm of Handcock, Dykes & Trotter, at 11, Victoria-street, London, S.W.1. Mr. Trotter is a member of the Institutions of Civil, Mechanical and Electrical Engineers, President of the Illuminating Engineering Society, Vice-Chairman of the National Illumination Committee of Great Britain (affiliated to the International Illumination Commission), Chairman of the Joint Committee on Illuminating Engineering of the Department of Scientific and Industrial Research and member of other scientific institutions. In 1896 he took up the post of Electrical Engineer to the Government of the Cape of Good Hope and in 1899 he returned to London, since when he has been Electrical Adviser to the Board of Trade.

Digitized by Google

EXPERIMENTAL RESEARCHES ON THE SKIN EFFECT IN STEEL RAILS.*

BY A. E. KENNELLY, F. H. ACHARD AND A. S. DANA.

Summary.—A number of measurements are described, from which it is found that the best workshop method is that based on the use of a particular sort of dynamometer. The effective alternating-current conductance of a rail is found to be proportional (among other things) to the square root of the ratio of the conductivity to the permeability. The skin effect resistance can be approximately predetermined and a rule is given for the best form of rail to be adopted.

The following research was conducted during the years 1914-15-16, at the Massachusetts Institute of Technology, under an appropriation from the American Telephone & Telegraph Co.

Objects of the Research.—The research was made to determine, by direct measurement, the impedance offered to alternating currents such as occur in electric railway work by standard steel rails of various shapes and sizes; also, to ascertain how this impedance varied with frequency and with current-strength, and whether the impedance could be predicted from physical data concerning the steel used in the rails.

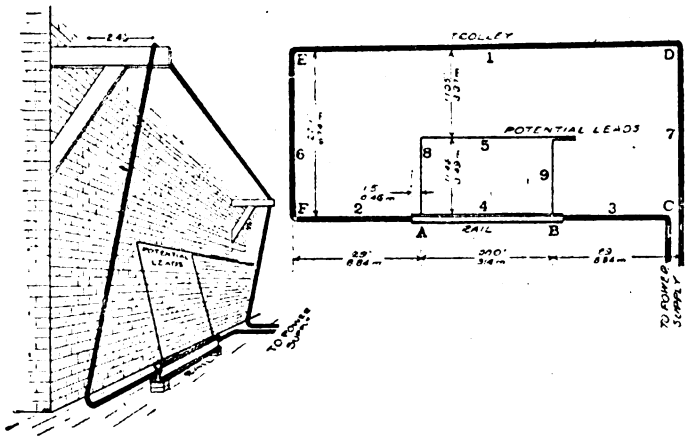


FIG. 1.—DIAGRAM OF TEST CIRCUIT.

Types and Dimensions of Rails Tested.—The tests were extended to 11 sample track rails and two sample contact rails, 33 ft. (10·07 metres) in length, ranging in linear mass from 60 lb. to 100 lb. avoirdupois per yard (30 kg. to 50 kg. per metre), with corresponding cross-sections from 6 sq. in. to 10 sq. in. (38·5 sq. cm. to 64·5 sq. cm.). The cross-sections of these rails are represented to scale in Figs. 3 & 4.

Frequencies and Strengths of Alternating Testing Current.—Three frequencies have been used in the tests—namely, 25, 45 and 60 cycles per second. The bulk of the work was, however, carried on at or near two frequencies only—*i.e.*, 25 and 60 cycles per second. The current-strengths employed in the test rails varied from 10 to 800 amperes R.M.S.

Arrangement of Test Circuit.—In order to make the measurements as nearly under practical railway conditions as possible, the test circuit was so constructed that the rail and its parallel return conductor occupied the same relative positions as one rail of a railroad track and its overhead trolley wire (No. 0000 A.W.G., diameter 0·46 in., or 1·17 cm.); *i.e.*, with the trolley wire 2 ft. 4½ in. (71·8 cm.) to one side of the rail and 22½ ft. (6·86 metres) above it. The arrangement of the test circuit is shown in Fig. 1. *AB* is the rail under test, occupying a horizontal position raised about 1 ft. (30 cm.) above the ground on brick pillars. The rest of the rectangular loop *BCDEFA* was composed of straight copper conductors (wire or cable). The extensions *AF* and *BC* from the ends of the rail were made so as to enable the electro-magnetic field in the neighbourhood to be both more nearly uniform and more readily calculated. The circuit was erected in an alley between two brick buildings, remote from iron.

Sources of Alternating-current Supply.—For the frequency of 25 ∿, a General Electric three-phase 50 k.v.a. alternator six-pole 415 revs. per min. 230 volts 126 amperes was used. For the frequency of 60 ∿, a Mordey single-phase 40 k.v.a. alternator was used, with 9 poles and 9 pancake coils, for supplying about 135 amperes root mean square, at about 300 volts. The arrangement of circuits used is shown in Fig. 2. The transformer *T* was a General Electric Co.'s 15 k.v.a. 60 ∿ single-phase transformer from 220 to 18 volts. The secondary terminals were connected directly to the test circuit through two four-terminal manganin resistors, and the primary terminals to the generator through an adjustable rheostat having very little inductance. At the frequency of 25 ∿, and maximum rail current, the primary voltage impressed on the transformer was about 230 volts, with 130 amperes, or 29·9 k.v.a. with 12·5 kw. At the frequency of 60 ∿, the corresponding primary voltage on the transformer was about 330 volts, with 125 amperes. Occasionally, tests were also made at 60 ∿, with currents from the shop mains, supplied by a General Electric Co.'s 14-pole 100 k.v.a. three-phase alternator.

The wave-form of voltage and current supplied from the Mordey generator was nearly sinusoidal. The wave-form of 25 ∿ voltage, from the 50 k.v.a. generator, showed appreciable harmonics; while the wave-form of its current showed only a moderate triple-frequency harmonic. The wave-form of 60 ∿ voltage and current from the shop mains had yet more marked harmonics.

Method of Measurement.—Since no exact theory of skin effect in steel rails has yet been worked out, it was very desirable to apply more than one method of measurement, in order to secure a satisfactory experimental check upon the results.

The following were the four methods tried:—

Method 1.—By astatic electrodynamometer of fixed and moving coils, measurements were made of rail R.M.S. voltage and of rail R.M.S. current, as well as the active power expended in the rail. By an astatic dynamometer is meant one whose moving system comprises two oppositely wound coils, so arranged as to be substantially unaffected by local stray magnetic fields, either alternating or continuous. Denoting the fixed coils by *F* and the moving coils by *M*, the voltage across the rail potential points was measured with *F* and *M* in parallel, *M* having a suitable non-inductive resistance in its branch. The circuit current was measured by observing the voltage across the manganin strip potential points in a similar manner. The active power in the rail was measured by connecting *F* to the manganin strip, and *M* to the rail potential points, through a suitable non-inductive resistance. The dynamometer was calibrated by

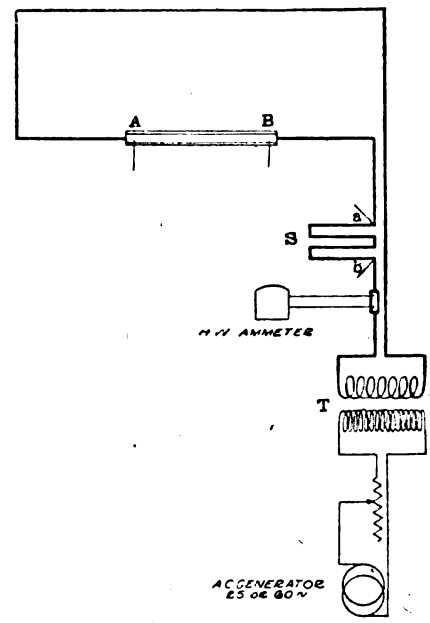


FIG. 2.—GENERAL TESTING CONNECTIONS FROM GENERATOR.

known continuous current passing through both coils. This method was found to be unsatisfactory. Not only does the impedance of both *F* and *M* vary to the harmonics in the traversing currents, but the mutual inductance between *F* and *M* also comes into consideration, and this varies with the deflection and angular position of M with respect to *F*.

Method 2.—Oscillographic measurements were made of both the voltage between rail potential points—hereafter called the

* Abstract of an article in the "Journal" of the Franklin Institute.

Digitized by Google

"rail voltage"—and the current in the rail circuit. From two such curves it is theoretically possible to compute the impedance of the rail, and, therefore, its skin effect, when its resistance to continuous currents is known. This method, although useful and convenient as a check, was found to be unsatisfactory in detail, owing to lack of precision in the oscillograms, and also to variations in the constants of the oscillographic vibrators.

Method 3.—The Drysdale-Tinsley alternating-current potentiometer was used at the frequency of 60~, measuring alternately the vector voltage across the rail and the manganin shunt. The ratio of these two measurements gives the vector impedance of the rail between potential points. This method has the advantage that, since the vibration-galvanometer of the detector circuit is tuned to the fundamental frequency, the harmonics in either voltage or current are virtually excluded, and also that computation of results is reduced to a minimum.

A disadvantage of the alternating-current potentiometer method is its sensitiveness to slight changes of frequency, in the vibration galvanometer and in the phase-splitting device. Under shop conditions of generator driving, it is often hard to keep the frequency constant within satisfactory limits.

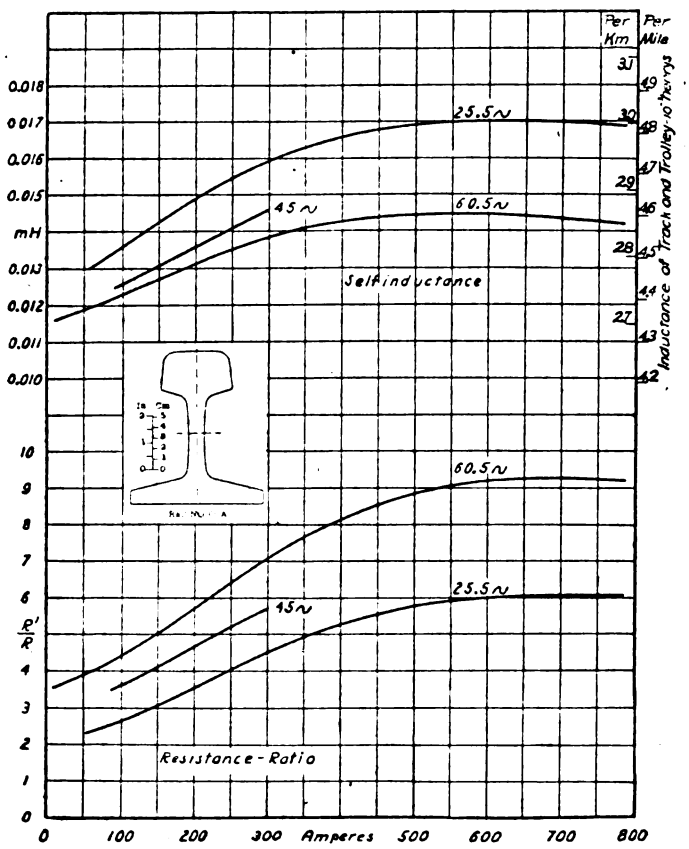


FIG. 3.—CURVES OF RESISTANCE-RATIO AND SELF-INDUCTANCE RAIL No. 96 A.

Method 4.—The Sumpner dynamometer was used to measure the current I amperes in the rail, and also to measure both active and reactive components of the rail voltage, which may be called E_R and E_x volts respectively. Then the effective resistance of the rail is $R' = E_R/I$ ohms, while the effective inductance is $L' = E_x/(\omega I)$ henrys.

In all four of the above methods, the P.D. on the tested rail was taken from two potential taps near the ends, and 30 ft. (914 cm.) apart. Only two methods—viz., numbers 3 and 4—were found to give uniformly consistent results. Tests made of the impedance of a rail by these two methods—*i.e.*, by Drysdale potentiometer and by Sumpner dynamometer—were found not to differ by more than 3 per cent. within the entire range, including discrepancies attributable to temperature variations, and they usually agreed within 1 per cent. Check tests were also made by both methods on the impedance of copper-rod and copper-strand conductors in place of the steel rail, with satisfactory agreement between them. The Sumpner dynamometer method was finally selected as the best adapted to the local testing conditions, reserving the alternating-current potentiometer for occasional checks.

The Manganin Strip.—In order to supply a working P.D. in phase with the rail current, a manganin resistance strip was employed in the rail circuit, marked S in Fig. 3, and provided with two pairs of potential terminals, one across 2,788 microhms, and the other across 933 of these microhms. This strip is made of two separate parallel plates of magnanin 58·3 cm. (23 in.) long, 10·2 cm. (4 in.) broad and 1·3 mm. (0·05 in.) thick, separated by mica insulation 1 mm. (0·04 in.) thick; so that the resistor is in the form of a very flat loop with the going and return conductors separated only by a sheet of mica. This strip was supported horizontally in a bath of oil, to keep it cool, when carrying currents above 400 amperes.

Direct-current Resistance Measurements.—In order to determine the skin-effect resistance ratio, it was necessary to measure the direct-current resistance of each rail at various times during a series of observations, and also the temperature coefficient of the rail's resistivity. This was done by direct-current potentiometer measurements in the usual way.

Temperature Measurements of the Rails.—The temperature of the rail was observed by thermometer, both before and after the measurement of impedance, at each current-strength in a test series. The thermometer was laid upon the rail, and had its bulb protected with a pad of putty. The rail currents above 100 amperes appreciably affected the temperature of the rail. Rail currents of about 750 amperes, during the time of application necessary for the measurements, sometimes raised the rail temperatures to 20°C. above that of the surrounding air.

Method of Connecting the Main Leads to the Ends of the Rail.—The rail ends had a hole of about 2 cm. ($\frac{3}{4}$ in.) diameter about 7·5 cm. (3 in.) from the ends. The web of the rail was scraped and cleaned near these holes, and copper lugs clamped firmly against the web by steel bolts passing through the holes. The contact resistance at these junctions was sufficiently low to prevent the junctions from getting unduly hot.

Situation of Potential Leads with Respect to Rail Circuit.—In measuring, by potentiometer, the direct-current P.D. between a pair of terminals on a rail, the disposition of the potential leads with respect to the rail circuit is of no material consequence, assuming that proper insulation is maintained. In measuring alternating-current P.D.s, however, the disposition of the potential leads with respect to the rail circuit becomes of great importance, since the mutual inductance between these circuits will cause an induced E.M.F. to be developed in the potential circuit over and above that due to the vector IZ drop sought, where I is the current and Z the rail impedance. By placing the potential leads in the form of a rectangle of suitably proportioned sides, the mutual inductance correction was rendered definite and susceptible of computation, and can, by trial, be made small.

Corrections for Temperature.—As has already been mentioned, the temperature of the rails tested was appreciably raised when the rail current exceeded 100 amperes, and even with short applications of 750 amperes the rail temperature was frequently raised 20°C. The resistivity temperature coefficient of the steel forming the rail was in each case measured by taking a series of continuous-current rail-resistance measurements, by potentiometer, at different observed temperatures. The mean values of the temperature coefficient so obtained range from 0·00265 in the harder steels to 0·00474 in the soft, higher-conductivity steel of the contact rails. In order to be strictly comparative, the measurements should all be taken with the rails at one and the same temperature of reference, since the skin effect varies appreciably with the resistivity. Since, however, it was not practicable to keep the rails at such a reference temperature, either on different days or with different current-strengths on the same day, the observed rail resistances R' have all been reduced to the reference temperature of 20°C. by means of the ordinarily used formula:—

$$R'_{20} = R'_T / \{1 + a_{20}(T - 20)\} \text{ ohms} \quad (1)$$

where T was the rail temperature in degrees Centigrade at the time of the test, and a_{20} the resistivity temperature coefficient as found for this reference temperature.

Discussion of Results.—Typical results of observations are presented in Figs. 3 and 4. The abscissas are in R.M.S. amperes flowing through the rail under test. There are two sets of ordinates. The lower set is in each figure the skin-effect resistance ratio R'/R; or the ratio of the apparent resistance of the rail in the presence of skin effect (reduced to 20°C.) to the resistance which it offers to continuous current from a storage battery at 20°C. The upper set of ordinates gives the inductance of the rail between contact points (914 cm.) in millihenrys, as referred to infinite flux radius. The total linear inductance of the rail L_1' is obtainable from these values by dividing with 914.

Digitized by Google

It will be seen that the skin-effect resistance ratio R'/R commences with feeble rail current, at a relatively low value, increases when the current is increased, and in nearly all cases reaches a maximum value within the limits of 800 R.M.S. amperes. Similar remarks apply to the rail inductance L_1'. The skin-effect resistance ratio is greater at 60 ∿ than at 25 ∿, as might be expected; whereas the rail inductance L_1' is greater at 25 ∿ than at 60 ∿, although the rail reactance $L_1'\omega$ would always be greater at 60 ∿ than at 25 ∿.

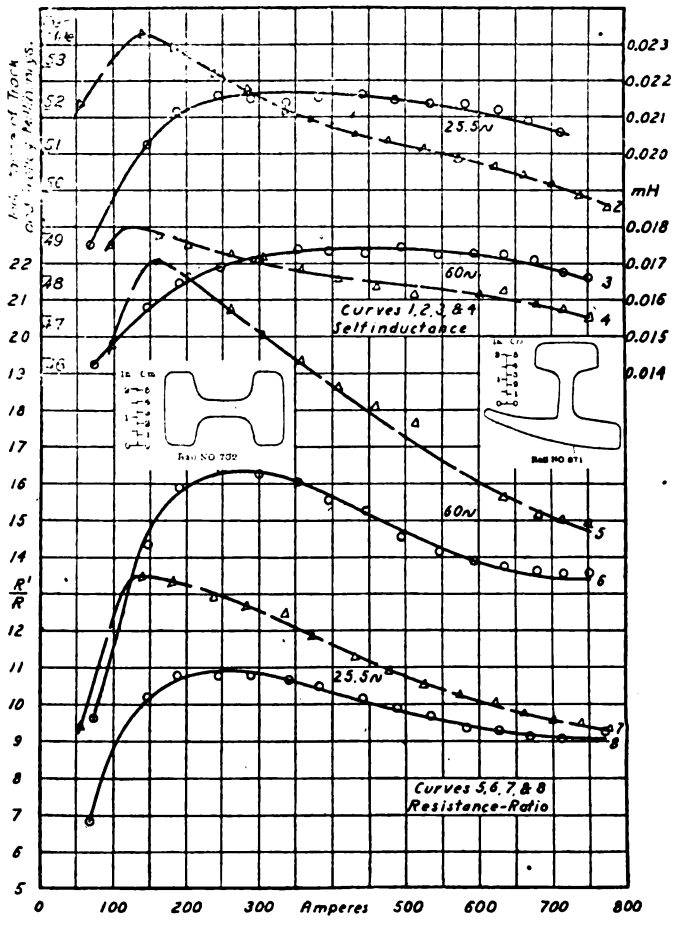


FIG. 4.—CURVES OF RESISTANCE-RATIO AND SELF-INDUCTANCE. RAIL No. 702-0———0-. RAIL No. 871-Δ— —Δ—.

The rise of skin-effect resistance to a maximum at a certain value of the rail current, is attributable to the variable permeability of the steel, which reaches a maximum at a certain value of the magnetising force H, depending on the magnetic quality of the steel, the effective skin penetration depth being changed accordingly. This phenomenon of a maximum impedance in steel prisms to a particular current-strength has been known experimentally at least as far back as 1893.

Fig. 4 shows the resistance ratios and inductances of two soft steel contact rails. The resistance ratio of No. 871 rises to 22—*i.e.*, that its alternating-current linear resistance at 60 ∿ is 22 times its direct-current resistance at the same temperature (20°C.). At 25·5 ∿, the resistance ratio of this rail is 13·5. Not only are these resistance ratios relatively large, but they occur at relatively small rail currents (150 R.M.S. amperes) and corresponding values of H at the perimeter (3 gilberts/cm.). This is attributable to the relatively large values of conductivity (7×10^{-5} abmho/cm.) and permeability (2,500 gausses per gilbert/cm.). The equivalent penetration depth of the alternating current at this maximum permeability and at 25·5 ∿ is only 0·076 cm.; so that very little of the steel is utilised electrically.

On the upper right hand of each figure is the computed scale of linear inductance (calculated) of the trolley wire and one track. The linear inductance of the system exceeds in one case 5 millihenrys per mile.

Fig. 5 shows the total alternating-current resistance R' in 30 ft. (914 cm.) of each of the track rails at 25·5 ∿ to the scale of microhms ordinates. The scale is also repeated in ohms per mile and ohms per kilometre of a track of two rails in parallel, assuming perfect bonding but no copper reinforcement, also negligible leakance to ground. Rail No. 161 has a higher linear resistance than any of the others, in spite of the fact that its conductivity is relatively high. The high alternating-current resistance is attributable to a small equivalent penetration depth ($\delta=0{\cdot}107$ cm. at 25·5 ∿), which in turn is due to the large product of γ the conductivity and μ the permeability. To direct currents, this rail would offer the lowest resistance among all the track rails tested.

It can be shown that the resistance-ratio R'/R for a rail can be deduced from the measured direct-current values of its conductivity γ and permeability μ for any assigned frequency, subject to a certain range of inaccuracy due to errors of permeability and shape, the actual effective alternating-current permeability differing to some extent from that observed by direct-current permeameter, and the shape of the rail involving edge effects owing to departure from a simple cylinder. The permeability and shape correction factors which must be applied to the computed values of R'/R, in order to arrive at the actual values, are at present beyond direct calculation, but may be estimated from experimental observations.

Fig. 6 shows some curves of observed and computed resistance ratios for low-permeability track rails 175 and 100, at 60 ∿ and 25 ∿ Here the maximum values are not exceeded at the maximum current of 800 amperes, and the correction factor is appreciably over 1·0 throughout. Thus, on rail 175, at 60∿, this factor is 1·23 at 100 amperes, and attains 1·47 at 350 amperes. At 25 ∿, the maximum value of the correction factor is 1·45 at 350 amperes.

Technic Recommended for Predetermining Rail Resistance Ratios.—According to the results here reported, it is sufficient for the determination of the maximum skin-effect resistance ratio R'/R in a steel rail to measure the values of γ and μ in a sample rod of the same material, which gives the computed value of R'/R for a given frequency and series of alternating-current rail-current strengths, assuming that the measured direct-current permeabilities do not appreciably differ from the actual effective alternating-current permeabilities at these currents, including the effects of hysteresis, and also that the rail has a simple circular or cylindrical cross-section. In order, then, to correct for the errors of permeability and shape, a correction factor should be applied to the computed ratio. This correction factor appears in the results here reported to have varied in track rails, at maximum permeability, from 1·2 to 1·3. It is

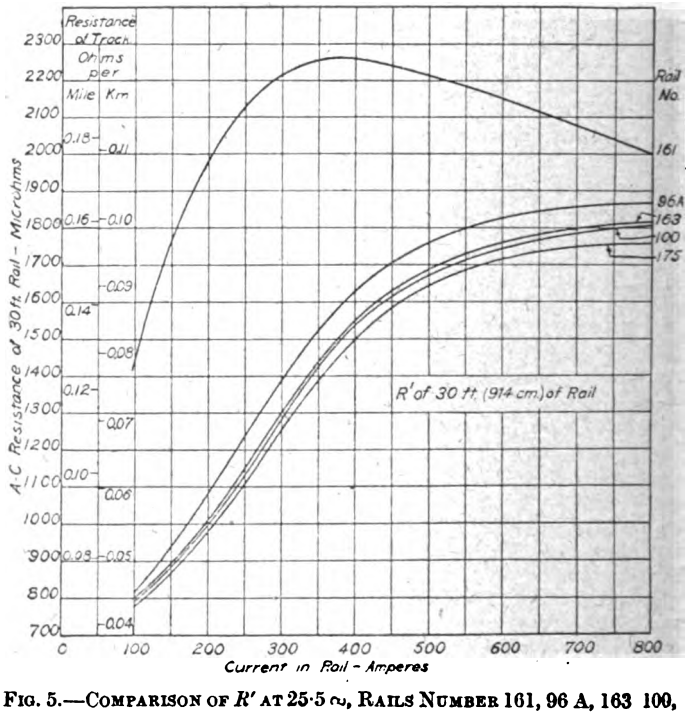

Resistance of Track Ohms per Mile Km
Rail No.
161
96A
163
100
175
R' of 30 ft (914 cm.) of Rail
A.C. Resistance of 30 ft. Rail - Microhms
Current in Rail - Amperes
0 100 200 300 400 500 600 700 800

FIG. 5.—COMPARISON OF R' AT 25·5 ∿, RAILS NUMBER 161, 96 A, 163 100, AND 175.

probably advisable to use the latter value for security. In other words, the computed value of R'/R should be increased by 30 per cent. for the unknown permeability and shape errors. The result may then be taken as the maximum skin-effect resistance ratio of the rail, at the temperature and frequency considered. At all other rail currents, the resistance-ratio and the resistance per kilometre will be less, at constant rail temperature.

Digitized by Google

Best Shape of Rail Section for Conducting Purposes.—In steel track rails, mechanical considerations are necessarily paramount for determining the shape of the cross-section. For conducting rails, however, where the stresses to be supported are much smaller, consideration may well be given to the best form of cross-section for conducting purposes. Provided there is sufficient depth beneath the surface in which the electric and magnetic fluxes can deploy—say, 4δ for a single surface of slab, or 8δ between opposite surfaces of a strap—the effective alternating-current conductance, in the presence of skin effect, depends upon the ratio P/S, or the perimeter per square centimetre of cross-section. This would point to the use of a flat strap as the best type of conductor. The edge effect in such a strap, however, militates against its use, to say nothing of its clumsiness and oxidizability. For these reasons it is preferable to employ

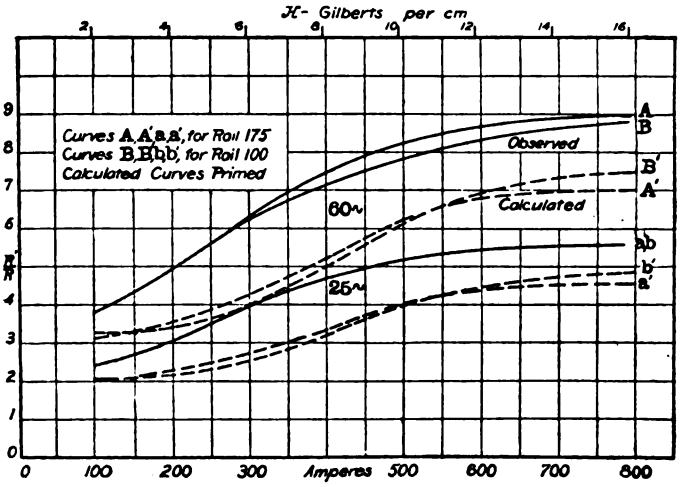


FIG. 6.—CURVES OF RESISTANCE-RATIO CALCULATED FROM INFINITE STRIP FORMULA AND DIRECT-CURRENT VALUES OF PERMEABILITY.

a steel tube or hollow cylinder. In practice, in order to improve the mechanical brush-contact surface, the tube should be flattened, at least on the contact side, and sharp edges in the contour avoided. If the section is simply tubular, of thickness exceeding 4δ cm., the interior surface of the tube is prevented from carrying any appreciable alternating current. By slitting the tube, however, or by rolling a plate into the form of a nearly closed box beam, 8δ or more in wall thickness, both the internal and external surfaces of the hollow conductor become available.

To test this plan, a steel tube was employed 150 cm. long and of the cross-section shown in Fig. 7. The resistance ratio of this tube was found to be 7·66, for 60∿ at 53 amperes R.M.S.* When a thin, longitudinal slit (1·19 mm. wide) was milled along this tube, the resistance ratio fell to 5·26, with the maximum at about 90 amperes. When the slot was widened to 3·18 mm., the ratio was observed to fall to 5·04 at 80 amperes. When the tube was cut in half, by making an opposite longitudinal slot, the value fell to 4·46 at 48 amperes. The values of current at which the maxima are obtained correspond very fairly with the reciprocals of the effective perimeters in each case. Inserting the slot did not double the effective alternating-current conductance, but did increase it in the ratio of $7·66/5·04 = 1·52$, the discrepancy being presumably attributable to magnetic leagake near or across the slit. It would appear, therefore, that the two half tubes, connected in parallel, would be a better joint conductor than the slotted tube, and would exceed the conductance of the unslotted tube in the ratio $7·66/4·46 = 1·72$.

It is hoped to investigate further this question of most economical conducting cross-section.

It should be pointed out that for a given shape of cross-section the effective alternating-current conductance of a rail depends upon both γ and μ, and not merely on one of these quantities. An increase in permeability may more than offset the advantage of an increase in conductivity γ. An ideal steel would have a very high conductivity associated with a very low permeability.

SUMMARY OF CONCLUSIONS.

Finally, the chief conclusion arrived at in the investigation may be summarised as follows:—

1. The maximum observed skin-effect resistance ratio among 10 track rails, at 25∿, varied between 5·35 and 10·1, and in two contact rails between 10·92 and 13·4.

2. The maximum observed skin-effect resistance ratio was found to vary substantially as the square root of the impressed frequency between the limits of 25∿ and 60∿.

3. The effective skin depth of alternating-current penetration, at 25∿, among all the 12 rails tested, varied between 0·76 mm. and 1·8 mm.

4. The values of the mean superficial R.M.S. magnetic intensity H at which the maximum skin effect developed, were between the limits of 3·3 and 16·4 gilberts per centimetre. These were but little influenced by frequency, and were in good agreement with the values of H for maximum μ, as obtained by direct-current permeameter.

5. The best workshop method of measuring the skin effect in track rails was, in this case, found to be based on the use of a particular form of dynamometer.

6. The effective alternating-current conductance of a rail is, to a first approximation, inversely as the square root of the frequency, and, at a given frequency, is directly proportional to the perimeter, and to the square root of the ratio γ/μ.

7. It is, therefore, in general, useless to increase the conductivity γ of the steel in a rail if the permeability μ is thereby increased in the same or a greater ratio.

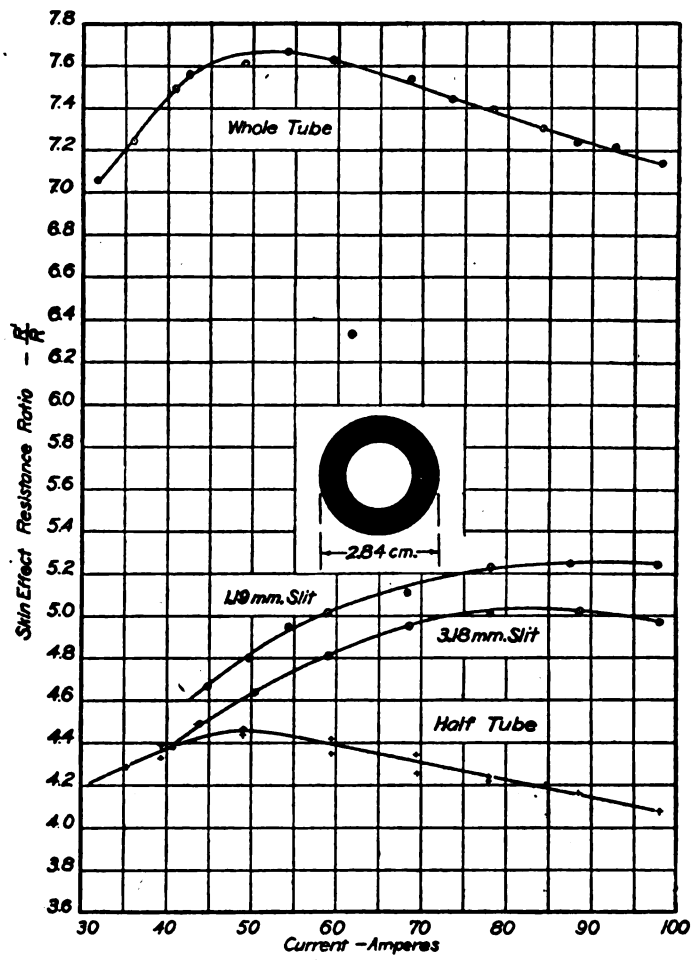


FIG. 7.—SKIN EFFECT RESISTANCE-RATIO FOR STEEL TUBE AT 60∿. OUTSIDE DIAMETER, 2·84 CM.—6·35 MM. WALL.

8. From the results here reported, it would seem that the skin-effect resistance ratio of a rail, to a given alternating-current frequency and current-strength, can be approximately predetermined from measurements of the conductivity γ and permeability μ of the steel, by applying an experimentally determined factor to cover edge effect and other discrepancies. This factor, which may be called the "edge-effect coefficient," appeared to be not more than 1·3 at the maximum skin-effect ratio.

9. The best form of rail for current-carrying capacity should be one in which the effective perimeter is a maximum while allowing sufficient depth of surface. Among the worst forms are probably a thick solid prism and a cylinder. A hollow cylinder may be greatly improved by slitting it, so as to admit current to its interior surface.

* The resistance ratio computed by formula from a sample rod of this steel, had a maximum at 53 amperes of only 6·45, representing a correction factor of 1·18 for hysteresis and permeability alone.

Digitized by Google

NOTES ON THE DESIGN OF ELECTROMAGNETIC MACHINES.*

2. ALTERNATING-CURRENT GENERATORS.

BY STANLEY PARKER SMITH, D.SC.

(*Continued from page* 660.)

2. ARMATURE WINDINGS FOR THREE-PHASE SYNCHRONOUS MACHINES.

Practically all types of single- and double-layer windings are useful for three-phase armatures. When there are only a few conductors per slot, say, 2, 4, 6 or 8, a two-layer winding with lap or wave connections is often employed, and since the coils have not to form a closed winding, as in a commutator machine, there is no need for such windings to obey the closing rules for lap and wave windings for continuous-current machines. Nevertheless, the common wave winding is a very popular winding among many makers for low-tension, three-phase armatures. In double-layer windings all the coils have usually the same span and are made on the same former. In single-layer windings the coils may either have a constant span, as in the mush winding, or a variable span, as in the three-phase winding with the two- or three-plane overhang.

The double layer windings were illustrated in Figs. 4 & 5 in the article on continuous-current machines,† whilst examples of single-layer windings are shown in Figs. 3 to 5 in this article. In order to obtain the largest output from a winding it will be

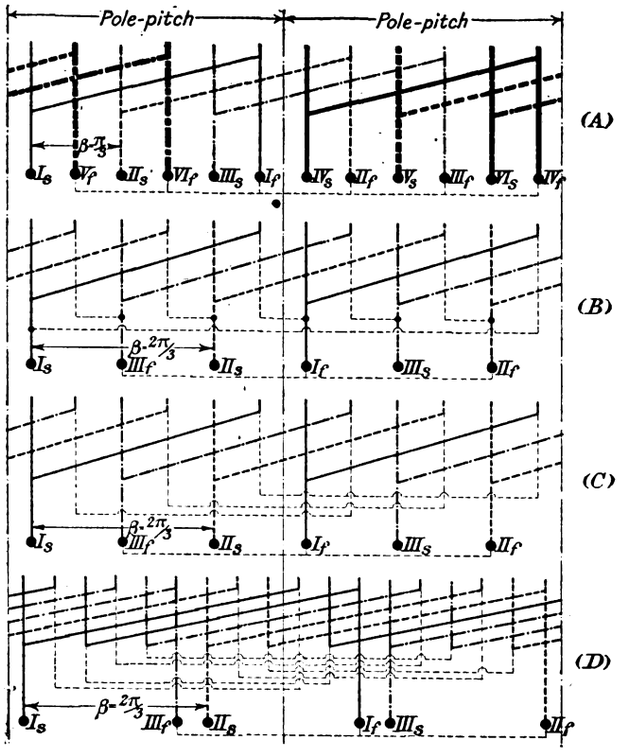


FIG. 3.—SINGLE-LAYER WINDINGS WITH CONSTANT-SPAN COILS.

(A) Six-phase winding—coil-span = five-sixths of pole-pitch.
(B) Three-phase winding, derived from (A) by joining opposite phases in parallel.
(C) Three-phase winding, derived from (A) by joining opposite phases in series.
(D) Three-phase winding—coil-span = pole-pitch.

shown in the next section that the coil-span should be as nearly equal to a pole-pitch as possible, whilst the phase-spread should be as small as possible. In the case of the three-phase winding, where three phases at 120° are required, the coil-sides of each phase can spread over 60° or 120° (electrical) of arc according to whether the double pole-pitch is divided into six or three parts. In the former case, the winding (or slotting) is really for a six-phase winding; but by connecting each pair of equal and opposite phases in series or parallel, as needed, a three-phase winding is obtained with the phase-spread one-half of that obtained when the double-pole pitch is divided only into three parts, as when three-phase tappings are taken off a closed commutator winding.

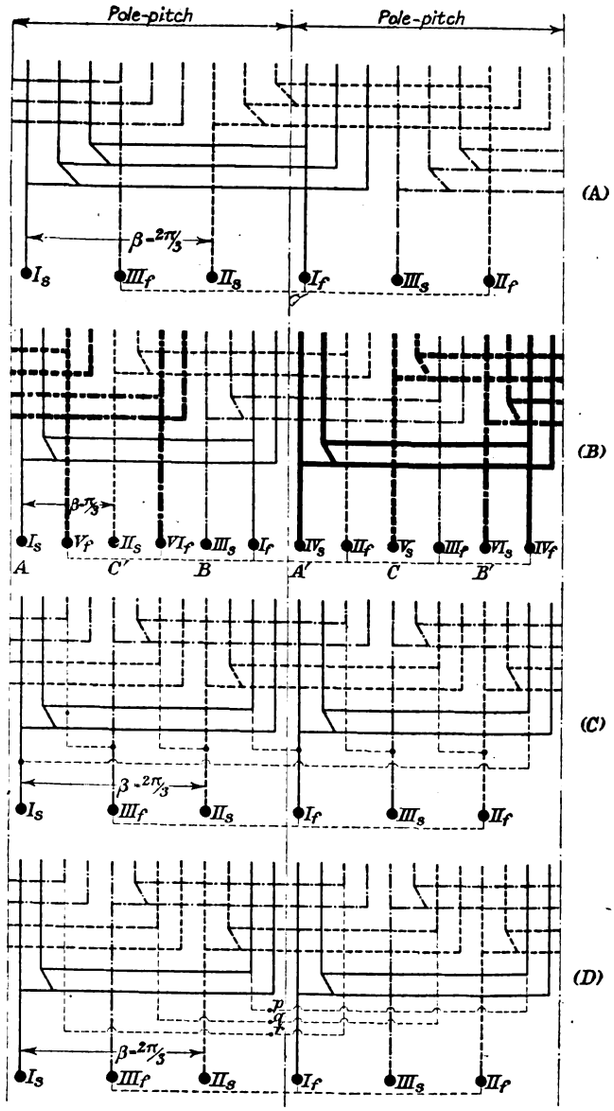


FIG. 4.—SINGLE-LAYER WINDING WITH VARIABLE-SPAN COILS.

(A) Three-phase winding with overhang in two planes.
(B) Six-phase winding with overhang in three planes.
(C) Three-phase winding, derived from (B) by joining opposite phases in parallel.
(D) Three-phase winding, derived from (B) by joining opposite phases in series.

Regarding the coil-span, it will be noticed that variable spans, as in Fig. 4, can be replaced by constant spans, as in Fig. 3, without affecting the position of the coil-sides in the slots. Further, Fig. 3 shows that for *three-phase* windings with a whole number of slots per pole the constant span is always equivalent to a full pole-pitch, though for the sake of convenience, the actual span may be made five-sixths of the pole-pitch when the number of slots per pole and phase is even, as seen in diagrams (B) and (C).

The arrangements shown in Fig. 4 may be said to be the standard forms of the three-phase single-layer winding, and it

* The first article of this series dealt with Continuous-current Machines and the first part appeared in THE ELECTRICIAN of June 2nd, 1916 (Vol. LXXVII., p. 250).

† "Electrician" Monograph No. 2.

Digitized by Google

is seen that the overhang can be accommodated in two or three planes at will. If the number of pole-pairs in the winding is odd the two-plane overhang leads to a difficulty, as seen in Fig. 4 (A), due to the fact that the two parts of the overhang of one phase are in different planes, necessitating a cross-over. This difficulty is not present when the number of pole-pairs is even. With the three-plane overhang, which is commonly employed in two-pole machines, we get a proper six-phase winding, as seen by comparing Figs. 4 (C) and (D) with Fig. 4 (B). An important advantage of this arrangement is the parallel connection of opposite phases of the six-phase system shown in Fig. 4 (C), giving a three-phase winding with as many circuits per phase as there are poles.

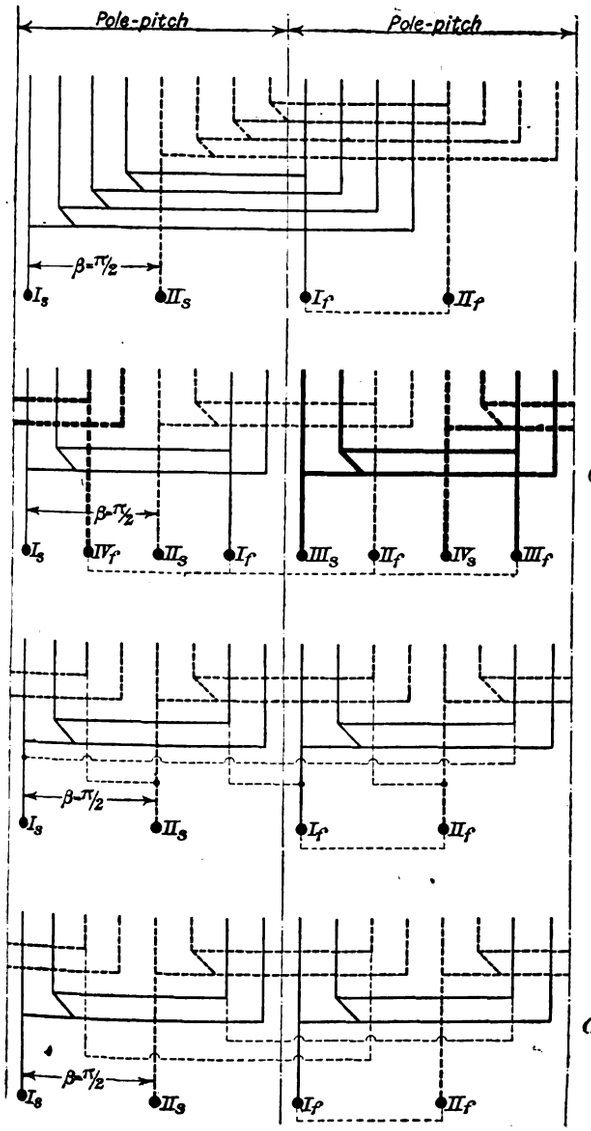


FIG. 5.—SINGLE-LAYER WINDINGS WITH VARIABLE-SPAN COILS.

(A) Two-phase winding.
(B) Four-phase winding.
(C) Two-phase winding, derived from (B) by joining opposite phases in parallel.
(D) Two-phase winding, derived from (B) by joining opposite phases in series.

A corresponding set of diagrams for a two-phase winding (two-phases at 90°) is shown in Fig. 5. Here diagram (A) corresponds with diagram (A) in Fig. 4; whilst the two-phase windings in diagrams (C) and (D) are derived from the four-phase winding in diagram (B) in the same way as diagrams (C) and (D) in Fig. 4 are derived from the six-phase winding in diagram (B). In passing it may be mentioned that the arrangement of the overhang shown in diagrams (C) and (D) in Figs. 4 and 5 for two and three-phase windings is often referred to as a *split-phase* overhang.

In many cases where a 6-phase rotary converter is fed directly off an alternator, it is necessary to obtain a balance for the three-wire system of the continuous-current supply. For this purpose, the 6-phase winding in Fig. 4 (B) can be used, the star point being connected to the mid-wire. The same result is obtained by connecting the points p, q and r in Fig. 4 (D) to the mid-wire and removing the star connection I_f, II_f, III_f. Though with this arrangement the third harmonic can flow in the phases, as in a 3-phase winding, it is seen that the wire connected to the star point does not provide a path for harmonics whose order is a multiple of 3, because at any instant these harmonics in phases *I*, *III* and *V*, with respect to the star point, are equal and opposite to these harmonics in phases *II*, *IV* and *VI*.

Number of Poles in a Three-phase Winding.—To obtain a symmetrical three-phase pressure, *i.e.*, three equal pressures at 120°, the three phases must be alike and displaced from one another by $2\pi/3$ electrical radians, or 120 electrical degrees. Since each pole-pair represents 2π electrical radians it is possible to find the correct positions $0, 2\pi/3$ and $4\pi/3$ in each pole-pair, provided the correct slot positions are available. In the case of a machine with p pole-pairs having the correct slot positions in each pole-pair, there are merely p bipolar windings all alike, which can be joined in parallel or series, as desired. This is the common way of building alternators, but we shall see presently that it is not the best design for the series connection, which is mostly needed.

Provided the proper phase positions are obtained with respect to the poles and slots, there is no need to have all pole-pairs alike. For example, if we wish to have a winding in which the same slot positions never recur in p' pole-pairs, where p' lies in the range of 1 to p, then so far as the poles are concerned, it is clear that the proper phase displacements between phases will be obtained provided $p'2\pi/3 = \pm 2\pi/3$. Leaving the slots for the moment, we find this is always possible when $p' = 3n \pm 1$, where $n = 0, 1, 2, 3$, &c., for then we get

$$p'\frac{2\pi}{3} = (3n \pm 1)\frac{2\pi}{3} = \pm\frac{2\pi}{3}.$$

Consequently, it is possible to have a three-phase winding where the same positions in the field never recur, with the following numbers of pole-pairs :—

$$p' = 3n \pm 1 = 1, 2, 4, 5, 7, 8, 10, 11, 13, 14, 16, \text{ &c.}$$

It is not possible, however, to obtain a single three-phase winding in any number of pole-pairs that is a multiple of 3.

For example, in a four-pole machine we can make $p' = 2$, for we then obtain the correct phase positions $0, 2\times 2\pi/3 = 4\pi/3$ and $2\times 4\pi/3 = 2\pi/3$. If we tried to make $p' = 3$, however, we should get for the phase positions $0, 3\times 2\pi/3 = 0$ and $3\times 4\pi/3 = 0$, which are obviously wrong.

Let the total number of pole-pairs in the machine $p = p'a$, where $a = 1, 2, 3$, &c., then a will represent the possible number of *similar* three-phase windings on the machine. Thus $a = p/p' = p/(3n \pm 1)$, and must lie in the range from 1 to p.

From the above argument it will be clear that if $p = 3n \pm 1$, we can have $p' = p$ and $a = 1$; whereas if p is a multiple of 3, we must make a a multiple of 3 such that $p' = p/a = 3n \pm 1$.

Example 1.—In an eight-pole machine, $p = 4$, we have the following alternatives :—

$a = 1$, for then $p' = 4/1 = 4$,
$a = 2$, „ „ $p' = 4/2 = 2$,
$a = 4$, „ „ $p' = 4/4 = 1$.

Usually such an armature is wound with $a = p = 4$, but it is just as easy to make $a = 2$ or 1, and so halve the number of repetitions or suppress them altogether—a matter of great importance when it is desired to avoid tooth effects in the pressure wave.

Example 2.—If $p = 3$ (six-pole machine) it is only possible to make $a = 3$, for this is the only value that makes $p' = p/a = 3n \pm 1$. Thus to get a three-phase pressure from a six-pole machine the winding must consist of three like parts and the slotting will be the same in every pole-pair (see later). In a 12-pole machine ($p = 6$) we can make $a = 3$ or 6, because both of these values make $p' = p/a = 3n \pm 1$.

Partly through convenience, and partly through ignorance, it has been customary to build alternators with $a = p$ (or $p' = 1$), but it is not unlikely that future requirements will make a radical departure from this practice essential when parallel circuits are not needed.

Digitized by Google

Number of Slots in Three-phase Windings.—We must now see under what conditions the slot positions will not recur in p' pole-pairs, and secondly what numbers of slots are suitable for three-phase windings.

Let S' denote the number of slot-pitches in $2p'$ pole-pitches (or in p' pole-pairs), then clearly S' and p' must have no common factor greater than unity, if the slot positions in the field are not to recur. For example, if there are 63 or 66 slots in 5 pole-pairs, it is seen that the slots do not occupy the same position with respect to any two pole-pairs. Thus in this case $p'=5$ and $S'=63$ or 66, whilst the common factor of 63 or 66 and 5 is unity. On the other hand, with 60 slots in 5 pole-pairs—a common arrangement—the C.F. of S and p is 5, and there are 12 slots per pole-pair; consequently $p'=1$ and $S'=12$, so that there can be five similar three-phase windings. Or again, if there are 36 slots in a four-pole machine, $S'=18$ and $p'=1$, since the H.C.F. of S and p is 2, so that there can be two similar three-phase windings; whereas if there are 39 slots, then $S'=39$ and $p'=2$, since the H.C.F. of S and p is 1, so that it is only possible to have one three-phase winding in this case.

We see, therefore, that the H.C.F. of the total number of slots S and the total number of pole-pairs p in the machine determines the number of similar windings it is possible to have on the armature. We have already defined $a=p/p'$ or $p'=p/a$, so that we now have in addition $a=S/S'$ or $S'=S/a$, where a is the H.C.F. of S and p.

Coming now to the possible numbers of slots to give three equal phases, it is clear that the S' slots in each p' pole-pairs must be divisible into three equal parts, *i.e.*, $S'/3$ must be a whole number. When $S'/3$=integer, moreover, successive phases are exactly $S'/3$ slot-pitches apart, which is needed for correct spacing—for $\frac{S'}{3}\times$angular slot-pitch$=\frac{S'}{3}\times\frac{p'2\pi}{S'}=p'\frac{2\pi}{3}$ $=\pm\frac{2\pi}{3}$, since $p'=3n\pm1$, by assumption.

(i.) *Single-layer Windings.*—If there are q wound slots per pole and phase, there will be $2p'q$ wound slots per phase in p' pole-pairs. Since there may be extra or empty slots we can denote the number of slots per phase by $2p'q+n'$, where $n'=0, 1, 2, 3$, &c., then the total number of slots in p' pole-pairs in a three-phase winding will be $3(2p'q+n')$—that is to say, $S'=6p'q+3n'$. We must now see how the value of a depends on the value of n'.

When $n'=0$, there will be simply $6q$ slots per pole-pair and every pole-pair will be alike. Thus $S'=6q$ and $p'=1$, so that $a=p$ and $S=S'p$. Thus a similar three-phase winding can be wound in each pole-pair whenever the number of slots in a pole-pair is divisible by six, and these $a=p$ similar windings can be joined in parallel or series as desired. With this arrangement, however, the tooth effects (see next section) will be repeated throughout the phase, with either series or parallel connection, so that this winding, though commonly used, is unsuitable wherever it is desired to suppress ripples in the pressure waves. It is quite simple to suppress ripples with the series connection by using extra slots (see below), but with the parallel connection, all the paths must be alike, so that some other expedient may have to be used, such as skewing the slots or pole-shoes. A further extension for the parallel connection is possible when q is even, for then S' is a multiple of 12 and the slotting is suitable for a six-phase winding. This enables us to get a three-phase winding with as many circuits as there are poles by merely joining equal and opposite phases of the six-phase winding in parallel—a very useful arrangement for low-voltage turbo-alternators—cp. Fig. 4 (C).

If $n'=1$, there will be $S'=6p'q+3$ slots in p' pole-pairs. Since $p'=3n\pm1$, S' and p' cannot have a C.F. greater than unity in this case. This is a very useful and simple way of preventing repetitions, for we have only to choose $p'=p/a=3n\pm1$ and add three empty slots in each p' pole-pairs. In cases where $p=3n\pm1$ we can, of course, make $p'=p$, and so only add three empty slots at 120° in the circumference.

If $n'=2$ and p' is odd, then $S'=6p'q+6$, because this even number can have no C.F. greater than unity with $p'(=3n\pm1)$, when the latter is odd. This may be more convenient for manufacture in some cases than three extra slots. This does not hold, however, for an even number of pole-pairs, because there is then a C.F. greater than unity with the number of slots.

Example 1.—Consider a 10-pole machine with two slots per pole and phase. For the three phases there will then be $3\times2\times10=60$ slots. Here $p=3\times2-1=5$, so that we can make $p'=p$.

If we make $n'=1$, *i.e.*, add three slots at 120°, there will be $S=60+3=63$ slots in all, and we have $S'=S=63$ and $p'=p=5$, since the H.C.F of 63 and 5 is unity.

Or, again, if we make $n'=2$, *i.e.*, $S=60+3\times2=66$, we still get $S'=S$ and $p'=p$, for 66 and 5 have no C.F. greater than unity. This is due to the fact that p is odd and not divisible by 3. In each case it is seen that slots $S'/3$ pitches apart are at 120 electrical degrees.

Example 2.—In an 8-pole machine with two slots per pole and phase there will be 48 wound slots. If we add three extra slots, then $S'=S=51$ and $p'=p=4$. If, however, we add six extra slots, then $S=54$ and $p=4$ have a C.F. of 2, so that $S'=S/2=27$ and $p'=p/2=2$, and there will be $a=2$ similar parts per phase.

(ii.) *Double-layer Windings.*—These are not used so widely as single-layer windings for alternators, because the number of conductors per slot is usually too large. The double-layer arrangement, however, is of great service for three-phase windings when the number of conductors per slot does not exceed 8 or 10. In such cases it is quite common to employ wave connectors with a *whole* number of slots per pole and phase, instead of the single-layer arrangement. This type of wave winding is not one that could be used with a commutator where the coils must be joined up to form a closed winding.* For this reason it is necessary to lengthen or shorten the connector after each tour (of p coils) round the circumference, in order to reach the coil-side next to the one started from at the commencement of the tour. Beyond certain mechanical advantages, the wave winding with a whole number of slots per pole is not superior to the single-layer winding with the same number of slots, for the tooth effects in the pressure-wave are not affected by the type of winding used in the slots. This same restriction applies to the use of lap windings for alternators when a whole number of slots per pole is used, and a preferable arrangement is to employ an odd number of slots per pole-pair (as shown later).

From the point of view of flexibility and suppression of tooth effects it is better to use a proper wave winding, as for a commutator machine, opening it in six places to obtain a phase-spread of 60°, as in a single-layer winding. The flexibility gained by the use of a common wave winding arises from the fact that a fractional number of slots per pole and phase can be used, *e.g.*, 2·7 or 3·5 slots per pole and phase are quite feasible, thereby giving the designer much more freedom in his work. The suppression of tooth effects is due to the fractional number of slots per pole, which prevents the slot positions in the field recurring in every pole pair.

Lap Windings.—These are not much used for three-phase windings unless parallel circuits are needed; for to join the several paths in series necessitates a set of cross connectors in every pole-pair. When parallel circuits are desired it is well if possible to make the number of slots per pole-pair an odd multiple of 3, which enables us to get three phases at 120°, but suppresses the tooth effects in the coil E.M.F. (see coil-span factor). Such a winding should be opened in six places to reduce the phase-spread to 60°, but the two opposite parts of each phase can only be joined in series when the number of coils per phase is odd. Any even number of coil-sides per slot can be used with a lap winding.

Wave Windings.—It is not intended to discuss these in detail here, because commutator windings were fully discussed in the first article, whilst in a recent Paper† by the author, the method of opening wave windings for three-phase pressures was dealt with. For this reason, only the common wave winding, having $a=1$, in which the slot positions in the field

* The closing rule for a wave winding is:—commutator pitch $y_c=(C\pm a)/p$ coils or segments, where C=number of coils or segments in the winding.

† "The Theory of Armature Windings," J.I.E.E., Vol. 55, p. 18. An abstract of this Paper appeared in THE ELECTRICIAN, Vol. LXXIX., p. 258.

Digitized by Google

Table I.

Permissible numbers of slots and coil-sides per slot in symmetrical 3-phase wave windings in which the slot positions in the field never recur.

Number of poles in machine.	Number of coil-sides per slot (up to 12).	Number of slots in *three-phase* winding.	Number of slots in *six-phase* winding.
2	2, 4, 6, 8, 10, 12	$3n$	$6n$
4	2, 6, 10	$6n \pm 3$	——
8	2, 6, 10	$12n \pm 3$	——
10	2, 8, 12	$15n \pm 6$	$30n \pm 6$
	4, 6	$15n \pm 3$	$30n \pm 12$
14	2, 12	$21n \pm 6$	$42n \pm 6$
	6, 8	$21n \pm 9$	$42n \pm 12$
	4, 10	$21n \pm 3$	$42n \pm 18$
16	2	$24n \pm 9$	——
	6, 10	$24n \pm 3$	——
20	2	$30n \pm 9$	——
	6	$30n \pm 3$	——
22	2	$33n \pm 12$	$66n \pm 12$
	10, 12	$33n \pm 9$	$66n \pm 24$
	8	$33n \pm 3$	$66n \pm 30$
	6	$33n \pm 15$	$66n \pm 18$
	4	$33n \pm 6$	$66n \pm 6$

n=any whole number.

never recur, will be briefly discussed. Here again, the winding should be divided into six parts to reduce the phase-spread to 60°. In machines with 2, 10, 14 or 22 poles it is possible to obtain a symmetrical six-phase winding, so that the two parts of each phase of the three-phase winding are alike and can be joined in parallel or series, as desired. With 4, 8, 16 and 20 poles it is possible to get a symmetrical three-phase winding, but the two parts of each phase are unlike, and must not, therefore, be joined in parallel. It is not possible to get a symmetrical three-phase wave winding, suitable for connecting to a commutator, with 6, 12, 18 or 24 poles, so that to suppress the tooth effects in such machines we must make $a>1$ or resort to the devices used in single-layer windings (empty slots, etc.). Table I. is given (taken from the Paper referred to on p. 698) showing the number of slots and coil-sides per slot it is possible to have in a symmetrical three-phase winding in which the slot positions in the field never recur (*i.e.*, $a=1$). The commutator pitch for these windings is $y_c=(C \pm 1)/p$.

For wave windings with $a>1$, which can sometimes be usefully employed as will be seen in Part II., the original Paper can be referred to, where numerous examples are worked out.

(*To be continued.*)

SIEMENS ROTARY CONVERTERS.

Types of Converting Plant.—There are at present on the market three principal types of converting plant—viz., the motor-generator, the motor-converter or La Cour converter, and the rotary converter. The question as to which of these three types should be chosen for any particular set of conditions depends very largely on circumstances, such as the nature of the generated current, the nature of the supply, and the nature of the load.

Where single-phase has to be converted to direct current there is no question that the motor-generator is the most suitable type of plant, since a single-phase rotary converter is not only inefficient, but it is also somewhat expensive. Further, it involves considerable difficulties in operation.

For the conversion of three-phase current into direct current, however, the rotary converter is now pre-eminent. Its adoption on a large scale in this country was considerably delayed owing, principally, to the fact that the prevailing frequency of supply is 50 cycles. The greatest development of the rotary converter took place in America, where the prevailing frequency, up to some years ago, was 25 cycles, and rotary converters for 25 cycles offered no difficulties either in design or operation. The earlier rotary converters for 50 cycles, however, suffered from the fact that they were liable to commutation difficulties, to flash over under heavy overloads, and to general instability of working. These troubles were due to the following causes:—

Owing to the fact that the supply to the machines was at a frequency of 50, and that the machines at the time in question were designed for comparatively low speeds, the distance between the points of opposite potential on the direct-current brush gear was rather small. Further, the machines were not provided with commutation poles. The absence of commutation poles rendered the machine liable to sparking at the commutator under heavy overloads, and this sparking, in view of the short distance between brush-arms, generally gave rise to flashing over, resulting in damage to the machine, and usually rendering it necessary to shut down. These difficulties have now been overcome by the provision of commutation poles and by increase in speed, with the result that the rotary converter for 50 cycles or for 60 cycles is now not only as stable as any other type of converting machinery, but is considerably superior as regards efficiency and is much lower in price.

The comparison between the rating of a rotary converter with two, three, four and six slip-rings compared with that of the same size machine used as a direct-current generator is shown in Fig. 1, where the rating is plotted against the power factor.

Siemens rotary converters are made for the usual frequencies and for outputs from 50 kw. to 3,600 kw. There is also a line of special traction rotary converters for voltages on the direct-current side of 1,200 and 1,500 volts, for 25-cycle circuits. For frequencies higher than 25 where these high voltages are required on the direct-current side, it is usual either to employ a single rotary converter with two commutators in series, or more generally two standard 600 or 750 volt rotaries in series. Similarly in cases where supply at 2,400 or 3,000 volts is required on the direct-current side, two 1,200-volt or 1,500-volt rotaries may be used in series, if the frequency is 25 cycles. For 50 or 60-cycle circuits, motor-generators consisting of two generators in series, driven by one motor, are usually adopted when the direct-current voltage is above 1,200.

The temperature rise (which is 40°C. on full load as measured by a thermometer) as set out in quotations is always based on the

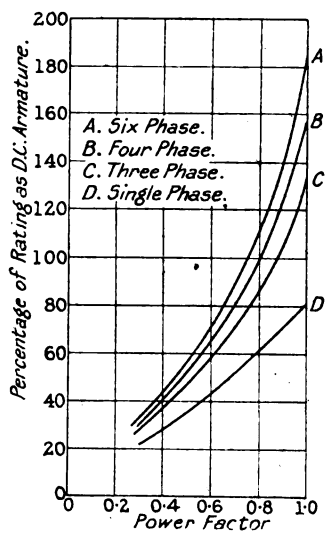


FIG. 1.—COMPARATIVE RATINGS OF SINGLE-, THREE-, FOUR- AND SIX-PHASE ROTARY CONVERTERS AT VARIOUS POWER FACTORS.

power factor at which the machine is designed to run, whether for converting alternating current to direct current or direct current to alternating current.

SOME MECHANICAL DETAILS.

Field Coils.—The field coils are wound on sheet metal bobbins thickly lined with insulating material. The compound and shunt windings are both wound on the same bobbin, so that the complete winding of one pole is self-contained. In cases where auxiliary windings either on the main or commutation poles are used, these are wound on independent bobbins and can be removed independently if necessary.

The ends of the conductors of the shunt coils are fixed to T-shaped terminals, which are held in place by the top layer of the winding. This forms a strong fixing for the end connection and avoids outhanging leads, at the same time facilitating the wiring of the machine.

The main and field terminals are situated at the bottom of the frame, and are mounted on insulated studs screwed into the frame itself. This forms a considerably stronger construction than a slate or marble base, and adapts itself to a number of different methods of bringing up the heavy leads to the machine.

Digitized by Google

Armature.—The armature is of the slotted type, built up of stampings of high permeability and low iron loss. The whole design of the armature core and spider is so arranged as to obtain the maximum possible ventilation. The core is provided with a number of radial ventilating ducts in which distance-pieces are placed to form fans, and the ends of the winding which project beyond the core are arranged in such a manner as to form an open mesh-work which provides a large cooling surface and itself assists the ventilation.

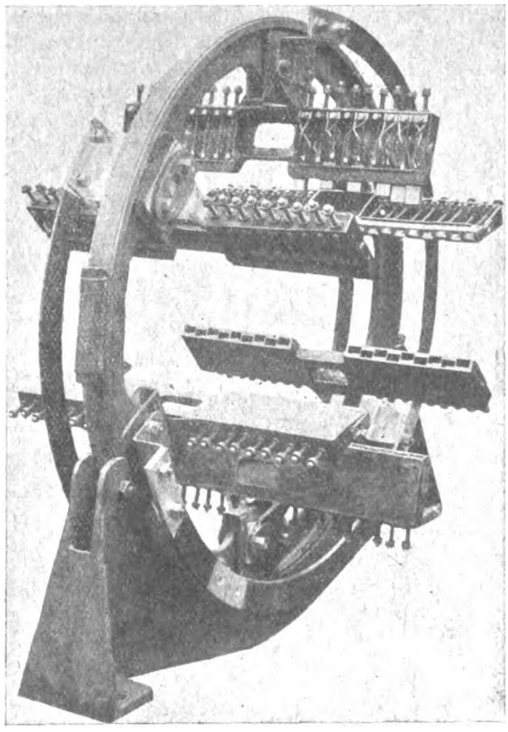


FIG. 2.—DIRECT-CURRENT BRUSH ARMS.

The winding consists of copper strip of rectangular section. All insulating materials are subjected to high-voltage tests before use, and the whole armature is subjected to an independent high-voltage test after the winding is completed. The windings are held in the slots by means of hard-wood wedges, and no binding material is used on that part of the armature which is situated under the poles. Steel-wire binding bands are used to hold the end connections projecting beyond the core.

The connections from the armature to the slip-rings are made of copper strip, so arranged as to withstand the centrifugal stresses. These strips are carried down to copper rods which connect them to the slip-rings themselves, and the joints between the respective strips and rods are supported by a clamping ring. All armatures are carefully balanced before the machines are put on test.

Commutator.—The end-rings are clamped by means of long steel bolts (except on the smaller diameter commutators), which pass right through the commutator and thus allow the necessary expansion without distortion of the segments.

Where the length of the commutator exceeds 14½ in., the Siemens double-commutator construction is used (*see* Fig. 3). This consists essentially of two standard commutators, each mounted on a cast-iron centre, and each with its own set of clamping rings. The corresponding segments of the two commutators are joined by means of tinned steel fan blades at the centre. The advantages of this type of construction are that greater support is given, the length of copper between the clamping rings being limited, the crushing stresses on the insulation are reduced, and the commutator is at least as cool as the rest of the machine, owing to the air drawn through by the fan blades at the centre.

Brushgear.—The distance along the commutator circumference over which the brush-holder extends, is reduced as much as possible. The tendency of the machine to flash-over under heavy overloads and short circuits is thereby reduced. The brushgear is of the radial type. At the alternating-current end the brushes are carried in boxes which are mounted at the side of a brass casting standing on the bedplate. All brushes are mounted on one side of the slip-ring, so that the other side affords ample cooling surface and grinding is facilitated. The pressure on the brush is obtained in the same manner as at the direct-current end—*i.e.*, by means of a helical spring, and the method of adjustment of the pressure is similar (*see* Fig. 2).

The slip-rings are of gunmetal and are shrunk over a mica cylinder on a cast-iron bush, which is keyed to the shaft.

All rotary converters are fitted with a damping winding, consisting of copper rods which pass through the pole faces, and are connected at both ends by heavy copper segments, thus forming a continuous squirrel-cage winding.

A speed-limiting device is fitted, which is so arranged that the direct-current circuit-breaker is tripped if the rotary should reach a speed above a certain limit (usually 15 per cent. above normal speed).

VOLTAGE CONTROL.

Voltage control is usually by reactance, by induction regulator or by synchronous alternating-current booster. With regard to the last method it is important to observe that the addition of a booster to a rotary converter upsets the balance between the armature reactions corresponding to the alternating current and the direct current in the rotary armature. This neutralisation of armature reaction is one of the principal features of the rotary converter, and one of its most important results is that the rating of any armature when run as a rotary converter is very considerably greater than when run as a plain direct-current machine. Another of its advantages is that it tends to make the commutating qualities of a rotary converter much better than those of direct-current generators.

The addition of a booster renders it necessary for the rotary converter to act to a larger extent either as a motor or a generator, and, therefore, interferes with the neutralisation of armature reaction. In booster rotary converters, therefore, it is necessary to make special provision in the design of the armature and of the commutation poles to meet this increased armature reaction. Provided these precautions are taken it is possible, by means of an alternating-current booster, to obtain a voltage variation of 15 per cent. on either side of the mean—*i.e.*, 30 per cent. in all—but it should be borne in mind that a voltage range greater than 25 per cent.—*i.e.*, 12½ per cent. on either side of the mean, represents approximately the limit of economical design, and ranges exceeding this should only be specified if they are absolutely necessary.

The importance of giving careful consideration to the question of voltage regulation when inquiring for converting plant cannot be exaggerated. Whatever method of voltage variation be adopted whether by reactance, induction regulator, or booster, an increase

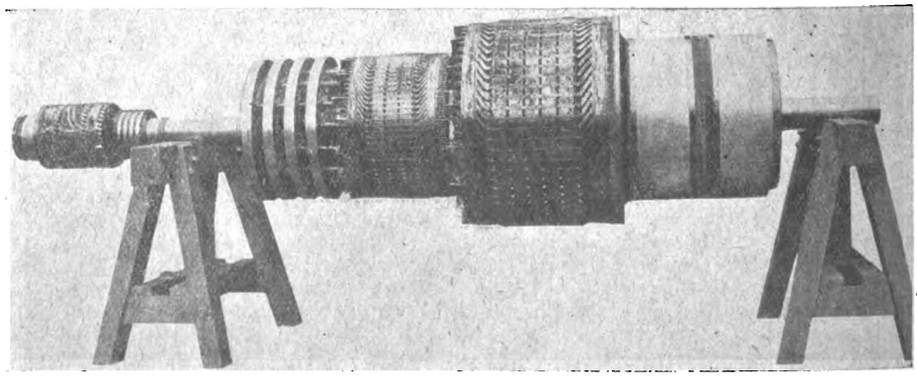


FIG. 3.—MAIN AND BOOSTER ARMATURES.

in the cost and a decrease in the efficiency of the machine as compared with a similar equipment for constant voltage is always involved. It should therefore be carefully borne in mind that in specifying the voltage variation with which a rotary converter will have to deal, this variation should be kept to the smallest possible limits, consistent with full use being made of the machine. For instance, a voltage range of 6,000-6,600 on the high-tension side of the transformer is frequently specified, when, as a matter of fact, the supply to the transformer will be at practically a constant voltage, or, at least, constant within 1 or 2 per cent.

Digitized by Google

The range of 6,000/6,600, or a similar range, is frequently adopted simply because the generators in the main power house have been designed to provide such a voltage range, if necessary, but whereas it is a comparatively easy matter to arrange for such a voltage range on an alternator without appreciable increase in cost, such is not the case with the rotary converter, and the voltage of supply to the high-tension side of the converting plant should, therefore, always be stated as closely as possible in accordance with the exact conditions which will be met.

In cases where is it desired to be able to operate the converting plant at any specified constant voltage between such limits as 6,000 and 6,600, this should be definitely stated in the specification. Tappings would then be provided on the transformer for four or five values between these limits, and a suitable tapping can then be selected, depending on the declared voltage at the power station and the length of feeder between the power station and sub-station, &c.

Similarly, on the direct-current side a voltage range of, say, 460/540 is sometimes called for when actually the 'bus-bar voltage never passes the limits of 480 to 520. The large range of 460 to 540 volts may possibly be specified in order to allow of a margin, this having been frequently the practice when specifying the voltage of a direct-current generator, but it should again be borne in mind that a considerable voltage range can quite easily be obtained on a direct-current generator without great extra cost, whereas such is not by any means the case with a rotary converter.

A similar case occurs where a machine is specified to give a voltage range from 460 to 550, the range from 460 to 500 being for lighting as a shunt machine, and from 500 to 550 over compound for traction. Such cases should always be dealt with as two separate voltage ranges using two tappings on the transformer, since it will never be required to vary the voltage smoothly across the whole range from 460 to 550, and seeing that a switching operation is necessary to cut in or cut out the series winding when changing from lighting to traction, or vice versa, there is no objection to making a change from one tapping to another at the same time.

The conditions which are most frequently met may be divided into four classes, as follows :—

1. Cases where the supply is at a constant pressure on the high-tension side of the transformer, and where a voltage range not exceeding 15 per cent. is required on the direct-current side, or where the total range, both alternating current and direct current, does not exceed 15 per cent.

2. Cases similar to 1, but where a constant power factor is required.

3. Cases where a variation on the high-tension side of the transformer up to 10 per cent. (*e.g.*, 6,000/6,600) is to be expected, and in addition a voltage range up to, say, 15 per cent., is required on the direct-current side, making a total exceeding 15 per cent.

4. Cases where reversible running or conversion from direct current to alternating current only is required under any of the conditions specified under 1, 2 and 3.

The case of (1) can be met by either a reactance, induction regulator or a booster machine, and the choice is almost entirely a question of price. It frequently happens that the cost of embodying the necessary reactance in the transformer, or of providing an external choking coil, is greater than the additional cost of an alternating-current booster. The induction regulator is generally too expensive to be provided for the above method.

The case of (2) can only be met by an induction regulator or a booster machine, and the booster machine is in general use for this purpose amongst British manufacturers, since it is possible to obtain the desired effect—*i.e.*, of unity power factor—whether the machine be compound or shunt wound.

By means of a special patent system of windings Siemens booster rotaries can be arranged so that whether the voltage range which is specified has to be obtained by compound winding or by hand regulation, a specified power factor can be obtained automatically at all loads and voltages. The system of windings is illustrated in Fig. 5, from which it will be seen that in the case of a compound winding the voltage range is obtained by means of a compound winding on the booster. This compound winding is arranged in series with an auxiliary compound winding on the rotary. Similarly, the shunt winding on the booster, which is, of course, necessary for hand adjustment of the voltage if required, is connected in series with an auxiliary shunt winding on the rotary.

Thus, any variation in the voltage, whether due to hand regulation or to increase of the series ampere-turns with increase of load, is accompanied by an increase in the field ampere-turns of the rotary itself. Hence the variation in power factor which results from the alteration in the voltage on the alternating-current side of the armature by reason of the boost up or down, is automatically compensated by a corresponding variation in the field ampere-turns of the main rotary and the power factor, therefore, remains constant at the value for which it was set before the variation in voltage took place.

In case (3) an induction regulator or a booster machine is absolutely necessary, quite apart from any power-factor question, since the total voltage range is beyond the limits which can safely be dealt with by the use of reactance and variation in the field strength of the rotary.

Case (4) is generally dealt with by means of a booster machine or an induction regulator, although reactance machines may be used, provided the converting plant, when running inverted, can run in parallel with synchronous machinery which can supply the necessary wattless component of current which is required to obtain the range of voltage. Such cases are extremely rare.

(To be continued.)

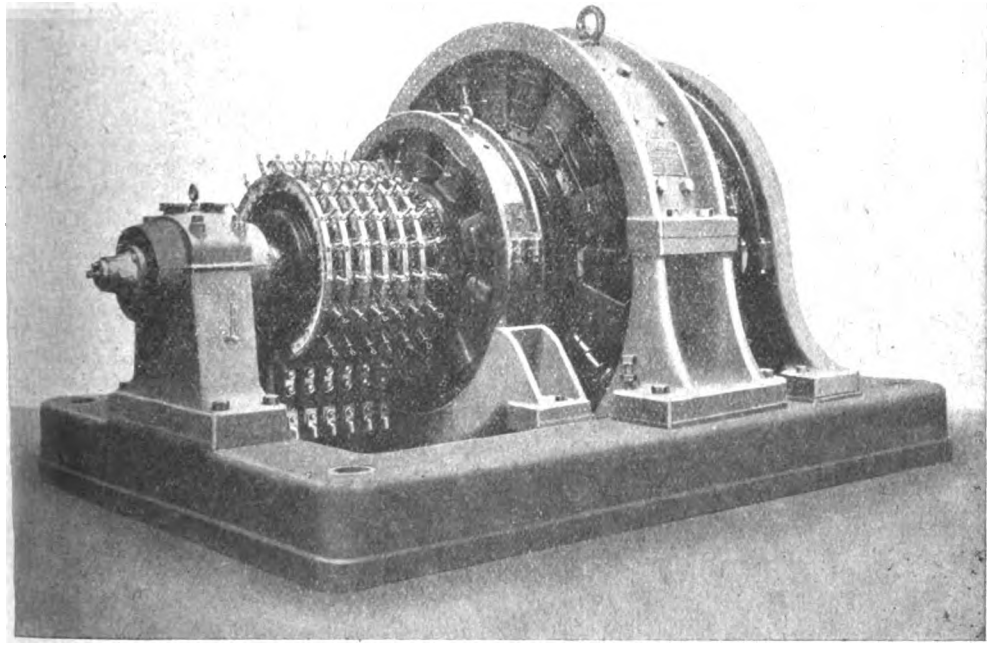


FIG. 4.—ROTARY CONVERTER WITH ALTERNATING-CURRENT BOOSTER.

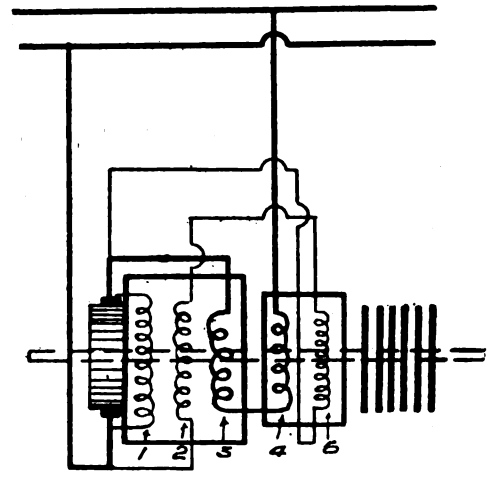


FIG. 5.—DIAGRAM OF PATENT SYSTEM OF FIELD WINDINGS FOR ROTARY CONVERTERS WITH BOOSTERS

Digitized by Google

The Electrician.

FRIDAY, AUGUST 3rd, 1917.

Editorial and Publishing Offices:—

8, BOUVERIE STREET, LONDON, E.C. 4.

Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

EDUCATION OF APPRENTICES.

We have felt for some years that the apprentice, as a class, was being neglected educationally in comparison with the young engineer, notwithstanding the fact that the apprentice of to-day may be the foreman of to-morrow, on whom the working efficiency of the workshop so largely depends. In this respect, Continental countries, more particularly Germany, have realised the position more adequately than we have in Great Britain. We are therefore glad to see that a report on the subject has been issued by the North-East Coast Institution of Engineers and Shipbuilders. This Society appears to be the first to have appreciated the importance of the matter.

At present, boys leave the primary schools at the age of 14, when they are as yet too young for heavy work in the shops and too old to continue instruction in the primary schools. Up to the age of 16 they cannot be expected to be of much value in the average shop, or to be capable of sustained muscular effort. It is an age, in fact, when such effort should not be demanded. There is, therefore, a period of waste between the ages of 14 and 16 which should certainly be put to very much better use. In the present report it is proposed to take advantage of this period by establishing junior technical schools. To these schools boys who intend to be trained in engineering and shipbuilding would be transferred at the age of 12 to 13, and would continue their education up to the age of 15 to 16. This, it appears to us, is an excellent suggestion. There is no reason why a boy should not be given some bias in the direction in which he is about to earn his living before the age of 14, and if he is given instruction of an elementary kind up to the time when he enters the shops at the age of 15 to 16 he will then be able to take up his mechanical training in an intelligent fashion.

The suggested curriculum in the junior technical school includes mathematics, experimental mechanics, elementary science, English subjects, machine drawing, manual training in wood and metal, and practical work in the laboratory. It is essential, as is pointed out in the report, that during this period "character should be formed, habits of industry inculcated, culture developed and a sense of citizenship be implanted, so that the boy on starting his apprenticeship shall aim strenuously at becoming a good workman and fitting himself for more and more responsible work, and developing sound citizenship."

It is proposed that the Institution should act in a consultative capacity with the local educational authorities, and that the selection of apprentices from the schools by firms should be made by members and masters of the administrative staff acting in close consultation with the head master of the junior technical schools. This will enable a selection to be made with far better prospects of success than the haphazard method of engaging apprentices at the present time.

We are glad to note that the report does not stop short at this stage. It is suggested that a small percentage of boys will be found with exceptional ability, solidity of character and of general promise upon entering the works. It is realised that it would be a sound business proposition for employers to have a number of these selected youths in strenuous preparation for the holding of higher positions in the industries, and with this object in view it is proposed that these selected apprentices should be engaged during half their time in the works and the remaining time at the local technical school, the curriculum being an extension of that given at the junior technical school, and including sound instruction in one foreign modern language. This education would be continued for two years, when a second selection would be made from these exceptional boys at the age of 18 years. Those finally selected would be passed on to the university, and it is pointed out that the educational authorities or the State should provide scholarships for these boys, so that they are freed from the anxiety of providing ways and means. It is proposed to make these selections sufficiently elastic to enable boys to be selected at some later stage if their development warrants such a step.

With regard to instruction in the works, it is pointed out that employers should provide definite practical instruction by expert craftsmen, and that this instruction should be continued throughout the whole of the apprenticeship. The desirability of this recommendation will be realised by everyone who has seen what has been accomplished by women munition workers in engineering shops as the result of systematic instruction, instead of relying merely upon skill which is picked up haphazard and upon information which is grudgingly given.

The Council of the North-East Coast Institution of Engineers and Shipbuilders is to be congratulated on the steps so far taken. It is evident that the position has been properly grasped by the engineers in that part of the country, and we trust that the matter will not rest merely with this report, but that active steps will be taken to put the recommendations into practice.

REVIEW.

Principles of the Telephone. Part I. Subscribers' Apparatus. By C. M. JANSKY, B.S., and D. C. FABER, E.E. (London: Hill Publishing Co., Ltd.) Pp. xiii.+160. Price 6s. 3d. net.

Most text-books on telephony, even the elementary ones, have been written by practical telephone men, with little or no attempt to emphasise the underlying principles. This book is an exception. Its authors are teachers of electrical engineering in the University of Wisconsin, and they have collaborated with the engineers of the Wisconsin Telephone Company. The result is an elementary text-book which fulfils to a high degree the purpose of the authors "clearly to set forth the principles that underlie good construction." The advantage afforded by the authors' teaching experience is apparent, too, in the clear explanations of these principles, and in the well-chosen exercises following each chapter. Two other volumes are to follow, on "Central Office Equipment" and "Outside Construction."

The book is intended to be used by students, and at the same time to appeal to men actively engaged in the installation, care and operation of telephone apparatus. It is probably for the former that the first introductory chapter, describing briefly the uses of the different parts of a telephone instrument, is included, and for the latter that considerable space is devoted to the principles of electricity and magnetism and of sound. But is it desirable to attempt to teach these subjects in a text-book on telephony? Surely the practical man who wishes to master the principles of his art will need a broader treatment of the sciences on which it is built than is permissible in a text-book on the art itself. The need for broader treatment is apparent from the book. For instance, Ohm's law is quoted in an example on p. 18, although it has not previously been mentioned under this name. Again, the authors barely

Digitized by Google

hint at such a necessary idea as the fall of potential along a wire or across a resistance.

The detailed treatment of the parts of the telephone instrument, of the localisation of faults, and of the rules for good installation work is admirably clear. The action of the condenser and the induction coil in the standard C.B. instrument really merits more precise explanation than it receives. This, however, is a point at which all text-books fail. No reference is made to subscribers' branch exchange switchboards or to extension instrument circuits, and in the instructions for fault finding no use is made of the assistance of the test clerk at the exchange. These omissions will be felt by those British readers who have passed beyond the most elementary studies.

There is evidence of a great deal of care in the preparation of the book. The illustrations are, with very few exceptions, new and very clearly reproduced, but some suffer from disproportionate scales, noticeably Figs. 5 and 90. Misprints are few, and not serious, except one on p. 57, where the direct current receiver is stated to operate with currents from 0·45 to 0·80 ampere. These figures should be 0·015 and 0·080. The keywords for indexing might have been chosen with more regard to the main idea in the readers' mind when he is using the index. For instance, "Function of Condenser in Telephone Circuit" appears under "Function" and under "Telephone," but not under "Condenser."

W. H. GRINSTED.

BRITISH TRADE IN FOREIGN COUNTRIES.

The Federation of British Industries, which has had under consideration the circumstances which will affect British foreign trade on the conclusion of peace and the preparations necessary to meet the new situation, has submitted its views for consideration by the Government. It is pointed out that the situation will involve a great increase of effort upon the part of all persons, organisations and individuals concerned with the industry and commerce of the country; but, above all, a very heavy responsibility will be thrown upon the Government commercial service, and, in particular, upon the departments and services charged with the promotion of foreign trade and with the collection and distribution of foreign commercial intelligence. The Federation is convinced that these responsibilities will be of such a nature that the duties, character and scope of these departments and services will require radical re-organisation and a very considerable extension.

Concentration of Control in a Single Department.—In the first place, it considers that in any organisation of the immense size and scope required for the Government commercial service where the action of individual officers, however able, is necessarily limited by the regulations, spirit and character of the whole service, the adoption of a system based upon sound principles of organisation is a question of the first importance. It feels, therefore, that any mere attempt to impose detail reform or additions upon the existing organisation will be doomed to failure, and that the only chance of success lies in a fundamental reconstruction of the present administration. The first essential in any sound system of large scale organisation is the provision of an active, vigorous and homogeneous central control, and the Federation believes that such a control can only be obtained by the concentration of the entire responsibility for the appointment and promotion of the personnel of the service, and for the direction of all their duties, in the hands of a single department, which shall also be in the closest possible touch with the industrial and commercial community, and responsible both for the distribution to them of the information collected and for ascertaining from them their needs and wishes in relation to foreign trade. The first recommendation, therefore, is that a single department shall be selected and that this department shall be charged with *all* duties connected with the promotion of British trade in foreign countries, and with such duties at home as are necessary to enable it to be in close and constant touch with the industrial and commercial community, and to direct the services abroad with a full and first-hand knowledge of industrial and commercial problems and necessities.

Selection of Controlling Department.—The Federation desires to suggest that the reconstruction required is of so fundamental a character, and will involve so complete a re-organisation of any department selected, that it is unnecessary to attach much weight to the relative fitness or unfitness for the task of existing departments or their personnel, and that the main object to be kept in view is the selection of a department whose natural functions are, or should be, of a character best adapted to harmonise with those of a department charged with the duty of promoting British trade in foreign countries. Judged from this standpoint, the Federation believe that the only department which it is possible to charge with these duties is the department in general charge of foreign affairs. Industrial and commercial interests are the most vital factor in the relations between modern states, and the primary cause of the existence of such relations: consequently the successful conduct of foreign policy in all its branches depends upon a due realisation both in theory and practice of the close inter-dependence and inter-action of political and economic motives. Such a realisation can never be attained by men who are not accustomed to deal with both political and commercial questions as part of their ordinary duties, and any system which deprives the department and service charged with the conduct of foreign affairs of full opportunities of gaining knowledge and experience of industrial and commercial questions will inevitably lead, as it has led in the past, not only to a failure to allow due consideration and importance to these question, but also to serious errors of proportion and consistency in the general foreign policy of the country. The only alternative to the step suggested is to create a new commercial foreign service under the direction of some other department. It seems probable that the large questions involved by railway, loan, dock and similar projects, and by the majority of schemes for the development of the natural resources of foreign countries, will assume a greatly increased importance in the future. These questions, which not only contain a strong political element, but also as a rule involve direct negotiations with the Government of the country concerned, must, together with the negotiations arising from the general readjustment of international commercial relations after the war, and the large range of problems of a nature partly political and partly commercial raised by the resolutions of the Paris Conference, necessarily remain for the most part in the hands of the department and service dealing with foreign affairs. Nothing but the most disastrous consequences can be anticipated if this department and service is not in the most intimate and direct touch with industrial and commercial opinion, and is not afforded the fullest possible opportunities of extending and improving its knowledge and experience of industrial and commercial questions.

Functions to be Fulfilled by this Department.—In the first place, the Federation considers that the Foreign Office should be responsible for the protection and promotion of all British industrial, commercial and financial interests and activities in foreign countries, and for the collection and distribution of all information on matters connected with industry, commerce or finance in those countries. These duties should include the prompt and vigorous support of all British efforts to secure contracts, concessions or orders in such countries. This support may—and, indeed, to secure success, should—at times entail the selection of one of several British competitors. The issue of all foreign loans in the United Kingdom should be subject to the approval of H.M. Government, and a necessary condition of such approval should be that the larger portion of the goods or services purchased by such a loan should be obtained from British sources. In all cases support should only be accorded to bona fide British firms, and should be refused to all firms, whether technically British or not, which are in any degree under foreign influence.

Department in Charge of General Commercial Matters.—The functions outlined above leave to be found means for the necessary organisation and control of industrial and commercial activity at home, and the collection of commercial intelligence respecting the Dominions and Crown Colonies. The Federation is of opinion that these functions should pertain to the department in general charge of commercial affairs, whether this department is the Commercial Section of the Board of Trade, a Ministry of Commerce or any other department. It believes, however, that it is essential that really efficient machinery should be established for the co-ordination of the work of the Foreign Office and of this department, and that in home, industrial, commercial or financial matters which may affect or be affected by the course of foreign trade, the latter department should consult the Foreign Office freely and fully, and should be to a large extent guided by its advice. They also consider that all items of commercial intelligence, whether collected by the Foreign Office, Board of Trade or any other department, from any part of the Empire or the world should be made immediately accessible to the other departments, and that, at least in so far as the Board of Trade and Foreign Office are concerned, a complete record of all the commercial intelligence in the possession of his Majesty's Government should be available in each department.

Re-organisation of Foreign Office and Foreign Services.—It is obvious that this division of functions, together with the necessity for a great increase in the scope, and a marked improvement in the performance, of the duties in connection with foreign trade, will necessitate a re-organisation and extension of the Foreign Office and of the foreign services, and a considerable reform both of their methods and personnel. The first essential to such an extension and re-organisation is a considerable increase in the funds allotted for the conduct of these services. In this connection the Federation considers that an adequate expenditure on the foreign commercial service is as necessary as an adequate expenditure on national defence. With respect to the Foreign Office, the Federation would recommend the establishment of a large commercial branch to undertake the duties which have been outlined above, and the provision of extra staff and accommodation for this branch upon a generous scale. The members of this branch should be placed in all respects, service rank, emoluments and future prospects, on a footing of absolute equality

Digitized by Google

with the members of the Political Branch, and there should be a constant mutual exchange of officials, at any rate in the junior ranks. It is of the most vital importance that the Commercial Branch should be in the closest possible touch with the industrial and commercial community. It, therefore, recommends that the officers of the branch should as part of their regular duties be available for personal interviews with British subjects who desire to discuss foreign trade questions, and that they should pay frequent visits to industrial centres. In addition to these facilities for personal intercourse it recommends that small committees should be selected representative of the manufacturing, commercial and financial firms interested in the trade of the countries dealt with by each section of the Commercial Branch. These committees should not merely act as consultative bodies for the sections, but should be encouraged to make suggestions and criticisms relating to the general conduct of commercial policy in the spheres for which the various sections are responsible. In addition to these sectional committees, a central committee should be established to advise the Foreign Office and Board of Trade on questions of general commercial policy, to suggest the initiation of new policy, &c. With respect to the Diplomatic Service there should be an increase of the diplomatic and clerical staffs at all embassies and legations to the extent necessary to enable diplomatists to devote a considerable portion of their time to the study of industrial and commercial questions and to the acquisition of practical experience in dealing with them. In regard to the personnel of the Foreign Office and Diplomatic Service all members of these services should possess sufficient knowledge, and should acquire sufficient practical experience, to enable them to judge the value and importance of the commercial factors in any general problem with which they may be dealing, and they, therefore, suggest that a certain minimum of commercial experience in each grade of the service should be rigidly insisted upon as a qualification for promotion to the next grade, such experience to be gained by work at a consulate, by work with the commercial attaché, by work in the Commercial Branch of the Foreign Office by a combination of these means, or by direct experience.

Commercial Counsellors.—It is obvious, however, that the members of the diplomatic service, although they should realise that industrial and commercial questions form a regular and most important part of their work, and that it is their duty to devote at least as much time and attention to these as to purely political questions, will, from the conditions of their service, seldom if ever remain sufficiently long in any one country to acquire a detailed and expert knowledge of local industrial and commercial conditions. The Federation would, therefore, recommend that, in order to supply this local knowledge, and the necessary continuity of local commercial policy, the present commercial attaché should be replaced by an officer of high rank attached to every embassy and legation, who might be entitled the Commercial Counsellor. This officer should be given a rank, position and emoluments second only to those of the ambassador or minister, to whom he should act as expert adviser in all questions affecting, or likely to be affected by, industrial or commercial considerations. He should also have sole charge of all the commercial work in the country, including all necessary powers of inspection and supervision, and in all commercial matters his authority should be second only to that of his Majesty's representative, to whom he should be responsible. Immediately under this officer should be one or more assistants, according to the size and commercial importance of the country, whose headquarters should be placed at the most important commercial centres. Both the Commercial Counsellor and his assistants should be given opportunities of paying frequent visits to the United Kingdom, in order that they may consult commercial interests, and keep in touch with the latest developments in industry and commerce. The members of this service should be provided with ample travelling allowances. While commercial counsellors and their assistants should remain as long as possible in one country in order to permit of their acquiring a thorough knowledge of local conditions, influences and personalities, they should from an integral portion of the general diplomatic service, and promotion to the highest posts in that servce should be open to such of them as show marked ability.

Consular Service.—The members of the regular consular service whose commercial duties will, as previously stated, be subject to the direction of the Commercial Counsellor, should be largely increased, in order to enable them to fulfil these duties adequately, and their emoluments, prospects and conditions of service should be improved in order that men of first-rate ability may be attracted to the service. This increase in numbers should be accompanied by an extensive redistribution of posts to correspond more closely with commercial needs than the present distribution, by the reduction to a minimum of the number of posts held by unpaid officers, who should not in any case be entrusted with other than purely routine consular duties, and by the provision of more suitable premises at the numerous consulates which are at present inadequately and inconveniently housed. At the same time consular officers should be provided with sufficient clerical and other assistance to set them free from all but a general supervision of routine consular duties, and to enable them to devote the bulk of their time and energies to commercial work, and the whole scale of local and travelling allowances should be revised in order that the consuls may travel freely in theirdistricts.

General Recommendations as to all Services.—The Federation is of opinion that only natural born British subjects should be eligible for appointment to any position, paid or unpaid, in the foreign service of the country. The creation of the new commercial branch of the Foreign Office will necessitate a considerable increase of staff, with a leaven of practical commercial exporience, which should be of particular value in the early days of the new branch when its procedure and methods are being established and its traditions formed. With respect to the commercial counsellors and to the consular service, men of ability should be selected whenever they can be found, and, as in the case of the Commercial Branch of the Foreign Office, the Federation attaches great importance to the introduction of men of practical business experience in the early stages in order that a sound business tradition may be established.

Promotion.—It seems obvious that the bulk of the services to whatever extent they may, or may not, be recruited from men of actual business experience, will consist, in fact, of men who have always been, or who have become as a result of their work, permanent officials in character and outlook, and it, therefore, becomes doubly necessary to provide such a powerful stimulus in the work itself and in the rewards for it, and so close a touch with the industrial and commercial community, that this outlook is as near to that of a man engaged in promoting his own business as is possible and desirable. The Federation believes that it would be impossible to provide this stimulus by any system of bonus or payment by results which would not be so manifestly inequitable as to do more harm by rousing discontent and jealousy in the service than it did good by stimulating zeal. It recommends, therefore, that the necessary stimulus should be provided in all the services and in the Foreign Office by the institution of a definite standard of efficiency, which must be reached by all officers at certain stages of their career. This standard should be a very high one, and should be administered by a Promotion Board, of which the membership should be sufficiently large, to exclude any risk of personal prejudice influencing the decisions. This board should be given power to postpone the promotion of all officers who fail to reach the required standard, and to enforce the resignation of officers who fall far below it. The board should also be permitted to grant pensions commensurate with their past services to all officers who are called upon to resign, whether these officers have reached the present pensionable age or not. The Federation would be glad to see some such system adopted for all Government service, but they feel that it is a question of peculiar importance in a service in which energy, initiative and enthusiasm are such vital factors, and where the influence of the man who has done good work in the past, but is now serving on for his pension, without hope and without interest, is so particularly disastrous not only to the duties upon which he is actually engaged, but to the efficiency and character of his subordinates and successors.

Training.—As it is impossible and indeed undesirable for officers who must be prepared to assist any of the infinitely varied industrial or commercial activities in which a British subject may indulge, to become specialists in any particular branch, it is obvious that any training must be of a general rather than a special character. The essential qualifications, therefore, are those of character and general education, and the Federation would suggest that the preliminary examination for the selection of candidates should be as far as possible of a type calculated to test general ability and a sound, general education. As, however, knowledge of commercial methods, even if it is only theoretical, should be of considerable value in enabling an officer to grasp more rapidly the practical requirements of his work, and their relation to other factors, the Federation would recommend that the candidates for all services either before or after appointment, should be required to pass a general course in elementary economics and commercial method, such as those now provided by the faculties of the several of the universities; with this course should be incorporated a study of two or more foreign languages. The remainder of any officer's training must be acquired, as in all other professions, by the actual performance of his work, but the Federation would recommend that frequent opportunities should be given to the officers of all services to pay visits to industrial centres, and that every effort should be made to render these visits as instructive as possible. It considers it of great importance that officers should in all cases possess an intimate knowledge of the language of the country in which they reside.

Provision of a Staff of Experts.—The Federation recommends that a large number of commercial and technical experts should be selected and employed on temporary missions as, and when, required to investigate and report upon industrial or commercial conditions or opportunities in particular markets and particular countries.

Temperature Indicators for Electrical Machinery.—The "Electrical World" mentions that temperature-indicators are being developed by the G.E.C. at Schenectady, which enable the temperatures of windings, &c., to be indicated on the switchboard. Their operation depends on the variation in resistance of a copper resistor placed in contact with the insulation of the winding or material to be examined. One of the windings of the temperature indicator is in series with a coil of manganin having a resistance equal to that of the temperature coils (usually near 80°C.). The other winding is in series with the temperature coil itself. The indicator thus acts on the differential principle, a rise in temperature causing a diminution in current in the circuit of the temperature coil and a corresponding deflection on the instrument, which is graduated direct in degrees. Compensation for variations in the supply P.D. is provided.

Digitized by Google

EDUCATION OF APPRENTICES.

In November, 1916, the North East Coast Institution of Engineers and Shipbuilders appointed a special committee to draft and prepare a detailed scheme for carrying out certain principles set out in a memorandum on the Education of Apprentices submitted by the Secretary of the Institution.

In the memorandum by the Secretary the following notes and recommendations were submitted in draft :—

One of the future factors of the well-being of the engineering and shipbuilding industries is the continuous supply of suitable trained men for every position from the lowest to the highest. It is not only necessary that they should have a knowledge of the industry as at present practised, but also that their education should enable them to seek and adapt new ideas so as to meet successfully the ever changing conditions, which affect its development. If the supply of such men is not forthcoming in the ensuing years, then inevitably it will be found that keener and better educated competitors will reap the fruits of scientific and industrial research and that our industries will languish and finally perish. To secure this object the apprentice to the trade must receive a suitable theoretical and practical training and his whole mental outlook must be broadened. This can only be secured if the employer considers that he is under a very strong obligation to provide opportunities for his apprentice to receive such training during the whole of their apprenticeship, whatever difficulties may have to be faced in the organisation of labour in the works.

If such provision be made then it follows that the boy's education before being apprenticed must be of such a character that he will be able to take every possible advantage of the opportunities offered, and it is essential that there should be no break in the continuity of his education between leaving school and beginning his apprenticeship. The large majority of the apprentices have received their education in an elementary school, which they leave at 14 years of age, and there is in most cases a gap of about two years for which at present little or no provision has been made by the Local Education Authorities. Hence it is desirable that

(*a*) Schools should be established for the suitable preparatory education of prospective apprentices up to apprenticeship age, and that

(*b*) These schools should have an educational aim, and not be merely places in which the trade itself is taught.

to provide for the continued education of these boys after being apprenticed it is essential that two or three half days a week be spent in suitable schools and that attendance thereat should be regarded by the employer as part of the apprenticeship both as regards hours and pay. The boys coming into the works direct from secondary schools at about 16 years of age should also have the advantages of this part-time day instruction before taking up their full-time university or higher technical course. The Local Education Authority is the proper body to initiate and carry on all such apprentice training schemes, but the employers must work in close co-operation with the authorities if the schemes are to have any real vitality and if the education provided is to be on the right lines. Such schemes can only be successful if there is a guarantee that in selecting apprentices preference will be given by employers to those boys who have had this preparatory training. Where one such school has been established in the district experience shows that the demand for the trained boys is greater than the supply, proving that the employers find it is in their own interest to encourage the provision of such schools. The North East Coast Institution of Engineers and Shipbuilders has always maintained a keen interest in engineering education, and it is in a position to urge upon the employers of the North East Coast to make every effort to encourage both the pre-apprenticeship and continued education of apprentices in their respective areas, and to advise them to appoint the Institution as their representatives and to act in a consultative capacity with the Local Education Authorities.

The following were the terms of reference to a special committee :—

1. That all such apprentice training schemes as are referred to herein be carried out by the Local Education Authorities and the Employers jointly.

2. That the Institution urge upon the Local Education Authorities within its district to make provision for the suitable preparatory education of prospective apprentices in engineering and shipbuilding works by the establishment of Junior Day Technical Schools within their respective areas. Such schools to be places providing two or three years' course for the suitable education of boys up to the age of apprenticeship, and not places in which the trade itself is taught.

3. That the Institution urge upon the North East Coast employers in the engineering and shipbuilding industries to give preferential appointment to youths from junior day technical schools and secondary schools, and to make provision for their apprentices to continue their technical education on two, or if possible three, half days per week in the institutions provided by the Local Education Authorities.

4. That the Employers' Associations in connection with engineering, shipbuilding and ship-repairing on the North East Coast be asked to appoint the Institution as their representative to act in a consultative capacity with the Local Education Authorities for the development of apprentice training in technical education.

PRE-APPRENTICESHIP EDUCATION.

The first important point that arose in the discussion was the definition of an apprentice, and in their report the committee say : "We desire to make it quite clear at the outset that our recommendations have no reference to those youths who pass direct, or after a period in works, from good secondary schools to a full university course, and subsequently enter the works as pupils." The second point was the suggestion that the directed education of prospective apprentices might be given in the top classes of the elementary schools. Your committee are strongly of opinion that the special organisation afforded by junior day technical schools is better educationally and economically, and that elementary schools should be used for this purpose only as a last resource. After considerable discussion your committee agreed that prospective shipbuilding and engineering apprentices should be drafted from the ordinary classes of the public elementary schools into suitable schools providing education other than elementary, in which the prospective apprentice would receive a three years' course of directed preparatory education before beginning their apprenticeship, and that, wherever possible, the place of this further education would be a junior day technical school. The aim of the junior day technical school is to continue the general education of the pupil upon the broad basis of the elementary school, combined with the direct preparation for the vocation by which he is to earn his livelihood, so that the boy may begin his apprenticeship intelligently and without waste of time. During the three years between leaving the elementary schools and becoming apprenticed, the groundwork of all the preliminary technical subjects will be well laid, so that the pupil will be able to continue his studies, during his apprenticeship with much greater facility than would otherwise be the case. The age of admission or transfer from the elementary school to junior day technical schools, should be from 12 to 13 years of age, so that the three years' course of instruction should be completed before the boy begins his apprenticeship at 15 to 16 years of age.

The curriculum includes :—mathematics and geometry, experimental mechanics, elementary science (physics and chemistry), English subjects (including economic history and geography), machine drawing, manual training in wood and metal, and practical work in the laboratory. A reasonable proportion of the teachers in the junior day technical schools will have had practical trade experience in engineering and shipbuilding ; though this does not mean that any attempt to teach the trades will be made. It is a recognition of the desirability of the foundations being laid by persons having some knowledge of the superstructure. It is essential that during this period character should be formed, habits of industry inculcated, culture developed, and the sense of citizenship be implanted, so that the boy on starting his apprenticeship shall aim strenuously at becoming a good workman, at fitting himself for more and more responsible work, and at developing a sound citizenship. We record here our opinion that in connection with junior day technical schools there should be representatives of employers and employees associated with the management in a consultative capacity, so that a true proportion shall be maintained between the academic and vocational sides of the education. Further facilities should be provided by the Local Education Authorities for the maintenance during the third year of the course, and possibly also during the second year, of necessitous but promising boys. If junior technical schools are to be established and maintained by the Education Authorities, it is essential for their success that employers should give preferential appointment to those youths on passing out of the schools, and the periods of efflux of those pupils must be arranged to suit the requirements of the district. To secure this preferential appointment the whole system of the selection of apprentices must be radically changed. The selection of apprentices should be made by a competent member of the works administrative staff acting in close consultation with the headmaster of the junior

Digitized by Google

day technical schools. Official Labour Exchanges in this connection are of infinitely less importance than the clear concept of the employer as to his necessities and the intimate knowledge of the headmaster as to the abilities of his pupils to meet those necessities. A full and generous provision of junior day technical schools for the North East Coast would provide for the day education of a very large number of boys, who would have received a good grounding from the age of 12½ years (approximately) to the age of apprenticeship, in mathematics, mechanics, science, mechanical drawing, English and in the working of wood and metal. The annual draft of these boys into the works should in a very few years produce a marked rise in the general intelligence and potentialities of the workmen.

EDUCATION OF SELECTED YOUTHS DURING APPRENTICESHIP.

The large number of well trained boys emerging from the junior day technical schools will be joined by a comparatively small number of boys entering upon their apprenticeship at about 16 years of age, direct from the secondary schools, and of this total there will be a small percentage with exceptional ability, solidity of character and general promise. Your Committee propose that the education of these exceptional youths should be on different lines from that of the general body of apprentices, because it is from the comparatively few youths of exceptional ability and sterling character that the future foremen and higher officers of industry will emerge in greater proportion. Your Committee assert with every confidence that it would be a sound business proposition for employers to have a number of selected youths in strenuous preparation for the middle to higher positions in the industries.

It is proposed that these youths of exceptional promise should be engaged half of each week as apprentices in the works and half-time as students in the Local Technical College, where they would receive technical education in continuation of that received at the junior technical school and proceeding to a much higher standard. The curriculum should include also sound instruction in one foreign modern language as well as in English. This education would continue for two years, that is from about 16 to 18 years of age, when a second selection would be made from these exceptional boys at the age of 18 years. Those selected the second time must have shown all that is implied in "staying power," character and work, and should pass direct to the University for the full engineering or Naval Architecture degree courses. It is not anticipated that the number so selected will be more than a very small percentage of the total number of boys entering the industries from the junior technical schools, and it should be incumbent upon the Education Authorities or the State to provide scholarships and maintenance grants, so that the poorest boy may have a straight road from the elementary school to the completion of his University course, freed from the anxiety of providing ways and means.

EDUCATION DURING APPRENTICESHIP OF YOUTHS NOT SELECTED FOR SPECIAL TREATMENT.

The selected boys having been withdrawn from those passing from the junior day technical schools to the works, the remainder, a large percentage of the total number, must continue their education without break during apprenticeship, and under such conditions as will enable this to be done without undue drain upon their energies and vitality. Your Committee approve the Council's recommendation that these youths should be liberated for at least two, and if possible, three half days a week for the purpose of their technical education. A scheme for providing attendance for education on three half days per week would involve a minimum absence from work of 10½ hours per week, and a maximum of 12 hours per week. Your Committee have considered the question of possible disorganisation in the works consequent upon the arrangement, but they are of opinion that—as the boys will not be absent all at one time the difficulties though real are not insurmountable. It is an essential feature of this scheme that attendance at part-time day continuation classes be regarded as part of the apprenticeship, and that there should be no reduction in wages on account of such attendance. The curriculum should be a continuance of that of the junior day technical school with modifications and should be on broad lines, such as is now being developed in the best types of evening continuation classes.

It is recognised that compulsory attendance at these part-time day continuation classes should cease when the apprentice reaches about 18 years of age, but it is anticipated that some of them will be well qualified and anxious to continue their studies at selected advanced evening technical classes, which the Local Colleges will be anxious to conduct, having been freed from the necessity of providing for the large number of junior evening technical courses. For the full development of the mechanical ability of the apprentice it is imperative that employers should provide definite practical instruction by expert craftsmen in the shops, and that this instruction should be continued throughout the whole of the apprenticeship. Your Committee are unanimous in expressing their belief that the extra expense involved both in this arrangement and in the absence of apprentices during class hours will be returned to the employers in a far higher degree on the one hand by the greater skill of the workman, and on the other hand in the broader mental outlook and initiative of the individual. The employers and Local Education Authorities must work in close harmony, and the latter must present periodical reports setting out the attendance, diligence and progress of the student and the disciplinary forces of the employers must be available in the early stages of back-sliding.

DEPUTATION TO BOARD OF EDUCATION.

Our attention has been called to certain of the present regulations of the Board of Education for junior day technical schools and other courses, which we consider are not in full sympathy with what should be the ideal aims of such schools and courses, and we recommend that a deputation representing the Institution be appointed to urge the Board by interview with the President, to recognise the importance of a generous provision of these schools and of day apprentice classes in this district; and in particular to request that:—

1. The schools should be regarded as a distinct type of higher school, in no sense inferior to a secondary school, to which boys can enter direct from the elementary schools at 12-13 years of age for a full-time three years' course of directed preparatory education before beginning their apprenticeship.

2. The same freedom and financial assistance should be given to them as to secondary schools, under similar regulations.

3. The education given to them should be regarded as directly preparatory to the half-time continuation classes organised for the more promising boys from 16-18 years in the Local Technical College, just as the continuation classes themselves should be recognised as preparatory to the University or Higher Technical Courses from 18-21 years.

In presenting this Report the Committee urge strongly that now is the time to press upon the Local Education Authorities the consideration of the scheme, with a view to its being put into operation at the earliest possible moment. The best boys, now in the upper standards of the elementary schools, who have determined to enter in due course either the engineering or shipbuilding industry need to begin their three years' course of instruction in the junior day technical schools at once, as it will be nearly three years from the date of starting before they will enter the works as apprentices. In conclusion, we agree that the Institution should act as representatives of the Employers' Associations in connection with engineering, shipbuilding and ship-repairing on the North-east Coast in a consultative capacity with the local education authorities for the development of apprentice training in technical education.

The following are the Committee's recommendations:—

1. That the North East Coast Institution of Engineers and Shipbuilders be appointed by the Employers' Associations in connection with engineering, shipbuilding and ship-repairing on the North East Coast, as their representatives, to act in a consultative capacity with the Local Education Authorities for the development of apprentice training in technical education.

2. That prospective engineering and shipbuilding apprentices be drafted at 12 to 13 years of age to junior day technical schools for a three years' course of general education, including, amongst other subjects, mathematics, mechanics, machine drawing and manual training.

3. That an Advisory Committee of representatives of the North East Coast Institution and of employers and employees be associated with the management of these schools in a consultative capacity.

4. That employers give preferential appointment to these youths on passing out of these schools, and that in future the selection of apprentices be a function of a member of the administrative staff of the works, acting in close consultation with the headmasters of the junior day technical schools. That the periods of efflux of these boys be arranged to suit the requirements of the district.

5. That a selection (a small percentage) be made from these boys of those showing exceptional ability, solidity of character and general promise at the beginning of the apprenticeship, and that they spend half the week in the works and half in the Local Technical College, in which they would receive a special two years' course of technical education. From these youths it is expected would be drawn the future foremen and higher officers of the industries.

6. That a second selection be made from these exceptional boys on the completion of the two years' course (see 5) and that these should pass direct to the University for the full engineering or Naval Architecture degree courses.

Digitized by Google

7. That the Local Education Authorities or the State provide scholarships and maintenance grants, so that the poorest boy may have the full course from the elementary school to the completion of the University Course without financial anxiety.

8. That the remainder of the boys (a large percentage) passing into the works as ordinary apprentices (not selected as in recommendation 5) should be liberated from the works for at least two half days a week and if possible three, for the purpose of attending part-time day continuation classes. That attendance at these classes be compulsory up to 18 years of age, and the time so spent be regarded as part of the apprenticeship, with no reduction in wages.

9. That definite practical instruction be given to all apprentices by expert craftsmen in the shops throughout the whole of the apprenticeship.

10. That suitable arrangements be made (*a*) for the transfer of apprentices from part-time to half-time, and vice versa on due cause being shown; (*b*) for the disciplinary forces of the employers to be available in the schools in the early stages of back-sliding; and (*c*) for the forfeit of the facilities provided under the scheme in case of continued failure of the apprentice to appreciate the advantages.

11. That in view of the near reform of our educational system, and the foreshadowing of compulsory part-time day continuation classes to 18 years of age, and in view also of the fact that Local Education Authorities are now considering their educational programme after the war, we recommend the Council, if this report be adopted, to press upon the local authorities the consideration of this scheme, with a view to its being put into operation at the earliest possible moment.

12. That a deputation from the Institution interview the President of the Board of Education to urge the importance of a generous provision of junior day technical schools and of day apprentice classes, accompanied by greater financial aid for their maintenance and by a revision of the regulations governing their management.

The report, which was received and adopted by the Council of the North East Coast Institution of Engineers and Shipbuilders in June, has also been submitted to and considered by the following Employers' Associations:—The North East Coast Engineering Trades Employers' Association, the North East Coast Ship-repairers' Association, the Tees and Hartlepool Shipbuilders' Association, the Tyne Shipbuilders' Association and the Wear Shipbuilders' Association. These Associations are in full sympathy with the objects aimed at in the report, and, with the exception of the last-named Association, which intends to give further consideration to the report, they generally approve of the Institution's scheme.

LEGAL INTELLIGENCE.

Gas Light & Coke Co. v. Hackney Borough Council.

As stated in our last issue judgment was delivered for the defendants in this case on the 25th ult.

Mr. JUSTICE ASTBURY, in delivering judgment, said the question of principle which was raised in the action was one of far-reaching importance to the electric light undertakings of the country and to their customers. One of the principal objects of an electrical undertaking is to utilise its plant to the best advantage, and one method of accomplishing that result was to obtain customers for energy during the day as well as during the dark hours, and in each case to encourage customers whose hours of consumption did not synchronise, so that the diversity between them enabled the plant to satisfy a greater number of hours of maximum demand than would otherwise be the case. Broadly stated, power users had better load and diversity factors than light users, and that accounted for their being usually charged a lower rate. The increase of the load and diversity factor, therefore, was of the greatest importance, and tariffs should be framed in order to obtain customers and classes of customers whose consumption contributed to that result. That being so as a general rule, it was obvious that a customer or a class of customers with a higher load factor due to the taking of a different supply in different circumstances was entitled in the interests of the undertaking to differential treatment in the matter of charges compared with the customer or class of customers whose load and diversity factors were inferior. The sections of the Electric Lighting Act, 1882, which were in question were 19 and 20. These sections said nothing about, and did not draw any distinction between light, heat or power users as such. The station turns out only one class of energy, which was measured in Board of Trade units, and the dissimilarity of circumstances and the non-correspondence of supply involved in sec. 19 must be looked for, not in the difference in the energy consumed or in the manner in which it was led into and distributed by wiring and meterage into the customer's premises, but in the circumstances of the customer in so far as they reacted on the supply that he took, and in the time, diversity and quantity of consumption. In other words, the purpose to which the customer put his energy which he purchased whether for lighting, power or heating was per se irrelevant. It was in the quantum of and the circumstances in which he took his supply of the one product that the undertaking offered for sale that the answer to the question as to undue preference must be looked from, and it was only for the purpose of classifying customers according to that test that they were for convenience divided into light, power and heat classes, such purpose involving well-recognised differences from the point of view of load factor, diversity factor and the quantity of units purchased. Customers might therefore be, and were in practice, divided into classes in accordance with those considerations, and they were charged with varying and different rates and classes of rates with the object of encouraging advantageous customers and classes of customers, as well as of attempting to fairly adjust the respective advantages obtained by the station from all of them. That had led to what was termed different systems of supply being adopted, that was to say for lighting, heating, power, &c., the customers in each case taking the only thing that the undertakers had to sell, but in circumstances which affected differently the load factor of the station in both diversity and quantity. If the different systems of supply were fairly arrived at, and were at the choice of the customer, a preference, prohibited by sec. 20, as between customers dealing in similar circumstances, and not between customers dealing in different systems of supply, either of which they were free to select, was given, and to the extent that customers under one system benefited the undertaking in the way described to a greater degree than customers under another, so they were given a benefit in the scale of charges. In the present case, although the wording of the 1914 circular of defendants, on which the action was launched, might be ambiguous in the sense that the 20 per cent. for light in the case of the power users was not expressly stated to be limited to factory lighting, that was put right in the circular and scale of charges issued in 1916, before the date of the writ, and in practice defendants had not allowed a user of the 20 per cent. in question for purposes other than the lighting of a factory or workshop having a power supply, nor had they threatened or intended to do so, nor apparently had anybody thought that such was the case, and he allowed an amendment of the pleadings raising the 1916 circular in order that the case might be determined, and it had accordingly been argued on those facts. In the case before him all power users were placed on the same basis if all took one supply at the same rate or price per unit, and they were all allowed to use 20 per cent. of such supply for lighting their factories or workshops, which must be lighted by some means or other if they were to take power supply at all. A similar practice had been sanctioned by Parliament in the case of many power companies, that being based on the footing that factory and workshop lighting as a rule did not amount to or exceed one-fifth of the total amount of the energy taken. For the reasons he had endeavoured to give, he was of opinion that no breach of the provisions of sections 19 and 20 of the 1882 Act by defendants had been established, and that they had not threatened or intended to supply energy otherwise than in accordance therewith. The action must be therefore dismissed, with costs against plaintiffs.

His Lordship, on the application of Mr. Percy Wheeler (for plaintiffs), granted an extension of the usual time for entering an appeal. It is stated that the Company has decided to take the case to the Court of Appeal.

Electrically Lighted Signs.

On July 19 Mr. Justice Ridley heard an action in which W. Sandorides (Ltd.) sued the Franco-British Electrical Co. (Ltd.) for rent in respect of an electric sign.

Mr. J. G. PEARCE (for plaintiffs) said the claim was for four quarterly payments, from August, 1915, to May, 1916, due to plaintiffs from defendants under an agreement, by which defendants were licenced to place an illuminated sign over premises in Oxford-street for five years from August, 1914, and for which defendants agreed to pay £120 a year in quarterly instalments. The sign which was placed there on the execution of the agreement, and which was there still, was a soap advertisement. The defence set up was that under the Defence of the Realm Act there were certain regulations regarding the lighting of the London streets and restrictions were imposed by which defendants were no longer able to carry out their agreement. But the plaintiffs' answer was that the sign was a sign by day as well as night By day it was visible from 300 yds.; it was there still. The only effect the working of the Defence of the Realm Act could have would be to make the sign of less value—certainly not of no value There was nothing in the Act to prevent the sign being illuminated during certain hours even now, and a great many signs were at the present time being illuminated up to nine o'clock.

Mr. DIGHTON POLLOCK (for defendants) argued that if the sign was not lighted it was of no use to his clients. If his Lordship held that the sign still had a day value then the defendants had a totally different thing to that for which they contracted.

His LORDSHIP said plaintiff was entitled to succeed in that case. Defendants might think it was a hard case, but there was a certain amount of hardship either way. It did not appear to him that the contract was not one which was rendered impossible. It seemed certain that the sign was being used in the day time. He was not inclined to accept the position of defendants, who took the electrical view, and it was impossible to do without electricity. The restrictions on the electric lighting of the London streets had been lightened, and defendants still had the advantage of the illuminations during certain hours, and in the future there might be still further facilities. He entered judgment for plaintiffs for £120 and costs, but granted a stay of execution pending a possible appeal.

Digitized by Google

Duty of Tramwaymen.

At Edinburgh last week, before the Lord Justice Clerk and Lords Dundas, Salvesen and Guthrie, the Dumbarton Burgh & County Tramways Co. appealed from a decree for £150 damages in respect of injuries received by a child named James Taylor. In January, 1916, a number of children collected in the vicinity of a tramcar, watching the men repairing an electric standard. When the work was completed the car was restarted. Most of the children were on the north side of the car, and they were warned off, but Taylor was on the south side, and a wheel of the car passed over his right hand, causing the loss of two and a half fingers. In the Outer House Lord Anderson granted the child's father a decree for £150 damages, on the ground that the car conductor was in fault in not looking on the north side of the car before it restarted, and that if he had done so he would have seen pursuer's child and warned him off.

The Division now allowed the appeal, and gave judgment for defenders, with expenses. Their Lordships were of opinion that the tramwaymen were not responsible for the accident, because they did not know nor had reason to believe that pursuer's child was on the north side of the car, and there was no duty therefore upon them to look out on that side of the car.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

14,441 SEELAU & NEWMAN. Telephonic receiver and transmitter boxes with phonographic styles. (1/9/13.)

1916 SPECIFICATIONS.

5,586 SUTTON, W. A. Electric junction boxes. (17/4/16.) 107,210.

7,121 STONE & Co. J. & DARKER, A. H. Dynamo-electric generators and systems connected therewith. (18/5/16.) 107,216.

8,191 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electro-magnetic lock-out switches or contact-makers. (9/6/16.) 106,869.

8,199 DECKER, F. J. Electric trucks. (9/6/15.) 100,648.

8,574 B.T.-H. Co. (G.E. Co.) Electric motors for ship propulsion and other purposes (17/6/16.) 106,877.

8,581 CONSTANTINESCO, G. & HADDON, W. Rotary motors actuated by alternating liquid currents. (17/6/16.) 107,230.

8,639 MARKS, E. C. R. (Soc. Anom. Italiana G. Ansaldo & Co.). Arrangement of electric storage batteries in submarines for that purpose. (19/6/16.) 107,233.

8,691 RELAY AUTOMATIC TELEPHONE CO., HERINK, H. J. & GRAHN, O. Telephone systems. (20/6/16.) 107,236.

8,756 BROOKE, W. Control of alternating electric current induction motors. (21/6/16.) 107,240.

8,796 B.T.-H. Co. (G. E. Co.) Methods of and means for controlling electric motors. (22/6/16.) 107,242.

A method of starting and accelerating an induction motor having two primary windings associated with a two-part secondary winding having its parts electrically interconnected, which consists in exciting said primary windings in such a manner as to induce opposite polarities in the parts of the secondary winding, gradually weakening the voltage applied to one of said primary windings and then building it up in the opposite direction.

8,902 MCGREGOR, J. A. KENNEDY-, & HODGKINSON, E. H. Ignition plugs for internal combustion engines. (24/6/16.) 107,248.

9,050 WATKINS, C. H. Sparking plugs. (27/6/16.) 107,254.

9,180 VERNIER, C. Joints for electrical conductors. (29/6/16.) 107,258.

9,185 TREHERNE, J. W. Electrical switches. (29/6/16.) 107,259.

9,277 RHODES, W. F. W., & FIRTH, J. Driving and controlling dynamo-electric generators. (3/7/16, addition to 224/16.) 106,886.

9,646 ELLISON, G. & ANDERSON, A. Electric switches. (8/7/16.) 107,268.

9,742 WESTWOOD, F. Portable electric lamps. (11/7/16, cognate application, 11,581/16.) 106,891.

9,819 MORRIS & WHITHAM & ALLISON, J. A. Flanging glass tubes for use in the manufacture of electric lamps and apparatus therefor. (12/7/16.) 106,892.

9,885 GOLDSMITH, H. Electric torches. (13/7/16.) 107,270.

9,938 B.T.-H. Co. (G. E. Co.). Protection of electric transmission systems. (14/7/16) 107,272.

Relates to a method of protecting a feeder of a system of distribution upon the occurrence thereon of abnormal conditions occasioned by a broken line wire which consists in selectively indicating the phase of the feeder upon which the broken line wire occurs and then opening the circuit of the faulty feeder.

10,088 READ, A. E., FRANKS, J. E. & BROOKS, M. Combined electric switches and couplings. (18/7/16.) 107,275.

10,126 WATKINS, G. ST. B. S. Sparking plugs for internal combustion engines. (18/7/16) 107,277.

10,677 ELECTRIC CONTROL (LTD.) & ELLEFSEN, O. Controllers for electric motors and the like. (28/7/16.) 106,898.

A movable portion of the core of the relay device or of each relay device is acted upon by a force, which tends to withdraw it from its coil, of sufficient strength to effect the withdrawal when in operation the pull exerted by the energised coil has diminished, as the motor speeds up, to the extent required at which its associated resistance unit may be safely cut out, and an electrically actuated accelerating switch for cutting out or short-circuiting the resistance, the operation of which is dependent upon the completion of an automatic control circuit, the completion of which is effected by two contacts engaging with one another, one of which is mechanically associated with the movable portion of the core of the relay, the other mechanically with an electrically actuated switch, which places the relay coil of that core in the motor circuit, and so arranged as to be incapable of making contact until the automatic control circuit is required to be in readiness for completion.

11,064 JONES, O. S. Magnetic separators. (5/8/16.) (Cognate application, 15,643/16.) 107,284.

11,428 B. T.-H. Co. Electromagnetic switches. (12/8/16.) 107,289.

12,148 READ, A. E., FRANKS, J. E., & BROOKS, M. Certain kinds of electrical switch boxes. (28/8/16.) 106,912.

15,023 MAVOR & COULSON & LAWRENCE, W. Carriers for fusible electric cutouts. (23/10/16.) 106,934.

15,733 SNEAD & Co. IRONWORKS. Method of and apparatus for electric heating and tempering. (14/6/16.) 106,940.

17,209 BERRY, H. H., & MARKHAM, W. J. Electric switches. (30/11/16.) 106,946.

17,271 NORTON, L. J. Electric switches. 1/12/16.) 107,336.

17,334 AKT. GES. BROWN, BOVERI ET CIE. Time limit electric circuit-breakers. (3/1/16 addition to 14,498/15.) 103,113.

18,194 ABINGDON-ECCO (LTD.) & BIANCO, C. B. Ignition magnetos for internal combustion engines. (19/12/16.) 106,954.

18,257 MIDGLEY, A. H. & VANDERVELL & Co., C. A. Electric switches more particularly for use in connection with switchboards. (20/12/16.) 107,340.

1917 SPECIFICATIONS.

930 NASER & LILLIENDAHL-PETERSEN. Auxiliary apparatus for telephones. (20/1/16.) 103,490.

2,161 KLYNE & BAKER. Insulation of electrical machinery and other apparatus. (13/2/17.) (Addition to 7,186/16.) 107,544.

2,785 WAYGOOD-OTIS, LTD. (Otis Elevator Co.). Electric lift system. (26/2/17. 107,357.

3,657 BRITISH WESTINGHOUSE ELECTRIC & MFG. Co. Electric motor-control systems (13/3/16.) 105,329.

A control system for electric motors adapted for regenerative operation, in which a single relay device is provided for governing the connection of the motors to the supply circuit during regenerative operation in parallel or in series, according to the speed or initial voltage conditions of the regenerating motors, said relay having its operating coil so connected to the motor circuits that the relay will be operated in accordance with substantially the voltage of one motor when the motors are connected in parallel and according to the sum of the voltages of the motors when they are connected in series.

3,658 BRITISH WESTINGHOUSE ELECTRIC & MFG. Co. Transformation of single-phase alternating electric currents into polyphase currents. (13/3/16.) 105,330.

Comprises a square or bridge consisting of alternate, condensive and inductive resistances, the single-phase circuit being connected to one pair of diagonal points of the square and alternating currents in quadrature being obtained from the other pair of diagonal points of the square, maintaining balanced polyphase relations in the polyphase circuit by varying either or both the voltages supplied from the single-phase circuit direct to the polyphase circuit or to the diagonal points of the square.

4,047 OZONAIR LIMITED & JOSEPH. Ozone generators. (20/4/17.) 107,557.

4,946 BRITISH WESTINGHOUSE ELECTRIC & MFG. Co. (Westinghouse Electric & Mfg. Co.). Circuit interrupters. (5/4/17.) 107,361.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

May 18, 1917.

7,137 MARR. Telephone receivers.

7,141 BIEBER. Electric batteries on flash lights.

7,150 HALL. Wireless telegraph aerials.

7,156 BROOK & HIRST. Electric motor controllers.

7,174 B. T.-H. Co. (G. E. Co.) Centrifugal compressors.

7,185 DUBILIER ELECTRICAL SYND. Electrical condensers. (2/5/16, U.S.)

7,191 BROOKE. Apparatus for control of dynamo-electric machines.

7,200 BROWN. Microphones.

7,206 BROWN. Ionic relays, amplifiers or detectors.

May 19, 1917.

7,254 BROWN. Telephone, &c., receivers.

7,270 PAUL. Electric contact making devices.

May 21, 1917.

7,326 B.T.-H. Co. (G.E. Co.) Centrifugal compressors.

7,329 PESCATORE. Electrodes.

7,337 BRITISH INSULATED & HELSBY CABLES, HARRISON & BAIRSTO. Loading coils for telephone circuits.

May 22, 1917.

7,352 HOLT. Self-regulating dynamo-electric machines.

7,360 MURDOCH. Electrical accumulators.

7,368 SOPWITH AVIATION CO. & CATO. Electric couplings.

7,372 & 7,373 ELLISON & ANDERSON. Elec. controllers, &c.

7,388 COOKE. Watertight terminals for electric cables.

May 23, 1917.

7,400 LUCAS. Anodes for electro-deposition.

7,403 LAMB. Insulators for supporting overhead electric conductors.

7,427 B.T.-H. Co. (G.E. Co.) Wireless telegraph apparatus.

7,431 FURSE & Co. & WILLIS. Apparatus for electric light and power distribution.

7,432 DAVIDSON. Manufacture of glass lenses for electric torches, &c.

7,442 KRONENBURG. Electrically welding rims, &c., of wheel tyres.

7,444 VALENTEDA CRUZ. Magnetometers for measuring weak magnetic fields.

7,450 WITHERS. (Levy.) Incandescent lamp sockets.

May 24, 1917.

7,457 FRENCH. Searchlights for vessels for finding submarines, &c.

7,461 BARR. Elec. water heating apparatus.

7,484 STYLES. Adjustable brackets for electric, &c., lamps.

7,487 PAXTON. Electric cables.

7,499 HARRISON. Electrical ignition systems for internal combustion engines.

7,505 DIBM. Electric alternators. (23/5/14, France.)

7,510 PALMER. Electric flatirons.

May 25, 1917.

7,519 HAMILTON & HOLLAND. Preventing oxidation or wasting of electrodes in furnaces.

7,547 B.T.-H. Co. (G.E. Co.) Elec. switches.

7,548 B.T.-H. Co. (G.E. Co.) Multi-speed a.c. motors, applicable to propulsion of ships.

7,557 JOHNSON. Terminal for electric conduit.

7,558 DUBILIER ELECTRICAL SYND. Forming arcs or other relatively low voltage currents across a gap, &c.

7,563 RELAY AUTOMATIC TELEPHONE CO. & BYGRAVE. Elec. timing devices.

7,571 IGRANIC ELEC. CO. (Cutler Hammer Mfg. Co.) Battery charging.

May 26, 1917.

7,591 SAYER. Insulators. (26/5/16, U.S.)

7,606 WESTERN ELECTRIC CO. Cores for Pupin loading coils, magnets, &c. (26/5/16, U.S.)

7,627 MARKS. (United Telegraph & Cable Co.) Telegraphy.

7,636 GILES. Apparatus for protecting electric installations.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Lieut.-Colonel C. B. CLAY, V.D., Commanding.

Orders for the Week.

Saturday, Aug. 4, to Sunday, Aug. 12.—Camp at Esher. During this period the Headquarters at Balderton-street will be closed and will be removed to the Headquarters at the Camp, Claremont Park, Esher.

Musketry.—The range at Belvedere-road will be open on Tuesday, Wednesday and Thursday, the 7th, 8th and 9th August respectively, from 5.30 to 7.

Armlets.—The new issue Armlets can now be obtained at Headquarters, and every enrolled man must obtain one without delay, and all old (red) Armlets must be returned to the Orderly Room.

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

Import Restriction Removed.

The Secretary of the Department of Import Restrictions notifies that the restriction upon the import of brass or ebonite electric lamp-holders, with or without switch or key, has been removed.

* * * *

Iron Ore Imports.

The import of iron ores into the United Kingdom in 1916 amounted to 6,905,936 tons, valued at £11,726,674, compared with 6,197,155 tons, of the value of £7,176,731, in 1915. Of the total imports, 64 per cent. came from Spain.

* * * *

Pre-War Contracts.

The Council of Newcastle and Gateshead chamber of commerce has adopted a resolution recommending cancellation of pre-war contracts.

The Council urgently recommend that emergency legislation be passed providing that no party to any contract for the sale, purchase or transport of merchandise entered into before Aug. 5, 1914, shall be liable for the non-performance of his obligations, in so far as the performance thereof shall have been rendered impossible, or only possible subject to excessive hardship by reason of the war.

It is also suggested that the Government should be asked to embody similar principles in the peace terms. The French and Italian Governments have, it is stated, already agreed to the principle of the resolution.

* * * *

Japanese Scientific Instruments.

H.M. Commercial Attaché at Yokohama reports that the manufacture of scientific and other instruments in Japan has reached considerable dimensions, and he gives figures of the values of the imports into and exports from Japan during 1916. These figures are:

IMPORTS.—Microscopes £4,000, surgical instruments £14,000, drawing instruments £8,000, philosophical instruments £24,000 and other scientific instruments £10,000, a total of £60,000.

EXPORTS.—Surgical instruments £82,000, philosophical instruments £35,000 and other scientific instruments £50,000, a total of £167,000.

In the past Germany and the United States supplied most of the imports of scientific instruments into Japan, but Japan is now exporting to China, Australia, British India, Russia and even to the United Kingdom and the United States.

* * * *

Financing Industry.

In the House of Commons on Tuesday the Chancellor of the Exchequer (Mr. Bonar Law) stated that, apart from the sums advanced under schemes for the restoration of credit at the commencement of the war, the total advances out of Votes of Parliament to private concerns (including firms and companies) by way of loan repayable in cash since the outbreak of war amount to approximately £46,000,000, of which about £27,500,000 had been repaid to date. He was not aware of any losses to the State in connection with the transactions.

* * * *

The Marconi Report.

The gross profit of Marconi's Wireless Telegraph Co. for the year 1916 was £486,700, compared with £581,700 in 1915, and the net profit was £318,400, against £377,800. With the £307,546 brought forward from 1915, there is an available balance of £625,980. The preference shares receive their 7 per cent., plus an extra 5 per cent.; the ordinary shares get 15 per cent. for the year, compared with 10 per cent. for 1915, and £330,109 is carried forward.

The above figures do not include the remuneration or compensation due from the Government for the use since the beginning of the war of the company's high power stations and other relative services. It is singular that, after three years no arrangement should have been come to for settlement of these claims, and the company has not yet even been afforded an opportunity of considering any proposal as to the basis upon which the amount due should be calculated. This extraordinary delay is very unjust towards a company which has rendered very good service to the Government and the country.

* * * *

Trade With South America.

In our last issue we gave particulars of the good progress made by some of the electricity supply, tramway and telephone undertakings in Rio de Janeiro, Sao Paulo and other cities in Brazil, but there is reason to believe that progress has also been made by similar concerns in Argentina, Chili and other parts of South America, notwithstanding difficulties caused by the War. Consequently manufacturers, exporters and machinery merchants would do well to keep in touch with Latin America, because when peace comes there will be great possibilities in this immense area for British enterprise.

According to the "Economist," before the War the Latin republics were increasing their imports of iron, steel, engineering; but foreign rivals (mainly the Germans) were taking the largest proportion of the increased business. After the war, those republics will call for unprecedented quantities of manufactured products, and there will be a splendid opportunity of placing ourselves again at the head of trading nations in those markets. Latin America, with an area of 8,000,000 square miles, and a population of 80,000,000 people, has a fertile soil and enormous mineral wealth. In the last calendar year before the war (1913) the total external trade of South and Central America, including Mexico, reached a value of £572,975,245, of which £265,150,525 was on the import side. In the aggregate, Latin American exports to the four leading countries in 1913 were as follows:—To the United States £95,525,700, United Kingdom £64,271,662, Germany £37,831,234, and France £25,665,813. In the same year Latin America's imports were:—£65,167,469 from the United States, £64,445,614 from the United Kingdom, £43,595,240 from Germany, and £22,096,377 from France.

The United States exports to Latin America exceeded British in 1913 for the first time, and our contemporary then states that had it not been for the war, there is little question but that Germany, too, would have got ahead of us in a few more years. Now the war, just as it has given a new value to Latin America's products, and opened out a new era in its development, also gives industrial Britain a magnificent opportunity of beating German competition in that part of the world. Our productive capacity, particularly in the steel and engineering trades, has been so largely increased under the exigencies of war, that we shall have available for export a much larger surplus of just such goods as Latin America will require than ever we had before. In Argentina more than 300,000,000 acres of excellent agricultural land are available, and as this is opened out there will be a huge demand for railway steel, structural material, building requisites, implements and tools of all kinds, whilst as time goes on the mineral resources of the country will be exploited, and there will be a great call for mining and general machinery and appliances. Brazil has enormous tracts of excellent grazing land available, and in Chile there are 35,000,000 acres of land still unoccupied and suitable for agriculture. As evidence of the trading possibilities in the leading South American Republics, the following figures for the last calendar year (1913) before the war may be given:—

Imports of Certain German Goods into the Argentine.

	$ Gold.		$ Gold.
Machinery (various) ...	2,694,684	Electrical appliances .	500,759
Iron and steel.....	2,579,723	Electrical machinery...	448,332
Steel rails	1,392,040	Railway carriages and locomotives.....	421,075
Electric wire.....	1,272,222	Galvanised iron	395,809
Motor cars.....	852,141	Electro-plated goods .	412,250
Bottles, &c.....	828,277	Iron and steel wire	380,343
Spare parts of machinery	717,653	Iron tubes	334,071
Manufactures of iron & steel	661,315	Locomotives	304,505
		Sewing machines	208,632

Imports of Certain German Goods into Brazil.

	Milreis.		Milreis.
Arms and ammunition	7,772,800	Rails and railway accessories.....	4,153,742
Machinery.....	6,951,922	Locomotives	3,988,679
Motors and accessories	5,705,278	Iron and steel, structural	3,781,220
Chemical products, &c.	5,803,610	Woollen manufactures	3,220,260
Earthenware & glass...	5,609,530	Sewing machines	2,977,323
Machinery, industrial .	5,513,155	Tools	2,045,223
Iron and steel wire	4,337,807	Iron and steel bars, &c.	2,010,005
Iron manufactures.....	4,287,669	Cutlery	1,781,811
Machinery, electrical...	4,251,435		

British made goods have always stood high in the estimation of South Americans, but our limited output in certain industries, coupled with our somewhat out-of-date commercial methods, caused us to lose much ground to the Germans in South American markets. In most trades the Germans in recent years produced on a much larger scale than ourselves, and they carefully nursed foreign markets. In several of the Latin American States the principal banks and commercial houses were capitalised with German money and managed by German agents, whilst large numbers of the stores were German-owned, and made a practice of selling only German goods. Export bounties paid by the German syndicates played an important part in German competition, whilst the German Government carried goods for export on its railways at half the ordinary rates, and subsidised German ships carrying German products abroad. After the war German finances may be too depleted to permit of the lavish subsidisation and bounty-feeding of exports which characterised German competition before the war. It is more than probable that German agents and goods will be accorded a less generous reception in the future than in the past, as a result of the war; and it is quite certain that not only will British industry have a much larger productive capacity than it had before the war, but that British trading methods will be more efficiently organised.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Bristol.—The Electrical Committee has provisionally arranged with the East Bristol Collieries Committee for a supply of electricity at Hanham Colliery, a point beyond the area of supply under the Bristol Electric Lighting Order, and it is recommended that application be made to the Board of Trade for an order under the Electric Lighting Act, 1909, permitting such supply, and to any other premises within 500 yds. of the main to be laid.

The committee also report that Mr. H. Brosinovitch was boiler house superintendent from Oct. 22, 1915, until Sept. 23, 1916, when he resigned, but the committee has not been successful in obtaining a successor, owing to the salary offered (£200 per annum) being insufficient to attract the attention of gentlemen with the necessary qualification and experience. It is now recommended that the committee shall be authorised to make an appointment at a salary not exceeding £300 per annum.

Burnley.—Application has been made for sanction to a loan of £1,600 for laying an additional feeder cable.

Halifax.—Sir John Snell, who has been consulted as to the suitability of the Copley site for a new generating station, has confirmed the views of the Electricity Committee, and the site has now been bought.

It is not, however, expected that the Corporation will proceed any further in the matter until the limitations of the present works compel it, or national developments make such a step desirable.

Ilford.—After negotiations the Coal Controller agreed to request the Ministry of Munitions to grant the necessary priority certificate to carry out a temporary scheme to make use of the steam from the destructor. It is proposed to transfer a 200 kw. set from Ley-street, and run a cable from the destructor to Mead's-lane, at a cost of about £600.

The charge for electric current supplied to the tramways during the year ended March 31 has been agreed at 1¾d. per unit.

The Director of Electric Power Supply at the Minister of Munitions has notified that he is prepared to approve a scheme of extension to a certain works. The L.G. Board, upon being referred to, requested that when tenders for converters and cable had been obtained the Board be furnished with a detailed estimate of the cost.

Islington (London).—Last week the Lighting Committee reported to the Council that on Jan. 15, 1915, they recommended the Council to adopt a scheme for the provision of additional mains, boilers, coal bunkers and other plant at an estimated cost of £52,757.

By direction of the Council, the scheme had been previously submitted to Mr. Albion T. Snell and reported upon by him. The Finance and Lighting Committees, who considered the scheme, informed the Council that in their opinion the extensions were necessary to enable the Council to meet the increasing demands for electrical energy. Application in due course was made for a loan to enable the work to be carried out, but, having regard to the restrictions upon capital expenditure, the loan was not sanctioned, and consequently the work was delayed.

The electrical engineer (Mr. A. Gay) now reports that the question of extending the plant must receive the serious consideration of the Council, and that unless some steps are taken to ensure additional plant being installed at an early date adequate supply both for power and lighting purposes cannot be guaranteed. The Committee are satisfied that it is urgently necessary that the above scheme should be carried out without delay in order to meet the constantly increasing demand for supply of electricity for power and to provide for the resumption of supply under normal conditions on the cessation of hostilities, which the existing plant would be inadequate to meet. The Ministry of Munitions are prepared to support the application for sanction to the loan in connection with the plant extensions and to grant a certificate P.5, which authorises the manufacture and delivery of plant necessary for the purposes of urgent work. The estimate of the plant and work involved in the scheme is as under: Two water-tube boilers, flues, brickwork, valves and other accessories, £14,000; bunkers, conveyor plant, motors, &c., £10,000; building work, £1,000; a 5,000 kw. alternator, condenser, pipework, foundations, switchgear, &c., £28,000; total, £53,000.

The Committee reported that it would be necessary to displace certain plant, and the estimated amount of outstanding loan in respect of such plant was £3,000, which would be paid out of revenue. They recommended that application be made to the London County Council for the sanction of the Treasury to the borrowing of that sum; that, subject to the sanction of the Treasury being obtained, the scheme be proceeded with; and that tenders be invited for the works proposed to be carried out and the materials required.

The report and recommendations were adopted by the Council on the motion of Ald. Yurly.

Leicester.—A site for a converting station has been purchased, and the estimated cost of the building is £1,580.

London County Council.—On Tuesday the following loans for electricity purposes were sanctioned:—

Battersea Borough Council, £1,441 for mains extensions; Bermondsey Borough Council, £3,746 for a new main; Bethnal Green Borough Council, £1,000 for house connections; and Hackney Borough Council, £3,500 to link up the Council's extra high tension system with that of the North Metropolitan Electric Power Supply Co.

Londonderry.—The Corporation have asked Mr. John Christie, engineer and manager of the Brighton Corporation electricity department, to assist the resident electrical engineer (Mr. Macrory) in carrying out the proposed extensions of electricity supply to the shipyard.

Nuneaton.—The Council has authorised the Electricity Committee to purchase for £1,200 a piece of land of about 3½ acres, adjoining the sewage pumping station, as a site for a new generating station.

Walthamstow.—The Treasury have agreed to a loan of £16,387 for extending the plant at the electricity works.

West Bromwich.—The Council has decided to expend £2,300 in extensions of the generating plant at the electricity undertaking.

Last year there was a deficit of £4,696 on the undertaking, largely due to the contracts for the supply of several large consumers at pre-war rates. An agreement had now been arrived at whereby those customers will pay a higher rate to meet the deficit.

The recommendation of the Electricity Committee for a revision of the charges was also agreed to.

Wolverhampton.—It has been decided to purchase 2,930 sq. yds. of land adjoining the existing station for future extensions.

GENERAL.

Bettws-y-Coed.—In view of the deficit on the electric light accounts the Earl of Ancaster has offered to make up the deficiency, which amounts to £400 a year.

Birmingham.—On Tuesday the Corporation adopted the new scale of charges for electric current prepared by the Electric Supply Committee.

The new scale, which increases the existing charges by approximately 15 per cent., will take effect as from the Michaelmas reading of the meters. Since the date of the last revision there have been serious advances in the cost of labour and materials, making further increases in the charges necessary.

Bradford.—On Tuesday the Corporation sanctioned a revised scale of charges for electric current to come into force on Oct. 1 next.

Power consumers having maximum demands of under 5 kw. and power consumers on the restricted hour rate will pay an additional amount in accordance with the price of coal on the same basis as power consumers having maximum demands in excess of 5 kw. This is said to represent an addition of 20 per cent.

The accounts of all other classes of consumers which are not subject to adjustment in accordance with the price of coal (with the exception of the Tramways department and consumers charged on the 4d. flat rate) shall be increased by 10 per cent.

For heating and cooking purposes current shall be supplied at a flat rate of ¾d. per unit plus 10 per cent. to consumers who are already taking supplies of electricity for other purposes at the premises for which the supplies for heating and cooking are required.

Brighton.—Owing to the continued rise in the price of coal and other materials it has been decided to increase all charges for electricity for lighting purposes by 10 per cent., and an addition is also made to the price of current for traction.

Edinburgh.—The Corporation is recommended to increase the charge for current for private lighting from 1¾d. per unit to 1¾d. and to add another 5 per cent. to the power rate, which will thus be 1¾d. per unit, plus 10 per cent. The change does not affect consumers who have special agreements with the Corporation.

The estimated expenditure of the electric supply department for the year 1917-18 is £102,820 and the estimated revenue is £156,290 on the old rates, but if the proposed increases are adopted an additional sum of about £3,000 is calculated upon. The balance will be required to meet charges for interest and sinking fund. Last year's estimated revenue was £149,920, and the actual revenue was £147,337. Last year's estimated expenditure was £94,140, and the actual expenditure was £91,799.

The East of Scotland Cinematograph Exhibitors' Association complain of the charge made for the inspection of electrical installations at Cinema Theatres. The inspections are ordered by the Magistrates, and the electricity department hold that, as they are in the nature of an ordinary trading concern, it does not fall within their duties to provide inspectors for the purpose except on reasonable charges. The Committee is to have a meeting with the Magistrates on the subject.

Digitized by Google

Heston and Isleworth.—At the last meeting of the Council the Electricity Committee announced that Mr. P. Rycroft, the chief electrical engineer, had had his Protection Card withdrawn by the Ministry of Munitions as he was not devoting full time to munitions work.

The Ministry recognise that Mr. Rycroft was doing very important work, and they suggested that the Council should be requested to apply on his behalf on Form M.M.81 as a pivotal man, when a Protection Card Army Form W.3476b, could then be issued.

Mr. Rycroft reported that it would be seen that "if a man in a scheduled occupation—where he is fully protected—undertakes additional national work, he is liable to lose at any rate some of the protection afforded by his professional and technical qualifications. This seems absurd, but he understands that the point is purely a technical one, and has only been raised by constant agitation of the Recruiting Officer."

The Committee stated that although they had been able, without seriously interfering with his duties as Electrical Engineer, to make arrangements for a part of Mr. Rycroft's time to be placed at the disposal of the Controller of Coal Mines for a limited period, for important national work, it would not be possible to dispense altogether with his services, as it was most essential that he should remain in close touch with, and in effective control of the electricity undertaking, and they therefore recommended "that application be made to the Munition Area Dilution Officer for the issue to the Council's Electrical Engineer (Mr. P. E. Rycroft) of a Protection Card and Army Form W.3476b."

In the course of the discussion, Mr. Hales thought it a shame to keep a General Service man back, and it was really touching the dignity of Mr. Rycroft to put him in the category "3476b," which meant unskilled labour.

The Chairman of the Committee said that some members imagined that all the electricity concern had to do was to light up a few houses. A number of small and several large factories depended upon the works for their supply of current. They considered it was in the national interest that they should keep Mr. Rycroft.

The recommendation was then carried by nine to six.

Hull.—The Board of Trade have extended for one year from the 31st ult., the periods mentioned in the Kingston-upon-Hull Electric Lighting (Extension) Order, of 1914, for carrying out its provisions.

Loughborough.—The Electricity Committee finds itself unable to maintain the full supply of current, and the Borough Electrical Engineer has been instructed to interview large consumers with respect to making arrangements for providing their own supply until certain necessary repairs have been carried out.

Maidstone.—The Council has increased the charge for electric current by ½d. per unit for lighting, and the fixed charge of 12s. per 30-watt lamp, and all other forms of supply has been increased 10 per cent. An addition of ⅓d. per unit has been made to the charge for traction.

Rotherham.—On Wednesday the Council was recommended by the Parliamentary Committee to promote a bill to empower the Corporation to supply electricity in bulk to the Mexbro' & Swinton Tramways Co.

The committee is prepared to meet representatives of the Rawmarsh, Greasbro' and Swinton Urban District Councils to discuss the question of the supply of electricity in these districts also.

The recommendation was agreed to.

Southwell.—The Corporation of Nottingham, which proposes to apply for a provisional electric lighting order, has been asked by the Rural Council to state whether it is prepared to give a supply of electricity in the whole of the rural area.

Southwark.—The Electricity Committee has increased the charges for current as follows:—

Lighting, 6d. per unit for first 1,200 units per quarter, 5d. for the second 1,200 units, 4d. for the third 1,200 units, and 3d. for all over 3,600 units. Two-rate (combined lighting and power), 8d. per unit during "restricted" hours, 2d. during "unrestricted" hours.

Mr. D. M. Kinghorn, who offered his services under the National Service Act, was offered the position of general manager of an assembly station by the Trench Warfare Supply Department, and he asked for the permission to accept it. The Committee, however, refused the application.

Stafford.—The Council has granted an increased war bonus of 5s. per week to male employés of the electricity department over 21 years of age, and male employés under that age and all female employés will get half this amount.

Stoke-on-Trent.—The Council has granted an increase of war bonus of 5s. per week to all male employees of the electricity department over 21 years of age, and half that amount to all male employees under that age and female employees. A war bonus of 5s. per week has been granted to all officials of the department receiving from £150 to £250 per annum.

LIGHTING AND INDUSTRIAL POWER.

Electric Power Supply.—At a recent meeting of the Urban District Councils Association it was reported that Mr. E. F. Vesey Knox, K.C., had been appointed on the Board of Trade Electric Power Supply Committee to represent the interests of urban district councils owning electricity undertakings.

The Council of the Association decided to appoint a sub-committee to consider the evidence to be furnished on behalf of the association, it being the view of the executive council (1) that the future electricity supply of the country must be looked at from a national and not from a parochial point of view, the first consideration being a supply of cheap electricity; (2) that it is essential that any scheme for the construction of large stations should secure a satisfactory supply of energy in bulk on fair terms to any local authority authorised to supply and desiring the same; (3) that the profit of any bulk supply undertaking ought to enure for the benefit of the community; and (4) that if any existing undertakings are taken over they should be acquired on equitable terms; and that the committee consist of Messrs. Harding (chairman), Bond, Nicholas and Postlethwaite.

The British Empire Producers' Association recently suggested to chambers of commerce and other commercial organisations that the class deserving of prior consideration consisted of manufacturers throughout the kingdom whose business was likely to be affected in international competition by the efficiency and cheapness or otherwise of electrical power distribution. They proposed, therefore, as a first step the presentation of a memorandum to the committee, and had requested chambers of commerce and associations of manufacturers and producers to support it. The association then hoped to be in a position to present more detailed statements as called upon by the committee, probably through the medium of a strong deputation representing the more important groupings of industry.

The Birmingham Chamber of Commerce has agreed to support the above suggestion.

St. Austell.—The Urban Council offer to pay 25 per cent. of the contract price for the public electric lighting, the contract price being £1. 16s. 9d. per lamp per annum.

Walthamstow.—The Council has entered into a contract with a firm to give same an increased supply of current under the following conditions:—

The switchgear and transformer required will be paid for by the company, and the capital cost of the cables and switchgear required at the generating station will be provided by the company; one-half of the difference between the pre-war cost and the present price of the cables and switchgear will be paid by the company; the balance of the amount advanced by the company will be repaid by the Council by a rebate on the price per unit of the current consumed, such rebate to be fixed at such an amount as will ensure the repayment of the total sum in a period of seven years based on an average consumption of 360,000 units per annum, and will be allowed after the scale charge for current has been arrived at. In the event of the company ceasing to require a supply of current, the cables and switchgear become the property of the Council without any further repayment being made. The company will take current for seven years at the prices at present in force, subject to certain conditions.

ELECTRIC TRACTION.

Glasgow.—Last week the Corporation discussed a new tramway comforts scheme, to replace the prize drawing which was recently discontinued. Before a decision could be come to the Council was counted out.

Huddersfield.—The Ministry of Munitions have refused to assist the Corporation in regard to purchase of electric motor wagons.

Nottingham.—The Tramways Committee has modified the tramway fares and workmen's fares will be issued on all cars leaving a terminus before half-past seven in the morning (instead of seven o'clock as hitherto), but no return tickets will be issued.

Tynemouth.—The Corporation proposes to acquire the section of the local Tramway Co.'s lines between the New Quay, North Shields, and the south end of the grand parade at Tynemouth.

The Corporation will be in a position to acquire the section of the line in 1920, and the subject has already engaged the attention of a sub-committee of the Council.

MISCELLANEOUS.

Brazilian Radio-Telegraph Station.—The Government proposes to erect a powerful wireless telegraph station near the mouth of the Amazon, which will be in direct communication with the Sayville station, New York.

Electric Digging Machine.—In connection with the construction of French dug-outs, as might be expected of our gallant and ingenious Allies, electricity is used for a variety of purposes, including the operation of excavating machines.

Working in ordinary earth, four men with two wheel-barrows and a machine driven by an electric motor can (says a "Daily Mail" report) shift from 25 to 35 tons a day. In a month, a shelter with sleeping accommodation for 500 men can be dug by a single company.

Digitized by Google

Engineers and the Industrial Councils.—The Lancashire, Cheshire & North Wales Enginemen's Federation has resolved that any scheme of the joint standing industrial councils to be acceptable and successful must provide that problems affecting different trades in one industry must not be decided by a majority vote of all trade unions in the industry, but by the trade union particularly affected.

Entertainment of Wounded Soldiers.—On the 18th ult. a number of wounded soldiers were entertained by the employees of the Siemens Wotan Lamp Works, Dalston, N.E.

The entertainment was one of the series of events arranged for by the Dalston Lamp-makers, at their own expense, in order to provide some little relaxation for the boys who are back in "Blighty" bearing the scars of battle. On this occasion the Committee decided on a brake trip to High Beach, and two representatives of the employees accompanied the party so that everything possible could be done for their enjoyment. Two brakes left the Metropolitan Hospital at 2.30 p.m., and the weather being favourable, the ride was thoroughly enjoyed by the men. "Smokes" were provided, and a substantial meal was served at Rigg's Retreat, High Beach. The party arrived back at the Hospital about 8 p.m. The following Committee were responsible for the arrangements: Miss Crisp, Miss Payne, Miss Fox, Miss Ashton, Miss Ros and Misss Cole. Mr. Price acted as secretary

Strike.—A strike recently occurred in the South Wales Coalfield owing to a dispute at Ebbw Vale.

At No. 5 colliery of the Ebbw Vale Co. it was alleged that an electric winder was not working properly, and a deputation waited upon the management with a request that an examination should be made by an independent electrical engineer, but this was refused, and after a mass meeting the whole of the men (numbering 8,000) decided not to resume work.

On Wednesday it was announced that the Government had sent Sir Richard Redmayne to Cardiff to meet representatives of the owners and miners at Ebbw Vale and Tredegar, and as a result the disputes had been settled. The men resumed work on Wednesday. The council's electrical engineer is to make an examination of the winding machinery at Ebbw Vale.

Tribunal Case.—The Engineer and Manager of the Eastbourne electricity works attended last week before the local tribunal in support of an adjourned application for the exemption of 12 workmen of military age.

The matter had been adjourned to hear the result of an application to the Ministry of Munitions to certify the works, the effect of which would be automatically to protect all the employés. Mr. Brydges read a letter stating that the application was declined, as the factory supply in Eastbourne was only one-third of the total demand for power purposes. Under these circumstances he asked the Tribunal to deal with the present applications on the basis of the men being employed in a certified occupation and in work of national importance.

After discussion the matter was adjourned for a week, in order that the Town Clerk might support the application on behalf of the Corporation.

University of Birmingham.—In the mechanical, civil and electrical engineering departments the full courses extend over four years, and students who enter after matriculation and pass successfully the examinations at the end of each year will be entitled to the degree of Bachelor of Science in engineering. The session 1917-18 commences on Oct. 2, and detailed syllabus giving particulars of the University regulations, lecture and laboratory courses, fees, &c., can be obtained from the Secretary.

Wages of Electrical Wiremen.—It was agreed to advance the wages of electrical wiremen and fitters by 1d. per hour with a pro rata advance to their assistants. The advance is to date back from April 1 last and is to be regarded as war wages to remain in force subject to four weeks notice by the Council.

TENDERS INVITED AND ACCEPTED.

Lamps and Lampholders.

The Commissioners of His Majesty's Works invite tenders for the supply of insulated lamps and lamp holders. Tender forms, &c., from the Controller of Supplies (King Charles-street, S.W.), and tenders must be delivered before 11 a.m. August 7, addressed to The Secretary, H.M. Office of Works, &c., Storey's-gate, London, S.W. 1.

LEICESTER.—The Council has accepted the tender of Siemens Bros. Dynamo Works (Ltd.) for a 1,000 kw. rotary converter at £3,100, and for switchgear at £410; and that of W. T. Glover & Co. for cables at £3,425.

ROTHERHAM.—The Corporation has accepted the following tenders:—

Messrs. Babcock & Wilcox, Ltd., extension to new power station and provision of six additional boilers, £150,600; British Thomson-Houston Co., switchgear extension, £10,945.

SALFORD.—The Council has accepted the tender of Doulton & Co. for stoneware conduits at schedule of prices.

WALTHAMSTOW.—The Council has accepted the following tenders: Foster Construction Co., extension to boiler house, £775; Fleming, Bikby & Goodall, line material; Frederick Smith & Co., trolley wire.

WOLVERHAMPTON.—The Council has accepted the following tenders:—

Drake's, Limited, duplicate drag link conveyer at electricity works, £350; Staveley Coal & Iron Co., c.i. pipes £750; Brush Electrical Engineering Co., two 300 kw. transformers, £238 each; Lea Recorder Co., two recorders, £85. 10s. each.

APPOINTMENTS VACANT AND FILLED.

An assistant constructional engineer is required by the City of Birmingham Electric Supply Department. Forms of application, which may be obtained from the secretary of the department, 14, Dale-end, Birmingham, should be sent to the city electrical engineer (Mr. R. A. Chattock) by Aug. 25. *See an advertisement.*

A lecturer in mechanical and electrical engineering and a lecturer in chemistry are required for the Technical College, Cardiff. Applications to the Principal by Aug. 4.

An engineer-manager is wanted for the Galway Electric Co. Salary £200. Applications to Prof. Perry, 25, Stanley-crescent, London, W. 11.

In connection with the scheme of re-organisation of the L.C.C. tramways the following appointments were confirmed at Tuesday's meeting of the Council:—

Mr. W. E. Ireland, rolling stock superintendent in the tramways department, to act temporarily as rolling stock engineer, and while so acting to be granted, in addition to his salary (£525 a year), a special allowance of £225 per year.

Mr. H. S. May, assistant rolling stock superintendent, to discharge temporarily the duties of rolling stock superintendent in the rolling stock branch as re-organised, and that while discharging these duties to be granted, in addition to his salary (£325 a year), a special allowance of £75 per year.

Mr. G. W. Knight, superintendent of central car depot, to occupy temporarily the position similarly designated in the rolling stock branch, and while occupying this position to be granted, in addition to his salary (£300 a year), a special allowance of £100 a year.

Mr. J. B. Welling, permanent way engineer, to occupy temporarily the position of head of the permanent way branch, and while occupying this position to be granted, in addition to his salary (£600 a year), a special allowance of £150 a year.

Mr. J. R. Wignal, technical assistant in the tramways department, to act temporarily as a technical assistant to the permanent way engineer, and while so acting to be granted, in addition to his salary (£340 a year), a special allowance at the rate of £100 a year.

Mr. W. P. Farquharson, general assistant in the general branch (£600 a year), is to act as chief clerk.

Mr. Richard Burrowes, B.Sc., lecturer and demonstrator in electrical engineering at the Battersea Polytechnic, is recommended for the position of lecturer at the Liverpool Central Municipal Technical School.

BUSINESS ITEMS.

Messrs. Handcock & Dykes announce that from Oct. 1 next they will have the advantage of the collaboration of Mr. A. P. Trotter, B.A., M.Inst.C.E., M.I.E.E., until recently electrical adviser to the Board of Trade. From that date the name of the firm will be Handcock, Dykes & Trotter.

William Young Robinson and Archibald Johnstone Shields, dealers in electrical goods, Kingsway Hall, Kingsway, London, W.C. 2, trading under the style of The Robinson Shields Co., have dissolved partnership. Debts by M. Shields, who will continue under the present style of the Robinson Shields Co.

Manufacturers Required.—The Commercial Intelligence Department of the Board of Trade have recently inquired for the names of British manufacturers or producers of the following articles:—

Carbon electrodes, diamond dies for wire drawing, drawing pins, boilers designed for using peat as fuel, gas generators designed for peat, and machinery for excavating and generally handling peat. &c. Communications to the Department, 73, Basinghall-street, London, E.C. 2.

Plant for Sale.—The Victoria Electric Plant Co., Spencer-street, Westminster, S.W. 1, advertise for sale a bi-polar motor-generator.

LIQUIDATIONS.

It has been decided to wind up voluntarily Korting Bros. (Ltd.), and Mr. A. G. Parker, C.A., 2, Coleman-street, London, E.C., has been appointed liquidator, with authority to consent to the registration of a new company to be named Korting Brothers (1917), Ltd.

Claims against the Leitner Electrical Co. (Ltd.), Maybury, Woking, must be sent to the liquidator (Mr. C. G. Corfield), 109, Finsbury-pavement, London, E.C. 2, by the 23rd inst.

A winding up order has been made against the Vaughan Engineering Works (Ltd.), 22, Cross-street, Islington, London, N.

Digitized by Google

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Burnley.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £168,549 (increase £1,510), of which £88,475 is outstanding.

Revenue was £34,340 (compared with £33,190 in the previous year) and total costs were £17,006 (against £16,809), leaving gross profit £17,334 (£16,380). Interest and sinking fund charges and income tax amounted to £13,870 (£11,907) and the net profit is £3,464 (£4,472).

Mr. J. E. Starkie (engineer) says in his report units sold were 5,222,626 (compared with 5,158,074). Power units increased 24·54 (31·67) per cent. Maximum load was 2,167 and load factor 27·51 (22·99) per cent. Reserve and depreciation funds stand at £23,551 (£23,079). Average price obtained per unit was 1·952d. (2·001d.). The consumption of current for heating and domestic purposes is on the increase (117 948 against 98,754 units), but Mr. Starkie fears the price charged at present (1½d. inside and 2d. and 2½d. outside the borough) is likely to be a deterrent in obtaining a revenue which might greatly compensate for the decrease in lighting units. Motors connected aggregate 2,064 H.P. (increase 383H.P.).

The details of the linking up scheme for Lancashire and Cheshire are almost ready for publication and it is expected that some of the schemes will be in operation in 12 months.

Glasgow.—The accounts of the electricity department for the year ended May 31 show gross revenue of £580,433. 11s. 4d. and working expenditure of £404,404. 5s. 4d., leaving £176,029. 6s.

Interest on loans absorbs £83,039. 18s. 10d. and sinking fund, &c., £76,049. 6s. 7d., a total of £159,089. 5s. 5d., leaving £16,940. 0s. 7d. After allowing for depreciation (which, together with the contribution to the sinking fund, is equal to a rate of 4 per cent. upon the gross capital expenditure), which amounts to £55,606. 11s. 4d., there is a deficit of £38,666. 10s. 9d. To meet this a sum has been transferred from reserve fund, which as reduced now stands at £19,172. 17s. 9d. The revenue account shows an increase of income of £49,713. 9s. 1d.; on the other hand, the working expenses increased by £81,752. 18s. 9d., principally due (apart from the larger output) to the greater amount paid for coal, the advance in the cost of material, increased rates and taxes, workmen's wages and to a sum of £5,885: 6s. 2d. allowed to employees on active service. There was also a considerable increase in the amount paid for interest and the contribution to the sinking fund. The average price received from consumers was 0·975d. per unit, compared with 1·108d. per unit for the previous year. The rate of interest payable to the Corporation loans fund in respect of money borrowed was £3. 17s. per cent., against £3. 10s. per cent., and the rate of interest payable to the bond holders in the former Burghs of Govan and Partick varied f om 3 to 3½ per cent. The valuation for the year 1917-18 amounts to £165,133, which is considerably in excess of last year's valuation, which amounted to £142,417, so that next year additional expenditure may be looked for in respect of rates and assessments. The capital expenditure during the year amounted to £255,353. 17s. 7d., and the total capital expenditure at May 31 (less depreciation) stands at £2,835,297. 4s. 1d. The total depreciation written off amounts to £766,915. 9s. 1d

In view of the great increase in the cost of materials, in wages (which are to be further advanced this month), interest on capital, &c., the Committee recommends that the charges for electric energy as from the date of last survey of the financial year 1916-17 be substantially increased. The most important changes are the raising of the initial rate for private lighting from 3½d. per unit to 5d. per unit, and for power from 1½d. per unit to 2d. per unit. The rebate rates have also been raised, but on the other hand, the 15 per cent. added two years ago has been abolished.

Hull.—The total receipts of the electric supply department for the year ended March 31 were £99,991. 8s. 4d., including £31,015 from the sale of current for lighting (1,957,242 units), and £65O,393 for power (14,471,767 units).

The total expenditure was £61,760. 16s. 11d., leaving a balance of £38,230. 11s. 5d. The cost of generation, including coal (£32,094), amounted to £49,230, distribution to £3,474, rent and rates to £2,878, management and general expenses to £3,816, special charges and miscellaneous items making up the balance. Interest absorbed £15,541, loan instalments £18,527 and income tax £2,953, leaving a net profit of £1,209. The number of units supplied to private consumers was 16,370,742 (against 14,786,426), the maximum supply demanded was 7,871 kw. (7,810 kw.) and there are 4,999 consumers (4,888). The working cost was 0·77d. and the total working cost was 0·92d. per unit.

In his report to the Electricity Committee the acting city electrical engineer (Mr. J. F. Magoris), in submitting his third annual report, states that there has been an increase over last year's figures under the heading of works costs and total working costs, both of which have risen to the respective pre-war figures of 1913-14. These increases are, with the exception of wages (on account of War bonus amounting to £1,206. 14s. 9d.), entirely due to the enhanced cost of fuel per unit sold. The price of fuel per ton delivered to the works has increased by 34·71 per cent. over the average cost of the previous year. The output of power for industrial purposes continues to increase and for the year under review was 49 per cent. higher than in 1913-14. On the other hand, the units for lighting, although slightly above last year's output, are 22 per cent. lower than 1913-14. During the year agreements were entered into for four important bulk supplies, and a new use to which the supply from the department's mains has been applied with success is the operation of steel rolling. The kilowatts connected to the mains are:—power 23,584 and lighting 8,396, total 31,980.

Sutton Coldfield.—The gross capital expended on the electric supply department at March 25 last was £56,068, of which £23,681. 11s. 10d. had been repaid.

Total revenue for past year was £9,736 (including £7,951 from sale of current by meter, by contract and for public lighting), and total expenditure was £5,700, and after providing £125 for bad debts the balance was £3,911. After meeting interest (£1,208), instalments of principal (£2,353), income tax (£126), and interest on temporary loan (£33), the net profit was £191. The cost of coal (£1,784) increased by £324, due to an advance in price from 7s. 2d. to 12s. 5d. per ton. The units sold were 614,370 (including 6,916 supplied to public lamps), and the total maximum supply demanded was 415·5 kw.

As the pre-war charges have not been altered, except by adding 10 per cent. to all accounts, the record for the past year is quite good.

Mr. J. Bamford, who presented the report, said the net profit was £191, against £551. The position was regarded as particularly satisfactory, seeing that the department was paying about £700 a year more for coal than before the war, and £250 for other items, while they were getting £400 a year less for public lighting and losing £350 by the operation of the Summer Time Act.

COMPANIES' MEETINGS AND REPORTS.

BRITISH THOMSON-HOUSTON CO. (LTD.)—The chairman (Mr. H. C. Levis), who presided over the ordinary general meeting on Monday, stated that he would like to repeat what was said in the report relative to the loyal and efficient co-operation of the employees in all departments of the company, notwithstanding the exacting demands imposed by the extraordinary business conditions which prevailed during the past year. The total number of employees who had enlisted was 1,309, and a very large proportion of that nu ber enlisted during the first two months after the declaration of war. The number who had fallen was 152, the number of wounded was 138 four were prisoners in Germany, and one was interned in Holland. The number of employees holding commissions was 102, of which 68 were promoted from the ranks, three had received the Military Cross, 15 the Military Medal, one the French Military Medal, one the Serbian Gold Military Medal, seven the Distinguished Conduct Medal, nine have been mentioned in dispatches, and 11 had been specially commended for service in the field After a reference to the changes in the directorate, he said the directors did not recommend payment of dividends, as, after consultation with the holders of a very large majority of the ordinary and preferred shares, it had been deemed wise to use the surplus profits for further depreciation of the goodwill and plant accounts. Last year the goodwill account was depreciated by about £30,000, bringing it down to £100,000, and the plant account by £60,000 This year they were able to depreciate the goodwill by an additional £40,000, leaving the net amount £60,000. In regard to the plant, they expended during the year £88,535, but they had made a further depreciation for the year 1915 of £12,093, being an additional amount allowed by the Government, and for the year 1916 they had allocated the sum of £103,715, making the total writing off for the year nearly £116,000. Their holdings in shares and debentures of other companies were now valued very conservatively. The profit for the year was £359,364, after deducting all expenses and charges of every kind, excepting only interest, and involved heavy payments to the Government, but they were glad that circumstances were such that their contribution could be so large. Last year they made a reserve of £25,000 to take care of possible depreciation in raw material; this year they wrote it back and used it for other depreciations, because it was not required, and due to the fact that it was proposed under the Finance Bill that they had two years within which to liquidate their stock of raw material, they felt there was little danger of making a loss in that connection. Their loan from the General Electric Co., of New York, had increased by £57,000, and the amount under sundry creditors, retentions, &c., was up £126,000, having increased from £300,684 to £426,910, but, on the other side, the item of apparatus finished and in process of manufacture had increased £124,000, sundry debtors, retention moneys, &c., had increased £135,000, and the cash balance had just doubled, increasing from £63,000 to £126,000. Practically their entire output was directly or indirectly for Government requirements.

The report and accounts were then adopted.

EBBW VALE STEEL, IRON & COAL CO. (LTD.)—At the meeting last week the chairman (Col. Sir C. Allen) said that notwithstanding difficulties in securing labour the outputs of material had been fairly well maintained and compared favourably with previous results. Two years ago

Digitized by Google

they purchased an extensive virgin iron ore field in Northamptonshire and since then extensive developments had been in progress, which promised to turn out quite up to expectations. The Ebbw Vale Co. would eventually control an output of something like 5,000,000 to 6,000,000 tons of coal per annum. As regards the iron and steel plant, extensive additions were still in progress, encouraged by the Government, in the way of new blast furnaces, coke ovens, electrical plants and accessories, which, when complete, would practically add 50 per cent. to our power of output.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The report for the year 1916 states that the company's through telegraph service has continued interrupted during the year. Telegraphic receipts have been limited to traffic traversing the eastern sections of the company's system. The new arrangement between the company, the Indo-European Telegraph Department and the Eastern Telegraph Co., under which there will be secured to the company a sufficient sum after payment of all expenses to provide a dividend of 7 per cent. on the share capital, came into operation on Aug. 1, 1916. As already mentioned, it would lie with the directors to recommend any additional dividend by drawing on the equalisation of dividends fund, but, as shareholders will observe, the accompanying accounts show that this has not been called for in respect of the year 1916. The company's revenue from message account and other sources amounts to £162,273. 12s. 6d., compared with £204,189. 19s. 10d. for 1915, or a decrease of £41,916. 7s. 4d. The expenses are, on commercial and general account, £55,519. 0s. 1d., and on maintenance account £19,810. 3s. 1d., making a total of £75,329. 3s. 2d., a decrease of £6,888. 17s. 4d. After deduction of income-tax the balance is £59,116. 14s. 9d. Adding amount brought forward (£19,797. 10s.) and the difference (£1,159.) between the amount set aside last year for excess profits duty for 1915, and the actual payment, the total is £80,073. 4s. 9d. Deducting £40,000 provided for investment fluctuations and the interim dividend of £10,625, there remains £29,448. 4s. 9d. From this sum is deducted the final dividend of £1. 2s. 6d. per share, amounting to £19,125 (making with the interim dividend 7 per cent. for the year), leaving £10,323. 4s. 9d. to be carried forward. With the final dividend above referred to a distribution of £1.10s. per share was paid out of interest received, making a total distribution for the year 1916 of £3. 5s. per share.

LANCASHIRE POWER CONSTRUCTION CO. (LTD.)—Dr. H. F. Parshall, who presided over the meeting last week, said that the company's Bill had received the Royal Assent and the scheme for the re-arrangement of capital would now be proceeded with. He explained the changes which would thereby be made in the balance sheet, and said that there would remain in the company's treasury available for issue about £175,000 of preference shares and £75,000 of ordinary shares with which to develop the business. The company had succeeded in obtaining their new turbine set, which would effect an improvement in their coal consumption. A great deal of new business was being offered to them which they were trying to "keep alive" until they got the permission of the Ministry of Munitions to undertake it or until the end of the war.

LONDON UNITED TRAMWAYS (LTD.)—An adjourned meeting of the holders of the first mortgage debenture stock was held last week to consider the report of the Committee appointed on June 13 last. Mr. W. N. Mattinson, K.C., made a statement concerning the work done by the Committee which had inquired into the financial circumstances of the company. He said he was not in a position to report fully as to all the causes of its present position, but the greatly increased cost of working due to the war was largely responsible for it. There were a number of questions relating to the physical state of the undertaking, the further capital expenditure required to maintain it, its relations with other undertakings, &c., which, in order to understand properly, required an intimate knowledge of tramway construction and working. The Committee had asked for information on a number of specific points, and that had been given them; but the Committee was of opinion that expert advice should be obtained without delay. The only course open to the Committee by which they could hope at once to get first hand the information required was by electing to the board two gentlemen to be nominated by the debenture holders. The present board had, however, declined the Committee's request, but they gave an assurance that they would give every information required by the Committee, and they had also formulated in a somewhat more definite form their tentative proposals. The Committee recommended that the bondholders should authorise them to incur all necessary expenses in obtaining professional and other advice. Mr. Mattinson moved a resolution to this effect, and this was seconded and agreed to.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—The net profit for 1916, added to the balance brought forward, after providing for expenses of management, depreciation and all other expenses, amount to £625,980. After deducting dividend on the preference shares of 7 per cent. for the year and interim dividend on ordinary shares of 5 per cent., the available balance is £547,345. The directors recommend payment of a further dividend on the ordinary shares of 10 per cent. for the year and on the preference shares 5 per cent. It is proposed to transfer £32,470 to general reserve and to carry forward £380,106. The directors do not recommend the distribution of larger dividends, as in view of the demands for apparatus and material likely to be made upon the company on the cessation of hostilities and the uncertain financial outlook they deem it prudent to strengthen its financial position. Following the usual custom, shares in associated companies and patents are taken at their cost price (£1,403,923) which shows an increase of £20,266. Owing to unfavourable rates of exchange large sums of money have been invested temporarily or placed on deposit abroad. The loss represented by the rates of exchange calculated on Dec. 31, 1916, has been written off against profit and loss account. The directors regret that the company is still without any remuneration or compensation from the Government for the use since the beginning of the war of the company's high-power stations and for other relative services. Moreover, the company has not yet been afforded an opportunity of considering any proposal as to the basis upon which either remuneration or compensation is to be calculated. A number of orders have, however, been received by the company from Government departments in respect of which payments have been duly made. The four heads under which considerable sums are payable by the Government were set out in the report for last year. The Marconi International Marine Communication Co. has continued to show a substantial development in its business and increased profits. Dividends for the past year amounting to 15 per cent. have been declared and £51,279 has been carried forward. In consequence of the considerable expenditure on capital account in providing installations for additional ship stations the remainder of the authorised capital was offered to the shareholders in November last at a premium of 15s. per share, and the issue was largely over-subscribed. The business continues to increase rapidly and the orders in hand are so large that additional capital becomes essential. The company has therefore taken steps to increase its authorised capital to £600,000. The American Trans-Atlantic stations, which were expected to constitute the principal source of revenue, have remained idle in consequence of the Marconi Co.'s stations continuing to be employed by the Government. A very satisfactory telegraph service was being conducted from the Pacific Coast across the Pacific Ocean to the Hawaiian Islands and Japan up to the time the United States entered the war, when the Government took possession of the stations. Negotiations are progressing rapidly in order to settle the basis of the payments to be made to the company. The action brought by Messrs. O. Locker-Lampson and Peter E. Wright has been discontinued. In view of the unconditional withdrawal by plaintiffs of all charges, the company and its directors agreed not to look to them for payment of costs, which will be borne by the company.

TROWBRIDGE ELECTRIC SUPPLY CO. (LTD.)—The chairman (Mr. John H. Blake) stated at the recent meeting that the past year had been an exceedingly satisfactory one. The profit was £546. 4s. 2½d., which, with £22. 14s. 6½d. from last year, made £568. 18s. 9d. to be dealt with. The directors proposed to pay 7½ per cent. dividend on ordinary shares, £143. 12s. 6d., and the 5 per cent. preference dividend; to place £225 to depreciation fund, £75 to reserve and to carry forward £56. 6s. 3d. The output had increased during the year, due, in part, to new consumers for lighting, but mainly to heavy day loads for power purposes in addition to an all-night supply. The staff had been working at high pressure, and they owed much to the engineers and staff. Messrs. Edwards & Armstrong had been running the plant since the company started, and their manager (Mr. James) had proved himself a great asset in the economical running of the works. The electric light had been a great boon to the town, and but for it there would have been at times a serious position. It had stepped in many times and prevented works being closed.

YORKSHIRE ELECTRIC POWER CO.—The net profits, after payment of bank and other interest, for the half-year ended June 30 was £17,617, against £13,550 for the corresponding half-year in 1916 and £9,873 in 1915. The dividend for the half-year on the amount paid up on the 6 per cent. cumulative preference shares was paid on the 1st inst. In view of the financial conditions arising out of the war, the directors are deferring the payment of a dividend on the ordinary shares until the accounts are made up for the year. The new 6,000 kw. turbo-alternator will shortly be running on load. In consequence of increased demands for current, it has been found necessary to place on order a further unit of the same size, for which space was provided in the new engine house at Thornhill.

CITY NOTES.

CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY CO. (LTD.) The directors have declared an interim dividend on the ordinary shares of the West End undertakings for the half-year ended June 30 at the rate of 4 per cent. per annum.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—An interim dividend at rate of 3 per cent. per annum has been declared on the ordinary shares for the past half-year

CITY OF BUENOS AYRES TRAMWAYS CO. (1904) (LTD.)—A dividend of 1s. 3d. per share (5 per cent. per annum), less tax, has been declared for the quarter ended June 30.

ELECTRICAL ENGINEERS' AMALGAMATION.—Some time ago the directors of Messrs. Dick, Kerr & Co. (Ltd.) acquired a controlling interest in Messrs. Willans & Robinson (Ltd.) and the holders of the 4 per cent. "B" preference stock of Willans & Robinson are being offered the equivalent of £65 per £100 stock, viz., either in cash or 50 6 per cent. cumulative preference shares of Dick, Kerr & Co., the object being to bring about a still closer fusion of interests between the two concerns.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—At an extraordinary general meeting last week the resolution (passed at the recent meeting) to increase the capital by the creation of 250,000 new shares of £1 each was confirmed.

METROPOLITAN RAILWAY CO.—For the half-year ended June the regular dividend on the preference stock and an interim dividend at the rate of 1 per cent per annum on the ordinary stock have been declared.

NORTH LONDON RAILWAY CO—The directors have declared an interim dividend of £2 per cent. for the half-year ended June 30 last on the consolidated ordinary stock.

Digitized by Google

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—Edinburgh Corporation increases the charge for electric lighting from 3⅛d. to 3¼d. per unit!

* * * *

MOTTO OF THE MOMENT (after the Hackney judgment).—"Sweet are the uses of diversity."

* * * *

I am inclined to agree with a correspondent that after its recent experience of preferential charges for electricity, the Gas Light & Coke Co. and doubtless the gas people generally will agree that the subject is getting a bit Hackneyed.

* * * *

The lady tracer is now in our midst. There's no mistaking the fact, for the other day I saw a blue print on which the nuts were shown with *eight* sides. As it happened the drawing was of a piece of gas apparatus, and I suppose it ought to have nuts of a different kind to those used by ordinary engineers. The gas industry must justify its existence—if only by being distinctive! * * * *

With characteristic engineering foresight the B. T.-H. Co. has sand-bagged the entrance to its Cannon-street office. If you are in the neighbourhood during a raid you'll be as safe as in a 30-ft. dug-out. I can imagine that this simple and effective expedient will be copied in the city, which will then really look as if "there's a war on!"

* * * *

ENGINEERING TERMS ILLUSTRATED:—BELTING.
[From "Glover's Almanac."

* * * *

Mr. J. Christie, chief electrical engineer of Brighton, in acting as co-consultant with the electrical engineer of Londonderry, has carried the idea of inter linking an important stage further. He has established an important precedent for co-operation in the electricity supply business which I hope will become reciprocal. Mr. Long, of Norwich, might, for instance, collaborate with the engineer of Limerick, and Mr. Street might introduce Southampton methods at Fort William. The idea becomes even more attractive if the Air Board can be induced to place aeroplanes at disposal to save railway fares!

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, July 31, 1880.]

THE TELEPHONE AND FIREDAMP.—It is well known that if a long dry tube, open at both ends, be held over a jet of burning hydrogen a musical sound is produced, the pitch and quality of which vary with the length, thickness and diameter of the tube. It has been proposed to adapt such a tube to a safety lamp underground, and to place it near a telephone in communication with another telephone in the manager's office on the surface. The alteration of the sound, due to a greater or less admixture of gas with the air of the mine would warn the manager of the state of the atmosphere in the workings.

SWANSEA.—During the Sunday School Centenary Service the strains of the chorus in the music hall were distinctly heard at the end of the telephonic circuit of nearly a mile in length. The apparatus was fixed by Mr. J. Legg, who is about to connect the Velindre Waterworks with the town hall, a line 9 miles in length. We hear that the same gentleman has just received an order from Madame Adelina Patti to put up a line between her castle (Craig-y-nos) and Penwyllt railway station, so that orders for carriages to meet guests may be given. The telephone used is the Gower bell, which gives great satisfaction.

Australasia.—The Borough Council of Waitara (N.Z.) has secured a licence to establish and work electricity supply works.

Electric Cranes.—At a recent meeting of the Wellington (N.Z.) Harbour Board the chairman said the experience gained in the recently built and equipped stores demonstrated the value of electric cranes, and the early installation in practically all the largest sheds of electric travelling cranes, as authorised, would be a sound investment, and were it possible to purchase the electrical plant it should be installed even at present cost. The use of hand-trucks should now be largely discontinued in favour of motor-traction.

Canada.—It is officially announced that land, water rights, &c., at Point du Bois Falls, on the Winnipeg River, have been leased to Winnipeg Municipality for the development of electric power.

The shipments of molybdenite from the Province of Quebec during the past year amounted to 129,275 lb., valued at £25,800.

It is reported that inexhaustible deposits of manganese dioxide have been discovered in Cypruss Hills, Alberta.

Straits Settlements.—Official records show that the following were amongst the imports into the Straits Settlements in 1916 from (*a*) the United Kingdom, (*b*) the Continent of Europe, (*c*) Japan, and (*d*) the United States of America:—

Electrical machinery, (*a*) £33,579, (*b*) £3,159, (*c*) £1,755, (*d*) £234; engines, boilers, and parts, (*a*) £68,563, (*b*) £12,810, (*c*) £234, (*d*) £25,389; telegraph and telephone materials, (*a*) £81,900, (*b*) £2,574, (*c*) nil, (*d*) £2,106.

Brazil.—In a report on the development of British trade in Brazil, the British Consul at Pernambuco reports that local conditions and requirements should be ascertained and carefully complied with.

One of the most important conditions of successful trading with Brazil is a thorough acquaintance with the Brazilian Customs tariff. It is often possible to avoid paying heavy duties by devoting careful attention to weight and other details, such, for instance, as the addition of paint, which frequently (*e.g.*, in the cases of iron, steel, &c.) brings an article under a class paying double the duty charged on an unpainted article. These remarks apply also to packing. And care must be taken to state correctly in the invoices the gross weight of packages (*i.e.*, the total gross weight), the gross weight of merchandise (*i.e.*, the weight of merchandise with the covers), and the real net weight (*i.e.*, weight of the merchandise only, exclusive of all packing and covers). Catalogues and price lists should invariably be printed in Portuguese.

Russia.—In a report by H.M. Consul at Ekaterinburg (Mr. I. Preston) it is stated that there is a good deal of business to be done in scientific and laboratory instruments and apparatus, which were formerly imported almost exclusively from Germany. British firms appear so far to have limited their efforts towards obtaining this business to the forwarding of catalogues in English.

IGRANIC "Z" Type Self-Acting Motor Starter

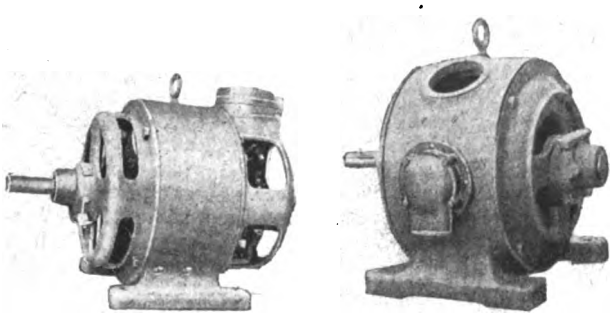
No. 110. Self-Acting Starter.

RELIABLE, EFFICIENT, ECONOMICAL, LABOUR SAVING.
For Automatic Control of Motor Driven Pumps, etc.
IGRANIC ELECTRIC Co LTD 147, Queen Victoria Street, LONDON.

Digitized by Google

SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current. For Three-phase Current.

for
ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350 Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

FOR
High and Low Tension
SWITCHGEAR

THE
NEW SWITCHGEAR CONSTRUCTION CO., Ltd.
SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

GLUE POT HEATERS
SOLDERING IRON HEATERS
WAX MELTERS, METAL POTS
CORE DRYING OVENS
ENAMELLING OVENS
IMMERSION HEATERS
HOT PLATES, AIR WARMERS

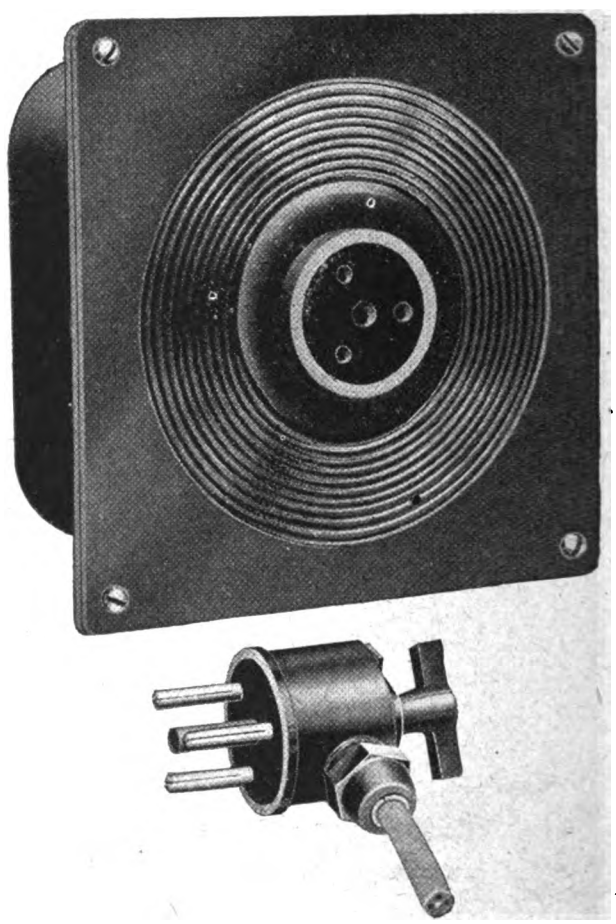
and all kinds of special Electrical Apparatus for Munition Works, Shell Filling Factories and all manufacturing purposes.

BELLING & CO.
DERBY ROAD WORKS,
Montague Road,
EDMONTON, N. 18.

COMBINED SWITCH, WALL SOCKET AND PLUG.

The problem of connecting portable apparatus to a permanent source of supply has occupied the thoughts of electrical manufacturers for a number of years, but their principal efforts have been directed towards the production of a convenient, small and artistic design of wall plug and socket suitable for use in private houses. With the introduction of portable electrical apparatus into factories this problem has assumed difficult proportions, and the Home Office regulations has still further complicated the problem.

To comply fully with the demands of the Home Office, and also with the requirements of factory engineers, it has been necessary to design a wall socket and plug which, while being of thoroughly sound mechanical construction, provides that (*a*) the wall socket must be combined with a multipolar switch, by means of which the tubular contacts in the socket may be rendered "dead"; (*b*) the plug must be so interlocked with the switch and socket that it is impossible to insert the plug while the switch is "on" and the tubular contacts "live," and it must also be impossible to withdraw the plug unless the tubular contacts are "dead"; (*c*) the multipolar switch must break contact on each pole; (*d*) the apparatus must be efficiently earthed, and it must be impossible to break the earth unless all the contacts are rendered "dead"; (*e*) the plug having been withdrawn, it must be impossible for anyone to turn the switch on, and thus make the tubular contacts in the socket "live"; and (*f*) the apparatus must be so constructed that, if necessary, it can be rendered absolutely watertight, and also flameproof for use in mines.



Messrs. Donovan & Co., 47, Cornwall-street, Birmingham, have recently designed and patented a unique type of wall socket and plug which, while combining great mechanical strength, fulfils all the above requirements.

The socket and switch are enclosed in a cast-iron case, which can be rendered watertight and flameproof. The switch is of the multipolar type, acting on each plug contact, and is so arranged that when the plug is withdrawn the contacts are "dead," and cannot become "live" unless the plug is inserted. The mere act of inserting the plug does not operate the switch, as has been the case in all previous designs. In the design under notice the plug is provided with a key, which operates the switch by turning to the right or left, and the plug is so arranged that it cannot possibly be withdrawn unless the switch is in the "off" position, and, further, if the switch and socket were removed from the case, and the switch were put on before being returned to the case, it would be

Digitized by Google

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite—Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1912 to 1917.

ATTWATER & SONS,

Telegrams: Attwaters, Preston. Telephone No. 1045 (2 lines).

Hopwood St. Mills, PRESTON.

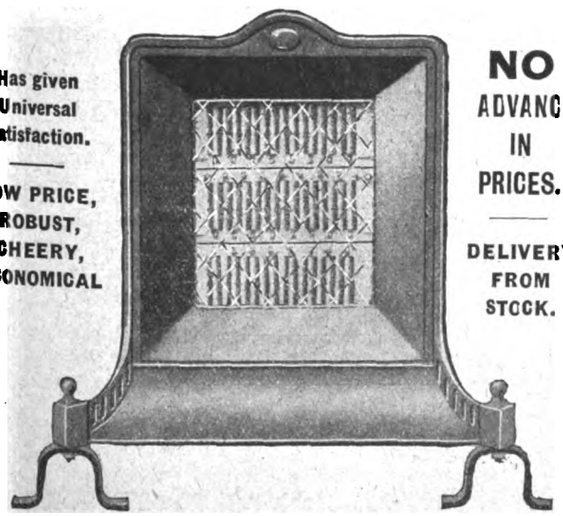
Established 1868. Codes: 5th Edition A B C & Western Union.

— THE —

ARORA

ELECTRIC

FIRE



Has given Universal satisfaction.

LOW PRICE, ROBUST, CHEERY, ECONOMICAL

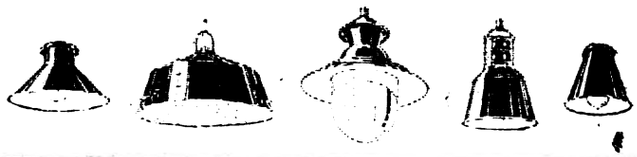
NO ADVANCE IN PRICES.

DELIVERY FROM STOCK.

Write for LIST G (Fires and Cookers).

to Sole Manufacturers—

THE ARORA CO., LOUGHBOROUGH.



THERE IS A SEARCHLIGHT ON FACTORY EFFICIENCY

SOONER or later the Factory Acts will compel good lighting.

Why wait for compulsion, when money can be saved by dealing with the matter now?

The greatest waste of to-day is that of artificial light in our factories. Millions of tons of coal are burnt, and much human effort is spent, to produce electric light, of which a large proportion is wasted in glare, and in the creation of shadows, and thus the light which was intended to add to our national efficiency is made to militate against it.

With Simplex Steel Reflectors properly installed, every ray of light is diverted to useful work, there is no glare, and there is "Efficiency and Economy."

Simplex Conduits Limited

Works: Garrison Lane, BIRMINGHAM

113-17, Charing Cross Rd., London, W.C.
16, Corporation Street, Manchester.
72a, Waterloo Street, Glasgow.
61, High Bridge, Newcastle.
11, Denmark Street, Bristol.
96, Whitechapel, Liverpool.
6, White Horse St., Leeds.
14, Heathfield St., Swansea.
4, Westgate St., Cardiff.
1, Crimon Place, Aberdeen.
281-3, Attercliffe Common, Sheffield.

Digitized by Google

FOR

SLIDING RHEOSTATS

CONSULT

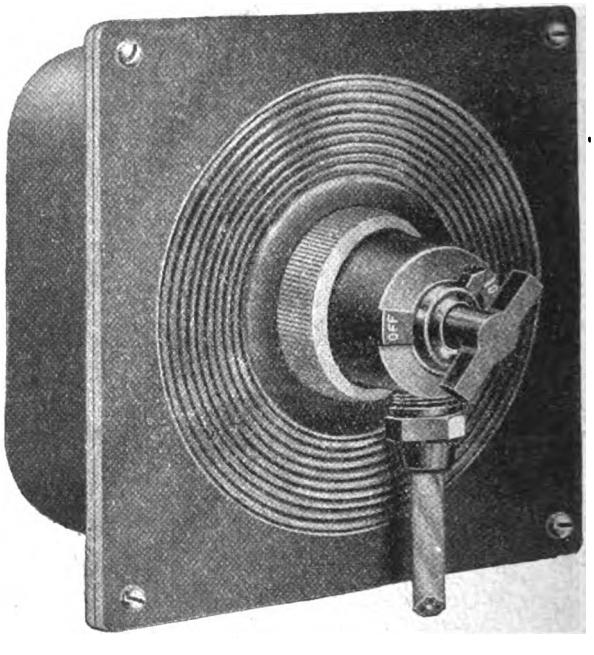
ISENTHAL & CO., LTD.,

(DEPT. 4)

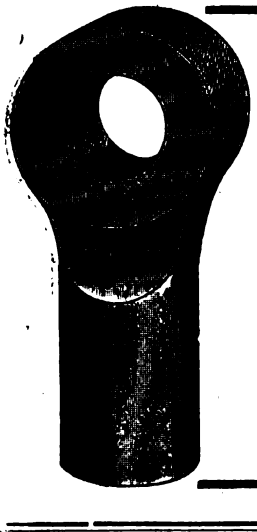
Denzil Works, Willesden,

London, N.W. 10.

impossible to insert the plug. The switch is of the quick break rotary type, with absolutely free handle arranged so that the switch cannot be held in semi or partial contact. The socket is made of a solid block of ebonite thoroughly shrouded in massive metal case, and the plug consists of a solid block of ebonite similarly shrouded in heavy metal casing.



The whole of the apparatus is, in addition to being a perfect electrical device, a thoroughly sound mechanical article. There should be a great demand for the apparatus, which is shown in the above illustration, for factories, shipyards, iron works, motor garages, coal mines and on steamships, and no doubt it will also be largely used in connection with stage lighting and heating in theatres, &c.



E. SHOWELL & SONS, LTD.

STIRCHLEY, BIRMINGHAM.

Cast

Cable Sockets.

Suite E74. Made in all Sizes.

Type A.—Straight.
„ B.—Offset.
„ C.—Right angle.

Illustrated Dimensioned Showcard for Drawing Office use supplied free on application.

Sole Agent for the Electrical Trade:—

LIONEL ROBINSON, 3, Staple Inn, London, W.C.

TELEPHONE: *Holborn* 6323.

THERMOSTATIC METAL.

The General Electric Co. (of New York) has placed on the market a "thermostatic metal," which bends or regains its original straightness in accordance with well-defined laws as the temperature rises or falls. The "Electrical World" states that as a result of this responsiveness to temperature change and the mechanical force developed the metal is used to actuate various mechanisms which end to neutralise either the temperature change or its effect upon devices.

The metal consists of two strong non-corrosive metals possessing widely different coefficients of expansion, the widest difference possible, it is said, for any known stable combination of metals. These two metals are firmly attached to each other throughout their entire length, so that there is absolutely no slipping of one metal on the other. The metal can be cut, stamped or pressed into practically any desired shape, and when annealed will have all its original inherent qualities. Moreover, it will not deteriorate nor take permanent "set" under applications of heat or force within definite practical limits. The metal is manufactured in various standard thicknesses ranging from 0·25 in. to 0·015 in., maximum width of 4 in. and maximum length of 36 in. As an indicator the metal is remarkable, as it can be used for temperatures as high as 500°F. The deflection per degree of temperature change, besides being quite considerable, is a constant for any definite piece of the metal.

H. Weidmann, Ltd., Rapperswil, Switzerland.

WE ARE SPECIALISTS IN THE MANUFACTURE OF—

PRESSPAN (2)

(Pressboard)

Best Quality.——Proved by repeated tests.

Sheets in thickness from 0·1 upwards.
Endless Rolls and Strips from 0·1 to 1 mm. thickness.
Presspan Coils and Tubes for Transformers.
Presspan Armatures, Discs and Shaped Articles.

VARNISHED PRESSPAN. BLACK PRESSPAN.
OILED PRESSPAN. MICA-COVERED PRESSPAN, &c.

Grand Prix: Marseilles 1908. Gold Medal: Berne 1914. Silver Medal: Paris 1900.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

PRESCOT INSULATING VARNISHES

We have a good range of these well tried varnishes and enamels.

The following are some of their principal features:—

PERMANENTLY ELASTIC
HIGH INSULATING VALUE (even when insufficiently stoved)
PENETRATING
CONSISTENT
LASTING
WITHSTAND HIGH TEMPERATURES
MAY BE STORED WITHOUT A SPECIAL LICENSE
NO EXCESSIVE LOSS BY EVAPORATION

Our Yellow and Black Stoving are eminently suitable for Field, Armature, and Transformer Coils, and have been proved of great value in protecting metal surfaces, both as an electrical insulator, and as a preservative against adverse atmospheric conditions.

Let us know your requirements, and we are confident we can meet them.

BRITISH INSULATED & HELSBY CABLES. LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

QUARANTEED SECOND HAND

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Viamaster, Sowest London.

For Effective Impregnation

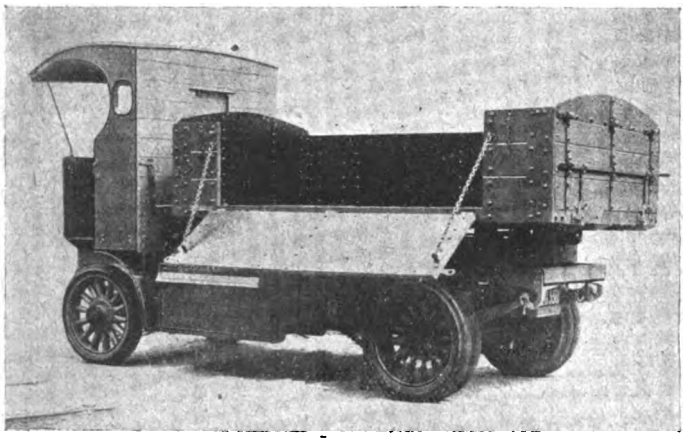
use "LACWATT"
Black or Golden Brown.
JENSON & NICHOLSON, Ltd.,
Insulating Varnish Department.,
Goswell Works, Stratford, E.15.

Digitized by Google

Since a definite and considerable opposing force is necessary to cause the metal to take permanent set, the metal can, it is claimed, be depended upon when used in devices where extreme accuracy is required. If the curving of this thermostatic metal on heating or cooling is opposed, the metal will produce a mechanical force, which is limited only by the force required to produce permanent set.

ELECTRIC TIPPING VAN.

The electric vehicle is making such rapid progress in this country, and local authorities, railway and transport companies, manufacturers, merchants and others have found it so useful for a variety of purposes that it is being employed for an ever widening circle of commercial and industrial work. Many local authorities, especially those



who own electricity works, are becoming users of the electric vehicle. The latest converts are the Kettering Urban District Council, to whom the General Vehicle Co. (Ltd.), of Imperial House, Kingsway, W.C., recently supplied a 3½-ton electric tipping van for the conveyance of coal. The body of this van has a side opening 8 ft. long to facilitate loading on a relatively low level, or approximately at the height of the average railway wagon, so that the great majority of the load is put on without any material lifting. The vehicle, which is shown in the accompanying illustration, is one of the company's standard model 3½-ton chassis. There are 44 cells of the Ironclad I.M.V. 8 type, and the capacity is 252 ampere-hours. It is hand-operated, and it can be completely tipped in two minutes. The tail gate is of a special design, with a wedge-shaped latch, which can be operated on either side by one horizontal pull. The body is wood, but steel-lined for purposes of strength, and elevates to an angle of 45 deg.

ELECTRIC MELTING OF NON-FERROUS METALS.

"Metal Industry" says there is no doubt that non-ferrous metals, including nickel, brass, copper, tungsten and various alloys, will be melted very frequently by electrical means in the near future. Many experiments have been carried out with a view to ascertaining the type of furnace best adapted to this work, but no universally applicable conclusion has yet been reached.

The arc furnace is probably the most economical, but there may be serious loss by volatilisation of such metals as zinc, tin and even copper. It is easier to control the temperature of the resistance furnace than that of an arc furnace; but the Hering furnace (in which the metal itself is the resister) and the induction furnace can only have a limited application to melting non-ferrous metals, owing to the high conductivity of the latter. The Hering "pinch-effect" furnace is said to require about 280 kw.-hours per ton of light brass or bronze chips, melted.

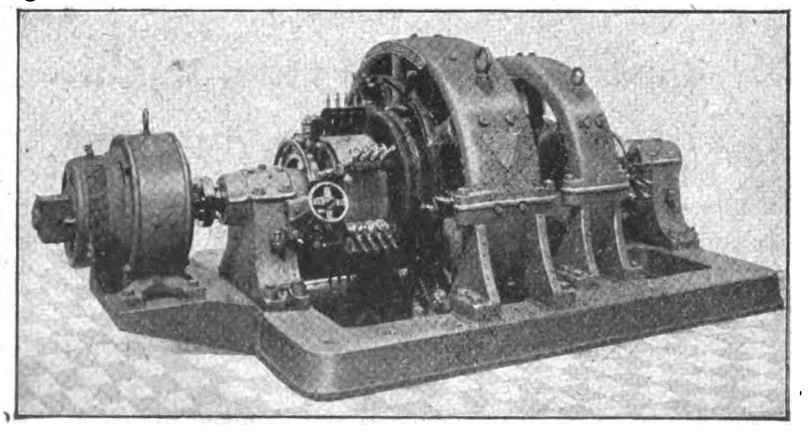
Many non-ferrous metals can be melted conveniently in the Hoskins furnace, which uses carbon resister plates to heat a crucible. In the Hilberger furnace the crucible itself is made the resister, and is said not to last long in brass melting. In any case much energy is saved if melting be performed without giving the furnace time to cool down. For a similar reason electric tilting furnaces are more economical than the crucible-lift-out type. According to H. M. St. John, 280 or 380 kw.-hours are needed per ton of yellow or red brass respectively, melted in a tilting furnace operated continuously. If power is used for only 10 hours a day, the consumption rises to 400 or 500 kw.-hours per ton. With the crucible-lift-out furnace the consumption is about 43 per cent. higher than the preceding data. Both the Heroult steel furnace and the Rennerfelt arc furnace have been recommended for the electric melting of copper. Dr. Stansfield considers that the Rennerfelt furnace is the most promising arc furnace for all non-ferrous metals.

VICKERS LIMITED.

Motors and Generators of all types.

Rotary Converters.

Complete equipment for the electrical lighting and driving of Machine Shops, Factories, Mills, etc.



Patent Automatic Reversing Drive for Machine Tools.

250 K.V.A. Rotary Converter. 6 phase, 50 periods, 480/560 Volts. 1,000 r.p.m. Inverted type.

River Don Works, SHEFFIELD.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,047. [Vol. LXXIX. No. 19.] FRIDAY, AUGUST 10, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES	727
Arrangements for the Week	729
Short-Circuit Heating in Power Stations and Transmission Lines. By Ludwig Binder	730
Siemens Rotary Converters. Illustrated.—*Concluded*	731
Multiplexing in Cable Telegraphy. By George O. Squier, Ph.D. Illustrated	733
Notes on the Design of Electromagnetic Machines. By Stanley Parker Smith, D.Sc. Illustrated.—*Continued*	734
A Study of Electromagnet Moving Coil Galvanometers for Use in Alternating Current Measurements. By Ernest Weibel. Illustrated	738
The Engineer in National Affairs	741
GREAT BRITAIN'S POSITION IN ELECTRICAL DESIGN	742
The Vector Analysis of Electrical Vector Diagrams. By A. Press.	745
Electrical Trade Anomalies. By J. M. M. Munro	746
The I.M.E.A. and the Electrical Industry	746
Industrial Fatigue	747
Government Control of Trade	747
A Thermo-Couple Potentiometer and Other Instruments. Illus.	748
Volunteer Notices	748
COMMERCIAL AND INDUSTRIAL SECTION	751
Electricity Supply	752
Tenders Invited and Accepted	756
Financial Matters	757

NOTES.

The Minister of Reconstruction.

THE debate in the House of Commons last week on the resolution to create a Minister of Reconstruction at a salary not exceeding £2,000 per annum showed, on the part of certain members, a great lack of appreciation of the enormous problems which lie before us on the advent of peace. The present state of affairs has come about slowly. Changes have been most drastic, but there has been time for public opinion to realise the needs of the nation before each step was taken. The converse process, on the other hand, may be comparatively rapid; in fact, in some directions it may be far more rapid than is desirable, and this rapidity may be a source of considerable danger. The only way to avoid such dangers is to appoint a Minister to co-ordinate, from the point of view of reconstruction, the various Government Departments concerned, and to look well ahead to see what steps may be necessary. For these services a sum of £2,000 per annum is a modest expenditure, and need cause no complaint. If no such Minister is appointed, it is obvious that the War Office, for example, would consider merely what men are required for the Army, and may proceed to disband accordingly. Similarly, the Ministry of Munitions, faced by no further need for war material beyond very modest requirements, may forget the vast problems involved in suddenly cancelling orders for munitions. If troublous times are to be avoided, it will be essential to consider the needs of the civilian population, the needs of industry and the requirements of the Army and Navy, as well as questions of reconstruction at home and abroad, in such a manner as to bring about the most effective results with the least inconvenience to the nation. We think it will be clear to any person who realises the magnitude of the task before us, that a single responsible Minister for such a purpose is essential.

Government Control of Trade.

IT is only natural that the increasing control of trade by the Government should give rise to a good deal of anxiety, and that doubts should be raised as to whether the Government is following the best course in its methods of control, admitting that control is essential. From this point of view the report of the Merchants' Committee of the London Chamber of Commerce merits serious consideration. The Committee regrets that the Government has not uniformly availed itself of the services of the mercantile community, with its exceptional knowledge of sources of supply, and its organisation, which has given the United Kingdom its unique position as an emporium of the entire world. The Committee has, indeed, been forced to the conclusion that the Government look on the merchant community as practically useless to the Empire and generally unworthy of consideration. We are not surprised that this conclusion should have been reached. So long as those in the Government civil service, in the army and in the navy, assume an air of superiority, and look upon the remainder of the population as persons of small value and less intellect, inefficiency is bound to result. The intricate basis on which the commercial supremacy of the Empire is based is largely not realised by those who seek to control trade on behalf of the Government, and thus control has often led to higher, instead of lower, prices and to scarcity. It is, therefore, of great importance that the services of merchants and others who are fully acquainted with the conditions should be utilised in dealing with trade problems. If those who normally handle trade have a proper understanding with the Government as to what is essential, we do not doubt that a suitable policy can be arranged, and that the results would be far better for the country generally than if a policy is pursued which consists in disregarding those who have handled the trade of the country for years. It is, of course, important that large profits should be avoided, but this could surely be effected and the desired results obtained notwithstanding.

Electricity Supply.

PENDING the publication of the report of the Board of Trade Electrical Trades Committee, a statement has been issued by the Incorporated Municipal Electrical Association stating their policy in general terms. As to why the report of this Committee should be so long delayed is not clear, the only explanation occurring to us being that a part of the Committee's work has now been handed over to the Board of Trade Electric Power Supply Committee, whose inquiries will, of course, be more comprehensive on this part of the subject, and whose findings should carry more weight in regard to electricity supply than those of a committee dealing with the electrical industry as a whole, and who would regard electricity supply merely as one of many branches. We are glad to notice in the statement by the I.M.E.A. that there is no hesitation in supporting the policy of generation by large power stations. The view is also expressed that these large stations could best be controlled and operated by district boards consisting of representatives appointed by the present statutory undertakings. The Council recognises that the transference to district boards

Digitized by Google

of some of the powers now exercised in regard to the generating side of the business may not commend itself to some existing undertakings; but as far as generation is concerned, which is the most important part from the point of view of low cost, it is evident that the Council is not willing to let individual interests hinder the proper development of the industry. Some reference is made to the Board of Trade Electric Power Supply Committee, and it is interesting to note that the three members who were recently added to this Committee to represent municipal interests were appointed without reference to the I.M.E.A. or to the individual municipalities concerned. This probably accounts for what, in our opinion, were somewhat unsatisfactory nominations.

Over-Specialisation in Engineering.

IN his Rede lecture for 1917 Sir RICHARD GLAZEBROOK, while agreeing with the view that over-emphasis of the compulsory study of Latin and Greek has harmful results in education, also referred to a certain danger of excessive specialisation and want of enthusiasm in instruction in scientific and technical subjects. Courses in electricity and physics, for example, are apt to become dull and stereotyped, and in their worst form have the same bad features that characterise the compulsory study of Greek and Latin grammar. This is especially true in preparation for examinations. The real problem is to devise educational methods which give the necessary familiarity with technical details and yet allow openings for wide views and an inspired outlook, without the cramping and narrowing effect of undue specialisation. Moreover, sufficient distinction is not, as a rule, drawn between instruction frankly intended for the expert and education in general scientific principles intended to convey some ideas of the wonder and possibilities of applied science to the public. Of this wide form of scientific education we have too little. There is a tendency for scientists and engineers to become specialists in their respective branches, while those outside professional engineering and scientific circles have little sympathy or understanding of such subjects. The most hopeful method of combating these tendencies lies in the co-operation between scientists and engineers of different types, both with a view to mutual education and the dissemination of knowledge in an interesting form among outsiders. This idea was well expressed by Mr. H. W. BUCK in his recent presidential address to the American Institute of Electrical Engineers. The engineer, he remarked, needs to remember that he is also a citizen—that the methods he applies professionally need to be also understood and appreciated in daily life. In order to bring this about the specialist must be able to take wide views, must be able to convey lucidly and agreeably the aims that science and engineering have in view, and must himself have the open mind which is capable of receiving new impressions. In particular he must prove by example the incorrectness of the popular view that the engineer is an intellectual machine without heart or imagination. On the contrary, as Mr. BUCK remarked, the greatest engineers and scientists have often combined mechanical skill with imagination, artistic perception and interests of the widest kind. In its highest form the scientific spirit is also conducive to humane ideas, and is in no way associated with the callous disregard of the claims of others, as the present conflict has led some people to imagine.

The "Beama Journal."—The July number of the quarterly "Beama Journal" contains a number of interesting articles. An editorial combats the conception, apt to be engendered by the war, that science is a friend to despotism, associated with the Prussian military caste. On the contrary, science is equally reconcilable with democracy: "The danger is not in Nature herself, but in the *nature of man*." The author of "British Manufactures in Russia" considers that great opportunities for British industry exist in Russia, if preparations are made at once. As a purely technical contribution we have a description of the "Split Conductor Protective System" by Mr. E. B. Wedmore. Mr. G. Forero draws an interesting picture of "The Electrical Industry in the Andes," and Mr. Broadbent's article on "Electric Railways in Great Britain" is concluded from the April issue. Mr. T. C. Elder emphasises the need for fuller publicity on the applications of electricity, a matter that will require immediate attention after the war.

Observations of Atmospheric Electricity and Ocean Magnetic Work.—A series of volumes reprinted from the publications of the Carnegie Institute, Washington (U.S.A.), describe in detail the work undertaken by the "Galilee" (1907-8) and the "Carnegie" (1909-1916) in connection with electric and magnetic observations at sea. The three volumes before us deal respectively with ocean magnetic work and atmospheric electric observations, records of which are presented in a very complete and elaborate way. The accurate determination of the intensity of the earth's magnetic field at sea naturally offers special difficulties, such as do not occur in a well-equipped laboratory on land, and magnetic storms can also be reckoned with, although their effect seems to have been relatively small and transient. In the earlier researches on the "Galilee" the observer had also to contend with the difficulty of a magnetic ship. The design and mounting of the various instruments are described in great detail, and this collection of data presented will no doubt constitute a valuable record.

"Journal" of the Municipal School of Technology, Manchester.—The most recent volume (No. 8) of the above journal contains a series of communications on very varied topics. Among other contributions we note "The Analysis of Energy Distribution for Natural Radiation," by S. Lees: "The Connection between Elastic Phenomena Exhibited during Slow Reversals of Stress and the Ultimate Endurance of Steel," by W. C. Popplewell: "Modern Boiler-room Practice and the Prevention or Abatement of Smoke," by J. T. Hodgson: "The Dilution Limits of Inflammability of Gaseous Mixtures," by H. F. Coward and F. Brinsley. Prof. Radcliffe writes on the training of engineers engaged on work associated with sanitation, and Messrs. Dempster Smith and H. Iinoya describe some suggestive experiments on lathe-finishing tools. Finally we may note an interesting contribution by J. Huebner on the history of dyeing. As usual, the journal is excellently got up, the printing being done entirely in the Department of Printing and Photography of the School of Technology.

Longest Power-Cable Span in the World.—The "Engineering News Record" gives an account of what is stated to be the longest power-cable span in the world—to be installed across the St. Lawrence river at the junction of the St. Maurice. This transmission, which is supplementary to the existing submarine cables, will require the erection of 10 towers supporting a 5,000 ft. span of three steel cables. The towers will be 350 ft. high and the span will exceed that across the Carquinez Straits in California (4,427 ft.), which is believed to be the longest in existence. The transmission will be at 100,000 volts and the insulation will present special problems. Insulators will be inserted between the ground and the tower supports, and these insulators, besides being subjected to a high electric tension, will each have to bear a mechanical stress of over 150,000 lb. The insulator group will consist of an elaborate arrangement of porcelain units of a new type subjected to pressure only and held together by an iron frame. Provision will be made for the replacement of any damaged parts without interfering with the mechanical safety of the span. It is hoped that the project will be completed by the end of the summer.

Memoirs of the Kyoto Imperial University.—We have recently received a series of publications of the Kyoto Imperial University. They are printed in English, and excellently got

Digitized by Google

up, and, except for a slight peculiarity in phrasing here and there, might have been the work of British students. Many of the Papers deal with matters of general chemical and physical interest, such as the "Studies of Solution," by Kajuro Tamaki; "Spark and Vacuum Arc Spectra of Some Metals in the Extreme Ultra-violet," by T. Takamine and S. Nitta; and "The Effect of an Electric Field on the Spectrum Lines of Hydrogen," by T. Takamine and U. Yoshida. The latter is also responsible for a well-illustrated account of some researches on the effect of Electric Discharges on Photographic Plates. Vol. I. (1916) contained several notes of engineering interest, such as "Disturbing Actions of a Shaft Governor," by G. Hamabe; "Combined Bending and Torsional Strength of Cast Iron," by T. Matsumura and G. Hamabe; and "The Induction Motor under Cyclical Operation," by S. Noda.

Glasses for Protecting the Eyes from Injurious Radiations. A Paper by Mr. W. Coblentz, issued by the Bureau of Standards, U.S.A., describes representative groups of glasses designed to protect the eye from (1) ultra-violet, (2) visible and (3) infra-red rays. Their properties are explained by a series of diagrams showing the transmission throughout the spectrum. Ultra-violet rays, in excess, are known to be prejudicial to eyesight, and appear to have a chemical effect, penetrating to the deeper recesses of the eye. Infra-red rays and heat, which may also be injurious, seem to affect only the outer regions of the eye, and their influence appears to be essentially thermic. Their effect requires consideration in connection with furnace work, where they are, possibly, responsible for cataract. The group of amber-coloured glasses is effective for the suppression of ultra-violet rays, and have a relatively good transmission in the visible spectrum. Among the Crookes glasses, the sage green and pale blue varieties are useful as a protection against infra-red rays, and transmit a fair amount of visible light; a thin coating of gold has the same effect, but the transmission of visible light is not so good. The Crookes neutral tinted glasses enable objects to be perceived in natural colours, and have a high transmission in the visible, but are not so successful in stopping infra-red energy. Other varieties, such as the greenish brown, besides protecting the eye from ultra-violet rays, also check the infra-red rays to some extent. The selection of glass for special purposes requires care. For furnace work, bluish green and sage green glasses, which are a protection against infra-red rays, and yet enable the workmen to see the molten surfaces, are useful. On the other hand, for working molten quartz, for searchlight work, and for operating oxy-acetylene or electric welding, very dark glasses, *e.g.*, of the green and yellowish green varieties, are needed in order both to block the ultra-violet and infra-red radiations, and to protect the eye against the high visible intrinsic brightness.

The Place of Cambridge University in Science and Industry.—In delivering the Rede lecture for 1917 (of which we have now received a reprint), Sir Richard Glazebrook recently discussed some vital problems relating to the teaching and application of science. He referred to the vast amount of experimental work undertaken as a preliminary to progress in the construction of aeroplanes and engines for aircraft, on the trajectory of projectiles in high-angle gun fire, and in wireless telegraphy. Equally striking are the achievements of medical science in the war: the annual admission ratio for causes other than wounds is less than half that in most other campaigns, while in the case of enteric fever it is actually less than 1 per cent. of that prevalent in the South African War. Examples were also quoted of great results following the application of science to industry. In all cases, Sir Richard remarked, no real distinction could be drawn between "pure" and applied science, no one could predict what practical results might follow from a purely theoretical discovery. There was a great need, however, for trained men with the genuine scientific instinct to reduce scientific discoveries to a form readily assimilated by the manufacturer. Such men the universities should provide, and it would be necessary to review their traditional methods of instruction. While remaining essentially the home of ancient learning, the university should open its doors to all capable of or benefiting from any branch of knowledge which it offered, and insistance upon compulsory Greek was therefore not desirable. Even the teaching of science itself required revision. Although much had been done since he joined in the work at the Cavendish Laboratory, there was a tendency for the teaching of scientific subjects, especially in schools, to assume a dry and uninspiring form. The problem of the future was to provide a general education in science, such as would instil a lasting interest in the subject and an appreciation of its practical value.

The Utilisation of Irish Peat.—A correspondent in "The Times Engineering Supplement" points out that few coal mines are worked in Ireland, and in the present circumstances the utilisation of the vast peat areas of the country, covering about 2¾ million acres, deserves study. The matter is being considered by a committee under the Department of Scientific and Industrial Research, with Sir John Griffith as chairman. The drawbacks to the use of peat, apart from the question of transport, are its bulk, its relatively low calorific value, and the large amount of water contained. The commercial success of processes of compression and artificial drying is doubtful; but its use in producer plants offers more prospect of success. Several such plants are in operation in Ireland. In their weaving factory at Portadown Messrs. Hamilton Robb have installed a Crossley suction gas plant with a capacity of 400 B.H.P., to which peat is conveyed from the shores of Lough Neagh, 12 miles away. With peat at 5s. a ton, it is stated that power can be obtained at $\frac{1}{16}$d. per horse-power-hour. It is also pointed out that valuable by-products, such as refined pitch for asphalt, as a caulking material or for electrical insulation, are obtainable. Other derivatives of peat tar include candle wax, lubricating and burning oils and disinfectants. The utilisation of Irish peat would be rendered more feasible by the development of central producer gas plants and electric generating stations, which will no doubt be considered by the above-mentioned committee. Such stations might be located near peat bogs, and thus avoid transport difficulties. A successful instance of such a plant is afforded by the station of the Società per l'Utilizzazione di Combustibili Italiani at Orentana, in Italy. This plant is situated near a bog of 1,482 acres, and can gasify and recover by-products from 210 tons of air-dried peat in 24 hours. The total capacity is over 3,000 H.P., current being distributed at 30,000 volts over an area of 25 miles radius.

OBITUARY.

DEATHS ON ACTIVE SERVICE.—The death is announced of Lieut. James Nelson Payne, who succumbed to wounds received in action in East Africa. Before the war he was an electrical engineer with Messrs. Bruce Peebles & Co., for whom he was engaged on work in the Transvaal on the outbreak of war.

The following deaths on active service are also reported:—

Sec.-Lieut. Neville E. Baker (R.E.), aged 22, who was killed on July 31, was attached to the Tank Corps as a signalling officer. He was killed by a shell while inspecting a wireless telegraph installation which he had erected.

Capt. Andrew H. Scott (R.E.), aged 29, who was also killed on July 31, is said to have been one of the first British officers to take up wireless telegraphy.

Gunner Arthur Holt (R.F.A.), aged 22, formerly employed by the United Electric Car Co., has been killed in action.

Pte. J. Audsley (Liverpool Regt.), formerly employed on the Blackpool Corporation tramways, has been killed.

Gunner Geo. Wilson (R.G.A.), formerly employed on the Burnley tramways, has died of wounds.

Pte. H. Akred (S. Lancs. Regt.), formerly an Accrington tramcar conductor, has been killed.

PERSONAL.

MILITARY APPOINTMENT.—We are informed that Company Sgt.-Maj. Fenton (Lancashire Fusiliers) has been appointed a Second Lieutenant in the 3rd King's Liverpool Regt. He was a tramcar driver in the employ of the South Lancashire Tramways Co. prior to the war, and had previously served over 21 years with the Colours and retired with a pension.

Digitized by Google

SHORT-CIRCUIT HEATING IN POWER STATIONS AND TRANSMISSION LINES.*

BY LUDWIG BINDER.

The question arises as to whether there is an excessive generation of heat in the machinery, transformers or portions of the network, when the switches do not open at once on short-circuit. It seems obvious that the excessive current on short-circuit should be broken at once, in order to avoid electrical and mechanical stresses. With direct-current machines, excessive sparking makes this very necessary, and quick-acting cut-outs are, therefore, universally employed. In these cases the power stations used to be of moderate size, and from the 'bus-bars a number of consumers were supplied. If a short-circuit occurred on one of the connections, it could be cut out without affecting the others. Polyphase stations were originally similarly constructed. But with an extended field of operations, other methods were necessary; each consumer could not be separately connected to the power station. Vast networks have grown up, which can be subdivided by switches; experience has shown that these switches cannot be opened suddenly. On the many miles of transmission line, all sorts of momentary disturbances take place, and if the switches always opened there would be no question of any kind of continuous supply, and it is on this continuous supply that consumers lay the greatest stress. Therefore, switches on these kinds of circuit only open after the disturbance has lasted for a given length of time, which is usually fixed at something between 1 and 10 seconds. There are two different types of adjustment, and both are equally effective with heavy currents. But all the switches on a network are not adjusted to cut out with equal speeds. Small consumers on the outskirts are cut out first, and the switches controlling heavier currents cut out later. For instance, there may be several consumers joined up successively on one main, and switches would then be so arranged that they are cut out one after another, in periods varying from 1 to 5 seconds. Thus, if the short-circuit occurs at the extremity of this line, the furthest switch would open in 1 second, and relieve the rest of the line of any further burden. This grading of the times in which the cut-outs act prevents the whole line from being disconnected; in the case of a considerable network, these times may vary up to 10 seconds, and there is usually a difference of 1 second between two successive cut-outs. But these considerations are not always taken into account, and then complaints are made that the switches are not in order, owing to frequent occasions on which the cut-outs act. It is then generally found that there is no proper grading of the times, and that the generator cut-outs open at every trifling short-circuit. Some people seem afraid of allowing a short-circuit to continue, owing to the serious mechanical stresses. But these stresses are so sudden that the windings must be constructed to withstand them. An oscillographic record is given by the author, showing the current on the short-circuit of a 7,500 kw. machine. It shows that in 0·01 second the current reaches a maximum and then falls fairly quickly. The short circuit was broken by a switch with an automatic cut-out. In spite of the fact that it was set to operate instantaneously, this only took place after 15 periods; the frequency was 50, and the time occupied was, therefore, 0·3 second. The stresses are proportional to the square of the current, and are greatest at the first onset.

Another question is as to the temperature effects, and these will now be considered. The author includes some of the substitute-metals, now commonly used in Germany, such as iron, aluminium and zinc, in his consideration of the problem; but, in the present abstract, the case of copper will be the only one to be discussed. Suppose a conductor to be stretched freely in air and to carry a steady current, then its heating depends on an exponential law, and on the time-constant T, which for a wire with a diameter of 8 mm. is about 10 minutes. For our present purpose, the start of this curve is the important part, and is approximately a straight line. It may therefore, be assumed that the heat is stored up in the conductor, and this is true for machines, transformers and cables. The author then enters on simple mathematical calculations, which show that the heating depends on the physical constants and on the current density. The form of the section is of no importance; and it is assumed that the electrical conductivity is constant, though it actually varies with the temperature. (The author adds a note explaining how this variation of conductivity can, if desired, be taken into account.) These calculations lead to formulæ for copper, aluminium, zinc and iron, and a table of figures is added, showing how many degrees Centigrade the temperature rises in one second for different current densities. This table is reproduced below, it being understood that for longer periods the temperature-rise, as stated, must be multiplied by the number of seconds during which the short-circuit lasts.

Table showing the Rise of Temperature per Second for Conductors of Different Metals.

	Current density in amperes per square millimetres.									
	10	20	30	40	50	60	70	80	90	100
	Degrees Centigrade.									
Copper	0·6	2·3	5·2	9·3	15	21	28	37	47	58
Aluminium	1·4	5·4	12	22	34	49	71	86	110	135
Zinc	2·6	10	12	40	65	90	120	160	200	250
Iron	4·8	19	43	76	120	172	230	304	385	476

On short-circuit the losses in the copper conductors are the most serious in the case of generators, the iron losses being almost negligible in comparison. The heat is almost confined to the winding. The connecting pieces between the conductors in the slots are obviously in this category; they have time-constants ranging from 15 minutes to 1 hour. The conductors in the slots are in fairly close contact with the iron, to which they give off a good deal of heat. But to all intents and purposes, the temperature in the conductor rises according to the exponential law in a manner similar to that of a wire freely suspended in air. The time-constant is of the order of a few minutes; therefore, for a short-circuit, lasting less than 10 seconds, there is no question of any conduction of the heat to the iron. (This time-constant is quite different from that which is found for normal working of the machine, where it may vary from 15 minutes up to several hours, values, perhaps, 30 times that given above.) When the short-circuit arises, a very sudden rush of current takes place; the current then falls, but not entirely symmetrically until it reaches a final definite value. This is clearly shown by oscillographic records. Attempts can be made by exponential approximations to determine some kind of curve by which the first rush of current declines to the final value; knowing the final value, we can then determine approximately the value of the first rush of current. In unfavourable cases the first rush may reach a value equal to 15 times the normal current, and the final permanent value of the short-circuit current would be at the most three times that of the normal current. The normal current-density would be between 2 and 3 amperes per square millimetre, and may be taken in large machines to have an average value of 2·5 amperes per square millimetre. From formulæ and curves, which are used as approximations, the author deduces on this basis the following results, viz.:

Length of short-circuit in seconds	21	2	5	10
Current density in amperes per sq. mm.	7	22	15·5	12
Rise in deg. C.	4·3	5·7	7	8·5

Actually the figures would be rather higher than these, as the effective resistance might easily be twice the direct-current resistance. In spite of this, there can be no serious question of any dangerous heating.

In the case of transformers, it is easily seen that, when the short-circuit arises, all the heat is stored in the windings. In the case of air-cooled transformers, the iron core is the only thing that could absorb any of the heat, but as it is separated by an air-gap or by thick insulation, it is impossible that in the short period during which the short-circuit lasts, there should be any large heat exchange. In oil-cooled transformers, things are certainly different; the oil is certainly in intimate contact with the windings, but the heat which passes into the oil is still negligible. Even for the outer layers of the windings, there is a time-constant of the order of several minutes. The strength of the short-circuit current depends on the conditions of operation. Suppose the transformers to be connected between the generators and the 'bus bars; then, in case of a short-circuit between one of the transformers and the 'bus bars, the current through the transformer can in no case be greater than that given out by the generator. The transformers introduce inductive and ohmic effects; the currents, therefore, have somewhat smaller values than in the case of generators, which have just been considered. The heating effects may be taken as 85 per cent. of those for the genrators alone. The current density in transformers varies within wide limits according to the make. For heavy outputs, it may be taken at 2·5 amperes per square millimetre, which is about the same as with generators. Thus, if the short-circuit lasts even as long as 10 seconds, calculation shows that the temperature might rise as much as 6°C., and this is negligible.

The case is, however, not so favourable when the transformers are supplied from the 'bus bars to which the generators are directly connected. Then a short-circuit on the consumer's side of a transformer is fed by all the generators. This case is, therefore, different. By the aid of formulæ and elementary considerations, the author comes to the conclusions on which the following table is based. The

* Abstract of an article in the "Elektrotechnische Zeitschrift," Nos. 44 and 45, 1916.

Digitized by Google

conditions are admittedly rather complicated, but these figures give an approximation of results which may arise under the circumstances :—

Length of short-circuit in seconds.....	1	2	5	10
Mean current density in amp. per sq.mm.	51	45	38	35
Temperature rise in deg. C.	15	23·5	42	70

The highest short-circuit current densities occur in transformers in the case in which a relatively small transformer is connected to the 'bus bars of a large power station. This case always occurs when current is taken for auxiliary purposes in the power station from such a transformer. If there is a short-circuit on the low-tension side, then the current is limited by the relatively high transformer resistances. The reaction on the generators cannot be great, and the voltage is maintained to a large extent. In such a case the continuous short-circuit current is practically the same as that which flows at the first onrush. Calculations show that in such a case there may be a rise of 33°C. in a second. There ought, therefore, in such cases to be no great delay before the switches open. In case, however, this is thought inexpedient, the short-circuit current should be limited by increased magnetic leakage in the transformer or by special choking coils. In all cases in which the transformer is joined to the power station by a considerable length of cable, as in the case of a sub-station, there is a very considerable choking-coil reaction ; there is, therefore, no interest attaching to this case.

As for switches, something depends on the method on which they are employed. Let us first suppose the oil switches to be connected between the generators and the 'bus bars. The coils of the cut-outs are the most sensitive parts of this circuit, on account of the cotton insulation. These coils are usually constructed to carry 2 amperes per square millimetre. In the examples we have already discussed, this current density might be expected to rise to 50 amperes per square millimetre. This corresponds to a temperature-rise of 73°C., which is scarcely serious, seeing that it only lasts for such a short length of time. The conditions are not so satisfactory if the short-circuit takes place on the outer network. Suppose the short-circuit to take place near the power station, then the current depends on the total output of the generators. If the short-circuit is on a comparatively unimportant branch of the network, then the rush of current will be correspondingly heavy, having regard to the current usually carried. There can, therefore, easily be excessive heating in the coils of the oil switch, which separates the short-circuit from the 'bus bars. But the heating lasts only for the fraction of a minute, and this must be taken into account. It seems that a maximum temperature of 185°C. is permissible with cotton. The temperature might be 85°C., before the short-circuit, and this would allow a temperature-rise of 100 deg. According to the author's formulæ and calculations, this would allow a current density of $130/\sqrt{t}$, and he concludes that the ratio of the permanent short-circuit current to the normal current carried by the oil-switch ought not to exceed the limit $50/\sqrt{t}$. These unfavourable conditions only arise on connections for very small currents. In such cases the oil-switch must be capable of carrying the short-circuit current of the whole station. This would require a very large switch. It is, therefore, desirable to limit the current by special choking coils, or to use subsidiary 'bus bars, separating them from the main 'bus bars by choking coils and oil switches, and from the network by other oil switches.

As for cables the highest relative current densities occur in short connecting lengths or in cables joining neighbouring power stations or sub-stations, in which cases serious heating may take place. But with transmission lines, in which the current density is kept low on account of voltage-drop, serious heating is not to be anticipated. The author concludes with the consideration of iron, zinc, and aluminium mains, with which the conditions are much more favourable than might be expected.

SIEMENS ROTARY CONVERTERS.

(*Concluded from p.* 701.)

POWER FACTOR.

From Fig. 6 it is apparent that the greatest rating can be obtained when the power factor in the armature itself is unity. Seeing that a transformer is nearly always necessary with a rotary converter, there is always a difference between the power factor in the high-tension circuit and the power factor in the rotary converter armature

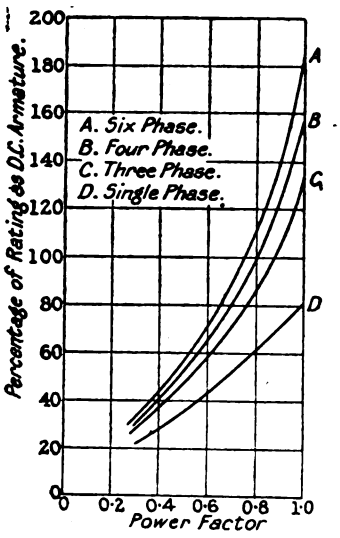


FIG. 6.—COMPARATIVE RATINGS OF SINGLE-, THREE-, FOUR- AND SIX-PHASE ROTARY CONVERTERS AT VARIOUS POWER FACTORS.

itself. If the power factor in the armature is unity, then the current in the high-tension circuit will lag behind the voltage by an amount depending on the reactance in the transformer.

The relation between the power factor in the rotary converter armature and the voltage on the direct-current side at any particular load is, of course, in the control of the designer, and it is, therefore, possible to design the complete rotary converter equipment so that any desired power factor (within reasonable limits) can be obtained on the high-tension side of the transformer. It is the power factor on the high-tension side which is of interest to the purchaser, since that is the power factor which is impressed on the mains feeding the plant.

In the case of compound-wound rotaries, where the voltage on the direct-current side is dependent on the load, it follows that the power factor is also dependent on the load. In the case of shunt-wound machines, however, it is possible at any load to adjust the excitation of the rotary, so that at one particular voltage a particular power factor is obtained.

Some purchasers specify that the power factor at full-load on a compound machine, or at some special voltage on a shunt-wound machine, should be leading, say, 0·95 or 0·9. It should be borne in mind, however, that in order to comply with such a requirement a larger armature is necessary, and the efficiency is reduced, and it very often happens that the additional expenditure involved is not justified. This is particularly the case with small machines up to, say, 500 kw., the leading wattless component of which would not be sufficient to make very much difference to the total power factor of the circuit unless the network itself is very small in comparison with the output of the converter.

In general, it may be said that rotary converters are not suitable for power-factor correction, since they are essentially machines which run best at unity power factor. This is apparent from Fig. 6, which shows how the rating is affected by the unequal distribution of heating which is caused by departure from unity power factor.

It should be borne in mind also that, apart from this unequal distribution of heating, a lagging wattless component of current in the armature has a de-magnetising effect on the main field poles of the machine. This de-magnetising effect has to be counteracted by the provision of extra copper on the field poles, and the extra cost which is thereby involved is, in a number of cases, not confined simply to the cost of the copper, since frequently the extra copper cannot be accommodated on the field poles without adopting the next larger size of frame. The use of the rotary converter as a power-factor corrector, therefore, involves not only extra cost in the provision of a larger machine, but also loss of efficiency.

In the case of booster rotaries the power factor is independent of the voltage, and by means of the special system of field windings which is illustrated in Fig. 5, Siemens booster rotaries are so designed that, whether shunt or compound, the power factor on the high-tension side is maintained at some predetermined figure. For the reasons given above it is best that this predetermined figure should be unity, but the arrangement of windings permits of maintaining

Digitized by Google

the power factor constant at any value desired, provided that value is within certain limits.

Parallel Running.

The voltage characteristic of a rotary converter is considerably flatter than that of a normal direct current generator. This is obvious when it is remembered that the armature reaction of a rotary converter is practically nil. Hence, if it be required that a rotary converter shall run in parallel with a standard direct-current generator, it is necessary to provide a rotary converter with a reverse series winding so as to increase the drop between no-load and full-load.

Commutation.

The problem of sparkless commutation of rotary converters is very different from the same problem when considered in regard to direct-current generators. In the case of a direct-current generator the principal difficulty in obtaining sparkless commutation is the large armature reaction. In the case of the rotary converter, however, the armature reaction is so small that at normal loads it is practically negligible, and the duty of the commutation pole is almost solely to overcome the reactance voltage in the short-circuited coil.

It may, therefore, be said that the commutating qualities of rotary converters can be made considerably better than those of direct-current generators, and it is partly for this reason that the overload capacity of the rotary converter is so great.

It should be noted, however, that neutralisation of armature reaction only takes place at steady loads. In the event of a sudden heavy overload or short circuit on the direct-current side of the rotary converter, it is apparent that the direct current in the armature may be momentarily considerably greater than the alternating current, and as a result there is momentarily a very considerable armature reaction comparable with that in a direct-current generator.

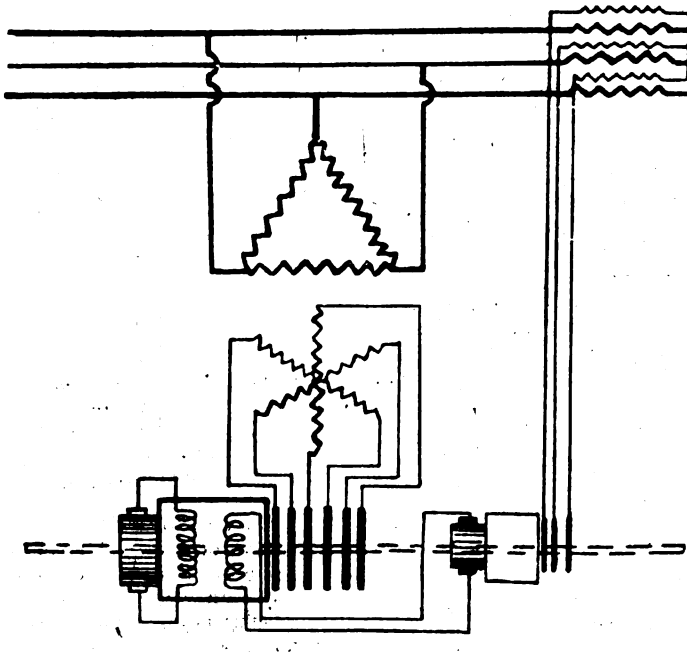


Fig. 7.—Diagram of Connections for System of Excitation for Reversible or Inverted Rotary Converters.

The commutation poles of Siemens rotary converters are so arranged that liners consisting of thin sheet iron of known thickness may easily be inserted between the commutation pole and the frame, and the air gap of the commutation pole may, therefore, be easily adjusted either on test at the works or after erection on site.

Three-wire Balancing and Inverted Running.

Rotary converters with transformers can be arranged to act as balancers on three-wire systems, utilising the transformer itself as a static balancer. In such cases the centre points of the secondary windings of the transformers, whether six or four-phase, are connected to the mid-wire on the direct-current side in exactly the same manner as the centre point of a static balancer is connected to the mid-wire in cases of direct-current generators fitted with slip-rings for balancing purposes.

For machines which have to act as balancers on three-wire systems, alternate commutation-pole windings are connected in opposite sides of the system, so that in the event of a large variation of load on one side of the system only, the necessary modification of the commutation-pole flux is obtained. This, of course, would not be the case were all the commutation-pole windings in one side of the system and the heavy overload occurred on the other side.

Any rotary converter is capable of converting either alternating current to direct current or direct current to alternating current, but in cases where conversion from direct current to alternating current is required it is necessary carefully to consider the effect on the rotary converter of a varying load or a varying power factor.

When a rotary converter is converting from direct current to alternating current it is running as a direct-current shunt or compound motor, and its speed, therefore, is dependent on field strength. If the power factor of the load varies there is a variable de-magnetising reaction in the armature of the rotary, and unless means are taken to prevent it, the speed of the machine, and hence the frequency of the alternating current which it supplies, will vary accordingly. If the rotary converter, when running inverted, is running in parallel with synchronous alternators of capacity considerably greater than itself, then the rotary itself will have no option, but to run at the same frequency. Correct division of the load between the rotary converter and the alternator is then a matter of adjustment of the alternator field strength or of the voltage on the direct-current side.

In most cases, however, where rotary converters have to run inverted, they will be running alone, and in such cases it is necessary to provide special means for excitation of the rotary converter so as to avoid the above-mentioned variation in speed and frequency on loads of varying power factor.

On Siemens inverted rotaries the main excitation of the machine is still provided from the commutator of the rotary, and the necessary adjustment in the excitation to counteract the tendency to speed variation is provided by an auxiliary exciter. This principle—namely, of taking the main excitation from the converter commutator itself and providing auxiliary means for the extra excitation—has two important advantages as follows:—

1. In the event of the auxiliary source of excitation failing, the main excitation is still available, and the danger of the machine running away is very considerably limited.
2. The auxiliary excitation can be provided at a very low voltage, so that there is no tendency to flash over on the small commutator of the auxiliary exciter which would be present if it were designed for the full voltage of the machine.

The system of excitation on Siemens inverted rotaries is illustrated in Fig. 7.

The exciter consists of an armature provided with commutator and three slip-rings, and an unwound field magnet. There is provided a series transformer with the primary connected in series with the main alternating-current circuit, and the secondary connected to the three slip-rings of the exciter.

A field flux in the exciter is set up by the armature reaction due to the current in the secondary of the series transformer. A P.D. is therefore generated at the commutator of the exciter, and this P.D. varies with the power factor of the main alternating-current load, owing to variations in the armature reaction.

The commutator of the exciter is connected directly across the auxiliary shunt winding of the rotary. Any variation in the power factor of the alternating-current load therefore causes variation in the current passing through this auxiliary shunt winding. The field strength of the rotary is this maintained at the correct value for constant speed, in spite of variations in the power factor of the load. It should be noted that this arrangement actually prevents variation in speed, and does not merely exert a corrective action on a variation of speed which has already occurred, as is of course the case where a direct-coupled plain exciter is used, the effect of which on the excitation of the rotary is dependent on an increased or decreased speed.

Speed of Rotary Converters.

There has been during the last five years a noticeable tendency on the part of British manufacturers to increase the speed for which rotary converters are designed, particularly for 50-cycle and 60-cycle machines. Part of this tendency is no doubt due to the all-round increased competition and consequent wish to cheapen designs as much as possible, though such reduction is not realised so easily in rotary converters. There is, however, in the case of rotary converters, a much more important reason for increasing speed than that of reduction in price—viz., the fact that an increase in speed is accompanied by an increase in the stability of the machine, and a large reduction in its tendency to flash over.

Progress in commutator construction has now rendered it possible to run at considerably higher speeds. It can be very easily shown that the distance between brush arms on rotary converters for any

Digitized by Google

particular frequency is directly proportional only to the peripheral speed of the commutator. Hence the object of the modern rotary-converter designer is to raise the peripheral speed of the commutator to such a value consistent with good commutation and mechanical safety, as to obtain the same distance between brush arms as in the case of direct-current generators and low-frequency rotaries.

A further result of the increase in speed is that it is possible to provide the machine with a much heavier and more effective damping winding, owing to the smaller number of poles, and, therefore, larger space available. Further, in the majority of cases the use of a high speed enables a single-turn armature coil to be adopted, thus reducing the reactance voltage and allowing considerable latitude in the design of the commutation pole. High-speed machines, therefore, are generally capable of heavy overloads, and are much more stable on short circuits than low-speed machines.

TRANSFORMERS.

It has been pointed out above that owing to the fixed ratio between the voltage on the direct-current side and on the alternating-current side of a rotary converter, transformers between the slip-rings and the source of supply are necessary in the majority of cases. The general design of the transformers which are used with rotary converters does not differ largely from the ordinary type of power transformer. Siemens transformers for use with rotary converters are

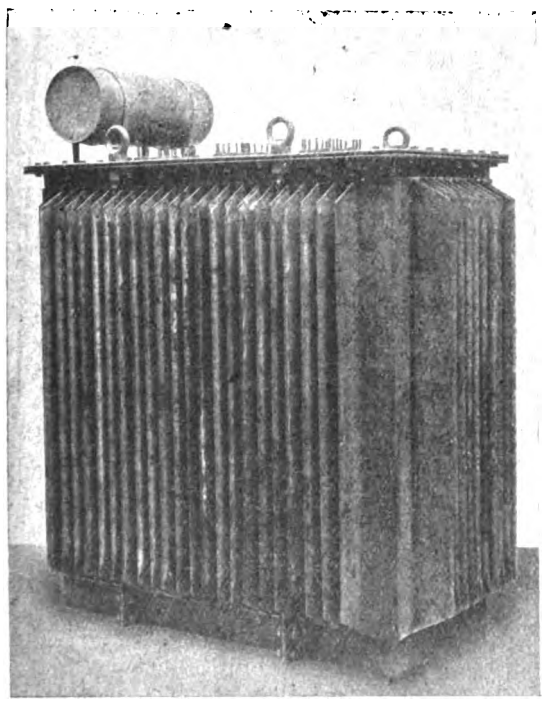


FIG. 8.—TRANSFORMER WITH EXPANSION VESSEL.

either of the "core" or the "shell" type. In these a special feature is the expansion vessel. The object of this expansion vessel is to prevent the formation of sludge in the oil, and to prevent the entrance of moisture into the main transformer tank. It is illustrated in Fig. 8, and, as will be seen, consists of a small external tank mounted above the top of the main transformer tank and connected thereto by a pipe in which there occurs an inverted U-section. The whole arrangement, comprising the main transformer tank, the pipe and the expansion vessel, is filled with such a quantity of oil, that when cold the oil level is about half-way up the expansion vessel. The oil in the main tank is, therefore, under a slight head, and it is necessary that the cover of the transformer and the terminals should be entirely oil tight.

One of the results of this arrangement is that there is no air space above the oil in the main transformer tanks. In the event, therefore, of a short circuit inside the tank, there is no risk of the formation of an explosive mixture.

When the transformer is on load the oil expands, and is driven out of the main tank through the pipe into the expansion vessel. It is cooled either on the way or on reaching cold oil in the expansion vessel, and the only surface of oil which is in contact with the atmosphere is the surface in the expansion vessel. There is a very small difference of temperature between this oil and the atmosphere, and there is, therefore, very little tendency to formation of sludge (which is caused by the oxidation of hot oil in contact with the atmosphere).

When the transformer cools down the oil contracts and the level in the expansion vessel falls, but the main transformer tank still remains quite full of oil. Any moisture which may be condensed can only collect in the expansion vessel itself where it collects at the bottom and may be drawn off. No moisture can reach the main tank, since in order to do so it would have to rise above the oil in the inverted U-section of the connecting pipe.

We have taken the above description and discussion on rotary converters from a pamphlet issued by Siemens Dynamo Works, Ltd. The pamphlet also gives information on the starting of rotary converters, and a statement of data required when inquiring about rotaries for special purposes.

MULTIPLEXING IN CABLE TELEGRAPHY.*

BY GEORGE O. SQUIER, PH.D.
(Brigadier-General, Chief Signal Officer, U.S. Army.)

The use of alternating currents in cable telegraphy offers the great advantage that multiplexing is made possible. Among the many schemes which may be utilised, the method of using separate cables for sending and receiving, transmitting several messages on one cable and receiving a corresponding number on another, seems to offer the best solution of the problem where the volume of traffic warrants. We thus eliminate at once the artificial cable, which is an indispensable element in duplexing, and also avoid the troubles incidental to the accurate balancing of the duplex bridge.

The transmitted current is very large as compared with the received current, and any deviation from perfect balance in the ordinary method of duplexing may introduce disturbing effects on the receiver. Even in using very low frequencies, say, 5 cycles per second (150 cable letters per minute), the ratio of the transmitted to the received

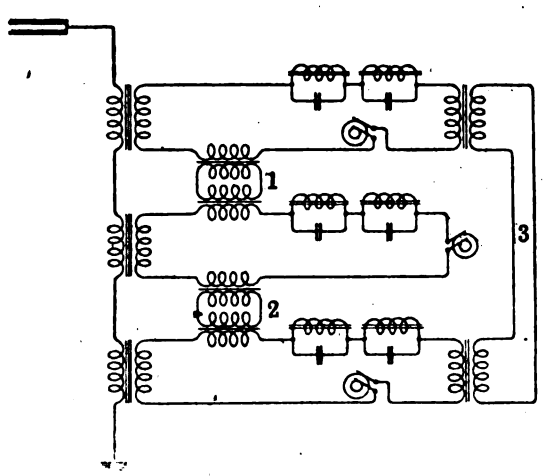


FIG. 1.—TRANSMITTING TERMINAL.

current in a long cable is about 20,000, and this ratio increases very rapidly as the frequency is increased. It is difficult to balance out the large transmitting current to a sufficient degree so as not to affect the receiver, and this limits the sensitiveness of the receiver and the speed of signalling. Even with all the refinements in balancing, the most that can be accomplished at present is the simultaneous sending and receiving of one message at each end of the cable.

In the plan proposed here of using two separate cables, one for sending and the other for receiving, the difficulties from balancing are completly removed, and the working capacities of the cables greatly increased.

The method is shown in Figs. 1 and 2. In Fig. 1 an arrangement is shown for transmitting three messages simultaneously on one cable. We have here three local transmitting circuits coupled to the cable, the frequency of each transmitter being different from any one of the others, say, 6, 8 and 10 cycles. In each local transmitting circuit two loop circuits are included which are separately tuned to the frequencies of the other two transmitters, offering thereby a high impedance to the current flow of these frequencies, thus preventing the transfer of current from one transmitting circuit to the others. To further check any transfer of current from one local

* From the "Journal" of the Franklin Institute; slightly abbreviated.

Digitized by Google

circuit to another, the intermediate circuits 1, 2, and 3 are introduced through which E.M.F.s of opposite phase to that induced by

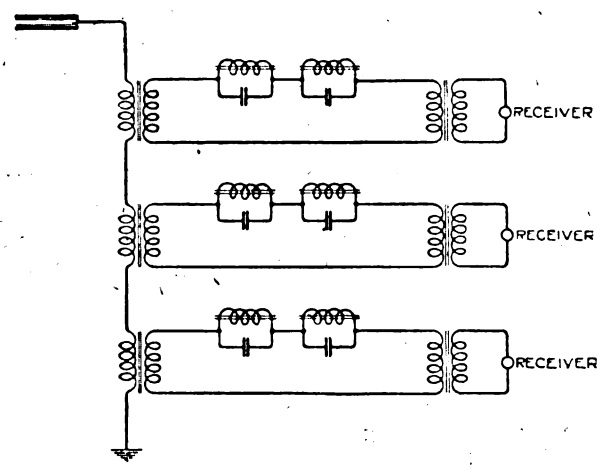


FIG. 2.—RECEIVING TERMINAL.

way of cable transformers are induced, and thus balancing out any residual effect from one circuit on another.

In Fig. 2 a receiving terminal of a cable is shown in which three circuits are used for the reception of three messages simultaneously. Each receiving circuit is coupled to the cable through an intermediate circuit. In each intermediate circuit two loop circuits are included which are separately tuned to the frequencies of the signals which are to be excluded from that particular receiver, each receiver responding accordingly only to a signal of one predetermined frequency and excluding the others. Loop circuits may also be introduced in the receiver circuits, and thus further increase the selectivity.

In the arrangement described above, the disturbing effects of local transmitter on receiver, characteristic of duplexing, are eliminated, and detectors and amplifiers of much greater sensitiveness may be employed.

Three transmitters and three receivers are shown, so that two cables could handle three messages both ways, but the method is not limited to this number. It would be necessary to increase the number of loop circuits and intermediate circuits employed in the transmitting and receiving circuits, but this would not offer any serious difficulties. The experience with radio-telegraphy offers a similar case. The practical solution at present used in radio-telegraphy is to employ two separate antennæ, one for transmitting and one for receiving, the pair furnishing the complete telegraph terminal.

The present war has emphasised the supreme importance of ocean cables as never before in the history of the world. As soon as peace is established a comprehensive plan of cable laying based on the maximum of international service, will deserve careful consideration.

NOTES ON THE DESIGN OF ELECTROMAGNETIC MACHINES.*

2. ALTERNATING-CURRENT GENERATORS.

BY STANLEY PARKER SMITH, D.Sc.

(*Continued from page 699.*)

3. E.M.F. INDUCED IN THREE-PHASE WINDINGS.

Coil-span Factor.—In the previous article it was shown that the fundamental of the E.M.F. induced in a coil of T_c turns rotating uniformly in a steady field is :—

$$\begin{aligned} e_1 &= T_c v L 10^{-8} \bar{B}_1 (\sin \theta_x - \sin \theta_{x'}) \\ &= 2 T_c v L 10^{-8} \bar{B}_1 f_{c1} \sin \theta_{x''} \\ &= \bar{e}_1 \sin \theta_{x''}, \end{aligned}$$

where $f_{c1} = \cos \frac{\varepsilon}{2}$ = coil-span factor of the fundamental.

Extending this for any harmonics that may be present in the *B*-curve, we have in a precisely similar manner for the amplitude of the nth harmonic :—

$$\bar{e}_n = 2 T_c v L \bar{B}_n f_{cn} \, 10^{-8},$$

where $f_{cn} = \cos n \frac{\varepsilon}{2}$ = coil-span factor of the nth harmonic.

Thus the instantaneous E.M.F. induced in a coil whose span differs from a full pole-pitch π by the angle ε will be

$$e = \bar{e}_1 \sin \theta_{x'} + \bar{e}_3 \sin 3\theta_{x'} + \ldots\ldots\ldots + \bar{e}_n \sin n\theta_{x'} \quad . \quad . \quad . \quad (1)$$

Distribution Factor.—For a group of m coils in series and having E.M.F.s displaced from one another by the angle ψ, we found for the fundamental,

$$\Sigma_a^m e_1 = f_{m1} m \bar{e}_1,$$

where $f_{m1} = \dfrac{\sin \frac{m\psi}{2}}{m \sin \frac{\psi}{2}}$ = distribution factor of fundamental.

Similarly, for the nth harmonic,

$$\Sigma_a^m e_n = f_{mn} m \bar{e}_n,$$

where $f_{mn} = \dfrac{\sin n \frac{m\psi}{2}}{m \sin n \frac{\psi}{2}}$ = distribution factor of the nth harmonic.

Thus the instantaneous value of the E.M.F. induced in the group of m coils will be :—

$$\begin{aligned} \Sigma_a^m e &= f_{m1} m \bar{e}_1 \sin \theta + f_{m3} m \bar{e}_3 \sin 3\theta + \ldots\ldots\ldots + f_{mn} m \bar{e}_n \sin n\theta. \\ &= 2 m T_c v L 10^{-8} (f_{m1} f_{c1} \bar{B}_1 \sin \theta + \ldots\ldots\ldots + f_{mn} f_{cn} \bar{B}_n \sin n\theta) \quad (2) \end{aligned}$$

where θ is measured form the middle of the group.

If a phase consists of one group of coils, or a number of similar groups, *i.e.*, if $p' = 1$, then the above expression represents the phase E.M.F.

Group Factor.—In general a phase consists of p' groups of coils in series, the successive groups being displaced from one another by the angle χ. These p' pressures of a phase are then summed up in the same way as the m pressures of the coils in a group, and the phase pressure becomes :—

$$\begin{aligned} \Sigma_1^T e &= f_{g1} f_{m1} m \bar{e}_1 \sin \theta + \ldots\ldots\ldots + f_{gn} f_{mn} m \bar{e}_n \sin n\theta. \\ &= 2 T v L 10^{-8} (f_{g1} f_{m1} f_{c1} \bar{B}_1 \sin \theta + \ldots\ldots f_{gn} f_{mn} f_{cn} \bar{B}_n \sin n\theta). \\ &= 2 T v L 10^{-8} (f_1 \bar{B}_1 \sin \theta + \ldots\ldots f_n \bar{B}_n \sin n\theta) \quad . \quad . \quad . \quad (3) \end{aligned}$$

where $T = p' m T_c'$ = turns per phase in series,

and $f_{g1} = \dfrac{\sin \frac{p'\chi}{2}}{p' \sin \frac{\chi}{2}}$ = group factor of fundamental,

and $f_{gn} = \dfrac{\sin n \frac{p'\chi}{2}}{p' \sin n \frac{\chi}{2}}$ = group factor of nth harmonic.

Winding Factor.—The winding factor is defined as the pro-

* The first article of this series dealt with Continuous-current Machines and the first part appeared in THE ELECTRICIAN of June 2nd, 1916 (Vol. LXXVII., p. 280).

Digitized by Google

duct of the coil-span, the distribution and the group factors; that is, for the nth harmonic the winding factor is

$$f_n = f_{en} f_{mn} f_{gn},$$

$$= \cos n\frac{\varepsilon}{2} \cdot \frac{\sin n\frac{m\psi}{2}}{m \sin n\frac{\psi}{2}} \cdot \frac{\sin n\frac{p'\chi}{2}}{p' \sin n\frac{\chi}{2}}.$$

Each of the three factors contained in the winding factor may be equal to or less than unity, and we must now see how the arrangement of the winding affects the magnitude of the harmonics in the pressure wave.

In passing, it may be mentioned that the common case for alternators is the single-layer winding with a whole number of slots per pole, with the result that in a three-phase winding the equivalent constant span of the coils is equal to a pole-pitch and all pole-pairs are alike. In consequence of this, ε and $\chi = 0$, so that $f_{en} = 1$ and $f_{gn} = 1$, whence we get for this case $f_n = f_{mn}$, and $a = p$ or $p' = 1$.

Effect of Coil-span Factor.—Since the coils lie in slots the coil-span must be equal to a whole number of slot-pitches γ, and in Figs. 3 and 4 it was shown that the variable-span coils of a single-layer winding can be replaced by constant-span coils, without affecting the induced E.M.F. in any way. In a three-phase winding the equivalent constant span of a single layer winding is equal to a pole-pitch with a whole number of slots per pole, and less than a pole-pitch when the number of slots per pole is a fraction. In the double-layer winding the coil-span can be greater than, equal to or less than a pole-pitch. Thus the deviation ε of the coil-span from a pole-pitch may or may not be equal to zero.

With full-pitch coils, $\varepsilon = 0$, so that $f_{en} = \cos n\varepsilon/2 = 1$, and the shape of the curve of E.M.F. induced in a coil is identical to that of the B-curve.

When the deviation ε from a full pitch is small, the values of f_{en} for the fundamental and the harmonics of a low order are not much affected.

By suitably choosing the coil-span—as is mostly possible in double-layer windings, and to a limited extent in single-layer windings, we can suppress any desired harmonic in the coil E.M.F. To do this we must make $\varepsilon = \pi/n$, where n is the order of the harmonic it is desired to suppress, for then

$$f_{en} = \cos n\varepsilon/2 = \cos n\pi/2n = 0.$$

(i.) *Suppression of Third Harmonic.*—The third harmonic is often troublesome in three-phase systems where the neutral is used, and one way of suppressing it and its multiples is to make the coil-span equal to two-thirds of the pole-pitch, *i.e.*, $\varepsilon = \pi/3$. Then for $n = 3$, $f_{e3} = \cos 3\pi/6 = 0$, or for $n = 9$, $f_{e9} = \cos 9\pi/6 = 0$. In the case of a double-layer winding, where it is specified that the third harmonics shall be suppressed in the phase pressure, this method can be used with advantage, because of the economy in overhang copper. At the same time it must be remembered that the output of the machine suffers, due to the fact that the coil-span factor for the fundamental becomes $f_{e1} = \cos \pi/6 = \sqrt{3}/2$, which is only 0·866 of the value for full-pitch coils; so that this is not a practice to be resorted to without good reason.

(ii.) *Suppression of Tooth Effects.*—It is often required to suppress the effects of the spacing of the coils in slots and the swinging of the flux occasioned by the teeth. This also can be done by giving the coils the proper span. For this purpose we make the number of slots per pole-pair $2Q$ odd. The coil-span then differs from the pole-pitch by an odd multiple of half slot-pitches; that is, $\varepsilon = x\frac{\gamma}{2} = \frac{x}{2}\frac{2\pi}{2Q}$, where $x = 1, 3, 5$, &c.

Since the flux swings with a frequency of $2Q$ times the fundamental there will be an E.M.F. of this frequency induced in each conductor. In the coil E.M.F., however, we find for $n = 2Q$—a possible harmonic, since $2Q$ is odd—the coil-span factor is

$$f_{e2Q} = \cos n\frac{\varepsilon}{2} = \cos 2Q\frac{x}{4}\frac{2\pi}{2Q} = \cos x\frac{\pi}{2} = 0.$$

Thus with an odd number of slots per pole-pair, all tooth effects are suppressed in the coil pressure, and therefore in the phase and terminal pressures also.

To obtain an odd number of slots per pole-pair we have only to adopt one of the means indicated in the preceding section. Thus in a two-pole machine with a single-layer winding, adding three empty slots gives the desired results. For example, with six slots per pole and phase, the three phases require 36 slots, and 3 extra slots brings the total up to 39—an odd number—which at the same time does not upset the symmetry of the phases.

Effect of Distribution Factor.—The effect of the phase-spread is taken into account by the distribution factor:

$$f_{mn} = \frac{\sin n\frac{m\psi}{2}}{m \sin n\frac{\psi}{2}},$$

where ψ is the phase displacement between the E.M.F.s induced in successive coils.

As far as the phase of the induced E.M.F. is concerned, all the conductors in a slot can be regarded as a single coil-side. In all windings, then, where successive coils in the winding are displaced from one another by a slot-pitch γ, we can substitute $\psi = \gamma = \pi/Q$, whence we get

$$f_{mn} = \frac{\sin n\frac{m\gamma}{2}}{m \sin n\frac{\gamma}{2}} = \frac{\sin n\frac{m}{Q}\frac{\pi}{2}}{m \sin \frac{n}{Q}\frac{\pi}{2}}.$$

The above expression holds for nearly all single-layer windings and for double-layer lap windings, but only for wave windings where $a = p$—a rather rare case. The ordinary wave winding falls under the treatment of uniformly distributed windings, as far as the distribution factors are concerned.

We shall first examine the effect of the number of slots on the distribution factor, and then the effect of the phase-spread on the distribution factor.

(i.) *Effect of Number of Slots on Distribution Factor.*—When the number of slots per pole is an integer the magnitude of the distribution factor f_{mn} follows a definite series depending upon the number of slots per pole-pair $2Q$. On the other hand, when the number of slots per pole is a fraction, the values of f_{mn} approximate those for a uniformly distributed winding.

With *a whole number of slots per pole, i.e.*, Q=integer, we have $Q = 3q$, and with the common narrow phase-spread the distribution factor becomes

$$f_{mn} = \frac{\sin n\frac{q}{Q}\frac{\pi}{2}}{q \sin n\frac{1}{Q}\frac{\pi}{2}} = \frac{\sin n\frac{\pi}{6}}{q \sin n\frac{\pi}{6q}}.$$

Since n can be any odd number we can write: $n = M6q \pm x$, where x is any odd number, 1, 3, 5, &c., and M is any number whatever, 0, 1, 2, 3, &c. Substituting for n we get

$$f_{mn} = f_{m(M6q \pm x)} = \frac{\sin (M6q \pm x)\frac{\pi}{6}}{q \sin (M6q \pm x)\frac{\pi}{6q}}$$

$$= \pm \frac{\sin x\frac{\pi}{6}}{q \sin x\frac{\pi}{6q}} = f_{mx} \text{ or } -f_{mx}.$$

Thus, with a whole number of slots per pole, the magnitude of the distribution factor is a series of the form:

$$f_{mx} = f_{m(6q \pm x)} = f_{m(12q \pm x)} = f_{m(18q \pm x)} = \ldots$$

or

$$f_{m1} = f_{m(6q \pm 1)} = f_{m(12q \pm 1)} = f_{m(18q \pm 1)} = \ldots$$

$$f_{m3} = f_{m(6q \pm 3)} = f_{m(12q \pm 3)} = f_{m(18q \pm 3)} = \ldots$$

and

$$\ldots = \ldots = \ldots = \ldots = \ldots$$

These are shown worked out in Table II.

Digitized by Google

Table II.—*Distribution Factors, $f_{m,n}$, for Three-phase Single-layer Windings with Whole Number of Slots per Pole.* ($Q=3q$.)

$q=Q/3$.	2	3	4	5	6	7	8	9	10	Winding uniformly distributed.
Q=slots/pole.	6	9	12	15	18	21	24	27	30	
f_1	**0·966**	**0·960**	**0·958**	**0·957**	**0·957**	**0·957**	**0·956**	**0·955**	**0·955**	**0·955**
f_3	0·707	0·667	0·654	0·646	0·644	0·642	0·641	0·640	0·639	0·636
f_5	0·259	0·217	0·205	0·200	0·197	0·195	0·194	0·194	0·193	0·191
f_7	−0·259	−0·177	−0·158	−0·149	−0·145	−0·143	−0·141	−0·140	−0·140	−0·136
f_9	−0·707	−0·333	−0·270	−0·247	−0·236	−0·229	−0·225	−0·222	−0·220	−0·212
f_{11}	**−0·966**	−0·177	−0·126	−0·110	−0·102	−0·097	−0·095	−0·093	−0·092	−0·087
f_{13}	**−0·966**	0·217	0·126	0·102	0·092	0·086	0·083	0·081	0·079	0·073
f_{15}	−0·707	0·667	0·270	0·200	0·172	0·158	0·150	0·145	0·141	0·127
f_{17}	−0·259	**0·960**	0·158	0·102	0·084	0·075	0·070	0·066	0·064	0·056
f_{19}	0·259	**0·960**	−0·205	−0·110	−0·084	−0·072	−0·066	−0·062	−0·060	−0·050
f_{21}	0·707	0·667	−0·654	−0·247	−0·172	−0·143	−0·127	−0·118	−0·112	−0·091
f_{23}	**0·966**	0·217	**−0·958**	−0·149	−0·092	−0·072	−0·063	−0·057	−0·054	−0·041
f_{25}	**0·966**	−0·177	**−0·958**	0·200	0·102	0·075	0·063	0·056	0·052	0·038
f_{27}	0·707	−0·333	−0·654	0·646	0·236	0·158	0·127	0·111	0·101	0·071
f_{29}	0·259	−0·177	−0·205	**0·957**	0·145	0·086	0·066	0·056	0·050	0·033
f_{31}	−0·259	0·217	0·158	**0·957**	−0·197	−0·097	−0·070	−0·057	−0·050	−0·031
f_{33}	−0·707	0·667	0·270	0·646	−0·644	−0·229	−0·150	−0·118	−0·101	−0·058
f_{35}	**−0·966**	**0·960**	0·126	0·200	**−0·957**	−0·143	−0·083	−0·062	−0·052	−0·027
f_{37}	**−0·966**	**0·960**	−0·126	−0·149	**−0·957**	0·195	0·095	0·066	0·054	0·026
f_{39}	−0·707	0·667	−0·270	−0·247	−0·644	0·642	0·225	0·145	0·112	0·049
f_4	−0·259	0·217	−0·158	−0·110	−0·197	**0·957**	0·141	0·081	0·060	0·023
f_{43}	0·259	−0·177	0·205	0·102	0·145	**0·957**	−0·194	−0·093	−0·064	−0·022
f_{45}	0·707	−0·333	0·654	0·200	0·236	0·642	−0·641	−0·222	−0·141	−0·042
f_{47}	**0·966**	−0·177	**0·958**	0·102	0·102	0·195	**−0·956**	−0·140	−0·079	−0·020
f_{49}	**0·966**	0·217	**0·958**	−0·110	−0·092	−0·143	**−0·956**	0·194	0·092	0·019
f_{51}	0·707	0·667	0·654	−0·247	−0·172	−0·229	−0·641	0·640	0·220	0·038
f_{53}	0·259	**0·960**	0·205	−0·149	−0·084	−0·097	−0·194	**0·955**	0·140	0·018
f_{55}	−0·259	**0·960**	−0·158	0·200	0·084	0·086	0·141	**0·955**	−0·193	−0·017
f_{57}	−0·707	0·667	−0·270	0·646	0·172	0·158	0·225	0·640	−0·639	−0·033
f_{59}	**−0·966**	0·217	−0·126	**0·957**	0·092	0·075	0·095	0·194	**−0·955**	−0·016
f_{61}	**−0·966**	−0·177	0·126	**0·957**	−0·102	−0·072	−0·083	−0·140	**−0·955**	0·016
f_{63}	−0·707	−0·333	0·270	0·646	−0·236	−0·143	−0·150	−0·222	−0·639	0·030
f_{65}	−0·259	−0·177	0·158	0·200	−0·145	−0·072	−0·070	−0·093	−0·193	0·015

From this table it is seen that the distribution factor for the fundamental is nearly unity with a phase-spread of 60°, whilst its value for the harmonics approaches that of a uniformly distributed winding, except where the order of the harmonic is in the neighbourhood of $M6q\pm1$. The consequence of this is that if harmonics of the orders $M6q\pm1$, $M6q\pm3$, &c., are pronounced in the B-curve the same harmonics will be pronounced in the phase pressure. For example, with open slots and a short air-gap the flux may swing vigorously to and fro with a frequency corresponding to the number of teeth in a pole-pair, and superpose a ripple of this order on the B-curve, which is equivalent to two harmonics of the orders $2Q\pm1$. For this reason it is common to see a marked tooth ripple in the pressure wave of alternators and rotary converters when there is a whole number of slots per pole.

With a *fractional number of slots per pole* the winding becomes equivalent to a winding distributed uniformly over the whole periphery, for, as the winding passes from pole to pole, the conductors occupy different positions in the field. Thus the effect of making Q=fraction is the same as skewing the slots by causing the coil-sides of a phase to occupy the whole of the 60° of arc belonging to the phase.

In the case of a uniformly distributed winding the E.M.F. vectors in the vector polygon become the arc of a circle, and the distribution factor is thus the ratio of the length of the chord to the length of the arc. Hence for a phase-spread of 60° we have

$$f_{mn}=\frac{\text{chord}}{\text{arc}}=\frac{\sin n\frac{m\psi}{2}}{nm\frac{\psi}{2}}=\frac{\sin n\frac{\pi}{6}}{n\frac{\pi}{6}}.$$

These values are shown in the last column of the above table and show that no pronounced harmonics are to be expected in the pressure curve, even when appreciable harmonics are present in the B-curve.

Thus to obtain a smooth pressure curve we have only to use a fractional number of slots per pole, or as explained in the preceding section, make $a<p$. When $a=p$ parallel circuits are needed, the same effect can be obtained by skewing the slots or shoes by a slot-pitch, using, of course, a whole number of slots per pole.

(ii.) *Effect of Phase-spread on Distribution Factor.*—To consider the influence of the phase-spread we can examine the simple expression for a uniformly distributed winding, which gives the limiting values for a phase completely spread over a definite arc.

It has been noted that the phase-spread of a three-phase winding can be made 60° or 120°, according to whether the coil-sides of a phase extend over one or two-thirds of the pole-pitch. Now the important value of the distribution factor is that of the *fundamental*, for on this the output of the winding directly depends. The value of f_{m_1}, therefore, should be as nearly equal to unity as possible, in order to get the largest output from the machine.

With a phase-spread of 60°, $f_{m_1}=\frac{\sin\pi/6}{\pi/6}=\frac{3}{\pi}=0{\cdot}955$, whilst with a phase-spread of 120°, $f_{m_1}=\frac{\sin\pi/3}{\pi/3}=\frac{3\sqrt{3}}{2\pi}=0{\cdot}827$.

Thus, with a phase-spread of 120°, the distribution factor of the fundamental, and therefore the output for the same heating of the armature winding, is only $\sqrt{3}/2$ times the value of this factor for a phase-spread of 60°. This shows clearly why it is standard practice to use the narrow phase-spread wherever possible. The common way of obtaining this as already explained in Figs. 3 and 4, is to use a six-phase winding and connect each pair of equal and opposite phases in series or parallel, as desired. In the case of double-layer windings this is also possible, and an example of how a wave winding is opened at six places will be given in part II. of this article. When a commutator is used the winding, of course, cannot be opened, but by using six slip-rings instead of three, and taking the tappings at 60° instead of at 120°, the same effect is obtained, and this is now the common arrangement employed for rotary converters. (*See* section 7.)

When, however, the effect of the phase-spread on the harmonics is considered it is found that the wide phase-spread causes to vanish from the phase pressure all harmonics whose order is a multiple of three. This is due to the fact that the

Digitized by Google

distribution factor of the third harmonic for a phase-spread of 120° is $f_{m3}=\frac{\sin 3.\pi/3}{3.\pi/3}=0$. On the other hand, with a phase-spread of 60° the value of the distribution factor for the third harmonic is $f_{m3}=\frac{\sin 3.\pi/6}{3.\pi/6}=2/\pi=0{\cdot}636$.

Consequently, when it is imperative to suppress the third harmonic and its multiples—which do not revolve in cyclic order at 120° like the rest, but all reach their maxima at the same instant, and may therefore give rise to trouble when the star point is earthed—it is possible to satisfy this condition by using the wide phase-spread, though this can only be done by sacrificing 15 per cent. of the output, as just explained. It will be noticed that suppression of the third harmonic and its multiples by using the wide phase-spread leads to the same reduction of output as is produced when these same harmonics are suppressed by reducing the coil-span.

To obtain the wide phase-spread it is customary to use the double-layer winding, taking the tappings or connections at 120°, but the same effect can equally well be obtained with a single-layer winding by using the connections shown in Fig. 6. Here the three-phase winding is obtained from a six-phase winding—a phase of the former being made by joining in series two phases at 60° of the latter. Since the third harmonics induced in phases at 60° then oppose one another ($3\times60=180°$) they will neutralise in each phase of the three-phase winding; so that no third harmonic can appear in the

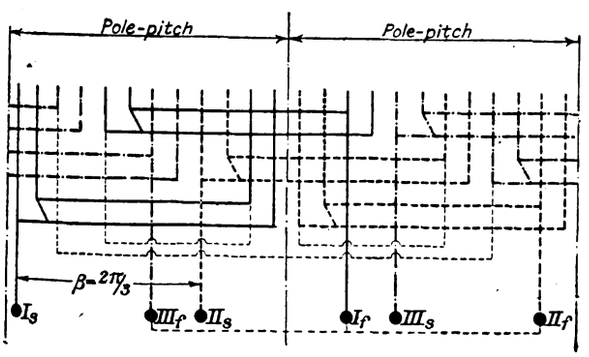


FIG. 6.—CONNECTIONS OF THREE-PHASE, SINGLE-LAYER WINDING FOR SUPPRESSING THIRD HARMONIC IN PHASE AND TERMINAL PRESSURES.

line or phase pressure, or in the neutral. Here again, of course, the output is reduced in the ratio of $\sqrt{3}/2$, but where it is imperative to use the wide phase-spread the above winding is often preferable to the double-layer arrangement for high-tension work, &c.

Effect of Group Factor.—There is no need to consider this factor separately, for it is equal to unity for a number of similar groups joined in series; whilst for the cases where the E.M.F.s of the several groups joined in series are not quite in phase, the effect of the group factor is merely to make the winding factor more nearly approach the value for a uniformly distributed winding.

The Interlinked or Terminal Pressure.—The standard connection for three-phase generators is to join the starts (or finishes) of the three phases together to form a neutral or star point, so that the line or terminal pressure is the resultant pressure of two phases. To find the effect of interlinking in this manner on the harmonics we need only consider the distribution factor. Taking again the uniformly distributed winding for the sake of simplicity, the distribution factor for one phase, consisting of a group of m coils in series, is

$$f_{mn}=\frac{\sin n\frac{m\psi}{2}}{nm\frac{\psi}{2}},$$

and for two phases, or a group of $2m$ coils in series, we have

$$f_{mn\lambda}=\frac{\sin n\frac{2m\psi}{2}}{n2m\frac{\psi}{2}}.$$ Thus the ratio $\frac{f_{mn\lambda}}{f_{mn}}=\frac{\sin n\frac{2m\psi}{2}}{2\sin n\frac{m\psi}{2}}=\cos n\frac{m\psi}{2}$.

Consequently to find $f_{mn\lambda}$ we have only to multiply f_{mn} by $\cos n\frac{m\psi}{2}$. For a phase-spread of 60°, which is what is commonly met with, $m\psi=\pi/3$, so that $f_{mn\lambda}=f_{mn}\cos n\,30°$.

From this it follows that no harmonic whose order is a multiple of three can appear in the terminal pressure of a star-connected generator with a phase-spread of 60°. At the same time interlinking has no effect on these harmonics in the phase pressure; and if it desired to suppress such harmonics in the coil or phase pressure, means must be adopted such as have just been explained.

Virtual Value of E.M.F. Induced in a Winding.—The virtual or R.S.M. value of any pressure wave is

$$E=\frac{1}{\sqrt{2}}\sqrt{\bar{e}_1^2+\bar{e}_3^2+\bar{e}_5^2+\ldots\ldots},$$

where $\bar{e}_1$, $\bar{e}_3$, &c., have been determined in the earlier part of this section. We can further write for the virtual value of the induced E.M.F.

$$E=kTf\Phi10^{-8},$$

where k is called the E.M.F.-coefficient.

To determine k we must know the coil-span, the phase-spread and the shape of the B-curve. Regarding the coil-span, this is mostly equal to or approximately equal to a full pole-pitch. The phase-spread depends to a slight extent upon the number of slots per pole and phase, but can generally be taken the same as for a uniformly distributed winding. The flux distribution is usually unknown, but in most cases the effect on the virtual E.M.F. is practically the same as if only the fundamental were present. The reason for this is easily seen from an example. Let the B-curve consist of the fundamental and a third harmonic equal in magnitude to 30 per cent. of the fundamental. Then $\bar{e}_1:\bar{e}_3=f_1\bar{B}_1:f_3\bar{B}_3=f_{m1}\bar{B}_1:f_{m3}0{\cdot}3\bar{B}_1=0{\cdot}955:0{\cdot}3\times0{\cdot}636=1:0{\cdot}2$; hence the virtual E.M.F. will be

$$E=\frac{1}{\sqrt{2}}\sqrt{\bar{e}_1^2+\bar{e}_3^2}=\frac{1}{\sqrt{2}}\sqrt{1{\cdot}04\bar{e}_1^2}=1{\cdot}02E_1.$$

Thus even with a flux harmonic $\bar{B}_3=0{\cdot}3\bar{B}_1$, the virtual E.M.F. is only 2 per cent. higher than it would be with the fundamental alone. The effect of higher flux harmonics will be still smaller. Thus we are quite safe in ignoring the effect of flux harmonics on the value of the *virtual* E.M.F.

For most machines, then, whether of the non-salient pole type or of the salient pole type, provided the pole-shoes of the latter are chamfered, it is near enough in most cases to take the E.M.F.-coefficient k the same as for a sinusoidal flux distribution. Substituting $v=T_1Dn=2pYn=2fY$, we have for the amplitude of the fundamental

$$\bar{\Sigma}_a{}^m\bar{e}=2TvL10^{-8}f_{m1}\bar{B}_1=2f_{m1}T2fYL\frac{\pi}{2}\frac{\Phi}{YL}10^{-8},$$

whence

$$E\frac{\Sigma_a{}^m e}{\sqrt{2}}=\frac{1}{\sqrt{2}}2\pi f_{m1}Tf\Phi10^{-8}, \quad\ldots\ldots\quad (4)$$

so that the E.M.F. coefficient $k=4{\cdot}44f_{m1}$.

For different values of phase-spread we then get

Phase-spread	60°	90°	120°	180°
E.M.F.-coefficient k.....	4·24	4·0	3·68	2·83

For greater refinements, the reader can consult "The Pressure Wave in Electrical Machinery," "Proc." I.E.E., Vol. LIII., p. 205.

(To be continued.)

Digitized by Google

A STUDY OF ELECTROMAGNET MOVING COIL GALVANOMETERS FOR USE IN ALTERNATING CURRENT MEASUREMENTS.*

BY ERNEST WEIBEL.

Summary.—The author discusses mathematically the principles underlying the construction of moving coil instruments for alternating currents and describes the constructions of four different galvanometers of this type. Finally he discusses their value as detectors, for the measurement of inductance and capacity and other special uses.

INTRODUCTION.

The increasing use of alternating-current bridge and potentiometer methods of measurement emphasises the need of an instrument for the detection and measurement of small alternating voltages. Instruments which have been used for this purpose are: The telephone receiver, the vibration galvanometer, the commutated direct-current galvanometer, the series and separately excited electrodynamometer, the vibration string galvanometer, and the vibration electrometer. Of these the telephone receiver and the vibration galvanometer are in most common use. None of the instruments yet constructed has as good a performance as the sensitive moving coil galvanometers used in the corresponding direct-current measurements.

The separately excited electrodynamometer has been used as an alternating-current galvanometer, but usually the instruments constructed were not very sensitive. A more sensitive one has recently been designed by Palm.

Stroud and Oates were the first to use a moving coil galvanometer with an electromagnet excited by alternating current. This was found to be very sensitive and was used in bridge measurements of inductance and capacity.

Sumpner and Phillips designed iron-cored instruments and devised a number of methods of measurements, using them separately excited as detectors. Sumpner gave special attention to the design of alternating current electromagnets in which the magnetic flux is very nearly in quadrature with the impressed voltage.

H. Abraham in 1906 described briefly an electromagnet moving coil galvanometer and showed that its performance depended upon the constants of the moving coil circuit. The effects of electromagnetic damping were observed and it was found possible by suitable adjustment of the constants of the moving coil circuit to make the motion aperiodic. He also observed that, on account of the induced current, the period and hence the sensitivity depended upon the reactance of the moving coil circuit. He found that, by compensating for the inductance of the moving coil by means of a suitable condenser in parallel with a resistance, the effect of the induced current could be made zero.

The step from the separately excited electrodynamometer to the electromagnet moving coil galvanometer is a natural one in the development of a sensitive alternating-current galvanometer. The use of iron in the fixed coil of the instrument results in a marked increase in the strength of the magnetic field, so that the induced current is sufficient to affect the performance. The use of such instruments is not as simple as that of the telephone receiver or the vibration galvanometer, but it is believed that in many cases the gain in sensitivity and usefulness more than compensates for the trouble involved.

THEORY.

Assumptions.—In order to determine the operation of electromagnet moving coil galvanometers of various kinds and under various conditions it was necessary to derive the general equation of motion of a coil carrying an alternating current in an alternating magnetic field. To do this it is necessary to consider all of the torques acting on the moving coil.

In most cases the moving coil is made of fine wire, so that the assumption of a linear moving coil circuit introduces no appreciable errors arising from the variation of the current distribution in the cross section of the wire. Therefore, we consider the electromagnet moving coil galvanometer to consist of a rigid linear circuit suspended so as to rotate through a small angle in an alternating magnetic field. The magnetic field will be assumed to be approximately uniform and to have no rotating components around the axis, so that it is possible to turn the coil to a position in which the resultant total magnetic flux is always zero. This is the normal position of the coil, and only small deflections from a reference position near this will be considered.

Fundamental Relations—The author then develops equations for the flux, torque and current.

If θ is the angular deflection

K is the moment of inertia of moving system, the equation of motion is of the form

$$K\frac{d^2\theta}{dt^2}+D'\frac{d\theta}{dt}+U'\theta=A+B,$$

where D', U' and B depend upon the constants of the galvanometer and the moving coil circuit and A depends upon the impressed electromotive force in the moving coil circuit. In this equation of an oscillating system acted upon by the torques A and B the particular solution shows that the motion may be either underdamped, aperiodic (critically damped or dead beat) or overdamped according as $(D')^2$ is less than, equal to, or greater than $4KU'$. The free period is

$$T=2\pi\sqrt{\frac{K}{U'}}.$$

This is the undamped period, and equals the time required for the coil to deflect 99 per cent. of the total deflection when critically damped. It is, therefore, a measure of the speed of the instrument. The logarithmic decrement is

$$\lambda=\frac{\pi D'}{\sqrt{4KU'-(D')^2}}.$$

The torques A and B produce deflections from the equilibrium position equal to A/U' and B/U'.

The period not only depends upon the moment of inertia of the moving system and moment of restoration of the suspension, but also upon the constants of the moving coil circuit and the excitation, and may be larger or smaller than the period without excitation. The damping is always larger with excitation. The torque B produces a deflection of the coil from its equilibrium position even when there is no impressed E.M.F. This deflection is proportional to the angle θ_0 and is due to the induced current in the circuit. The torque A which results from the impressed E.M.F. produces a deflection depending upon the magnitudes of the harmonics in the excitation and in the E.M.F., upon the phase relations and upon the constants of the moving coil circuit.

Simple Case.—For the simple ideal case of a sine-wave magnetic field and a sine-wave of impressed E.M.F. of the same frequency it can be shown that if

$$R'=\frac{G^2}{\sqrt{4KU}-D}=R+r,$$

the motion is aperiodic.

Here R' is the total resistance of moving circuit.
G is the rate of change with deflection of the effective value of the total flux.
K is the moment of inertia of moving system.
U is the moment of restoration acting on moving system.
D is the moment of damping of moving system.
R is the external critical resistance.
r is the resistance of moving system.

The operating constants of importance when the electromagnet moving coil galvanometer is used as a detector in bridge or potentiometer measurements are the sensitivity S, the free period T, and the external critical resistance R. This sensitivity is defined as the deflection per unit E.M.F. in the moving coil circuit when the motion is aperiodic and is expressed in millimetres deflection at 1 meter of the reflected ray per microvolt. The free period is in seconds and the resistance in ohms. The relations between these constants and the intrinsic constants follow from equations given above, and are

$$S=200{,}000\frac{\sqrt{4KU}-D}{GU},$$

$$T=2\pi\sqrt{\frac{K}{U}},$$

$$R=10^{-9}\frac{G^2}{\sqrt{4KU}-D}-r.$$

* Abstracted from "Bulletin" No. 297 of the Bureau of Standards (Washington).

Digitized by Google

For these conditions the operating constants are independent of frequency and are the same as for the direct-current galvonometer.

In order to design an instrument for use as a detector in a certain kind of measurement it is necessary to be able to calculate the intrinsic constants from the required operating constants. The necessary relations are readily obtained from the last set of equations.

Effects of Reactance and Harmonics, &c.—The author then discusses in detail the effects of reactance and harmonics. A change in the restoring torque resulting from reactance in the moving coil circuit will influence the period, damping and sensitiveness of the instrument. In making adjustments to get the best effect it is sometimes desirable to use series or parallel resistance, inductance or capacity. The general aim in such cases is to produce an electrical resonating system so that the total reactance in the moving coil circuit is zero or of such a value as will give the best operating constants.

The effects of harmonics can be considered as additions to the various torques acting on the coil, and they tend to change the position of equilibrium for no impressed E.M.F., to alter the period, to affect the damping, and to give a deflection proportional to the sum of the products of the harmonic flux and the harmonic E.M.F. and the cosine of the angle between them. Usually the magnitudes of the harmonics are small compared with the fundamental, and the selectivity can be still further increased by using an electrical resonating system in the moving coil circuit.

An explanation is also given of methods of measuring the constants depending on the resistance, capacity and inductance of the moving coil circuit. In doing this the period and logarithmic decrement on open circuit and with the moving coil connected to a fairly non-inductive resistance such that the decrement is increased about 10 times are determined.

The main torques to be considered are those due to (1) reactance due to acceleration, (2) constant damping, (3) suspension, (4) current resulting from impressed E.M.F., and (5) current resulting from induced E.M.F. There are also various "disturbing torques" which are usually small, and the author discusses various methods of eliminating their influence.

Construction and Performance.

General Design.—The construction of an electromagnet moving coil galvanometer for use in alternating-current measurements differs but little from that of the sensitive moving coil galvanometer for direct currents. In place of the permanent magnet a laminated electromagnet is used. The moving system can be the same as for the direct-current galvanometer, with modifications suggested by the analysis of the disturbing torques. It is easy to calculate the values of the moment of inertia K, the moment of restoration U, and the moment of displacement G necessary for an instrument which is to be used with apparatus having a given resistance, sensitivity and period.

In the construction of the moving system the resistance of the coil should be low and the material as free from magnetic impurities as possible. Thin insulating material (enamelled wire) keeps the moment of inertia low, and but little insulation is needed. But in case the instrument is to be used at high frequencies the use of thin insulation increases the capacity between turns and hence the corresponding disturbing torque. A large mirror adds to the moment of inertia, but much can be gained by the use of well-made mirror of good glass. The resistance of the suspensions should be kept reasonably low. Short, flat suspensions made by rolling small (0·02 mm.) copper wire have been found satisfactory.

The construction of the electromagnet should be such as to give a field of the desired strength and shape with as little power loss and distortion of the wave shape as possible. The strength of the field is limited by the magnetic properties of the materials used in the coil and also by the source of excitation available. At high frequencies special attention is necessary to keep the losses due to hysteresis and eddy currents low. The exciting winding should be so designed that the higher voltages required at the higher frequencies cause no trouble. The winding may be made up of several coils which can be connected in series or parallel as the case demands.

Usually the reluctance of the air gap is large compared with that of the iron and also low inductions (500-2,000 gauss) are used so that the production of harmonics in the magnetic flux depends upon the source of excitation. Since the inductance of the fixed coil is large compared with the resistance, the exciting current and therefore the magnetic flux will contain fewer harmonics than the impressed E.M.F. The magnitude of the harmonics can be still further reduced by the use of a resonating system. A large inductance in series and a suitable condenser in parallel with the coils improves the wave shape of the magnetic flux and hence increases the selectivity of the instrument.

In order to shield the moving system of the galvanometer from leakage and electrostatic effects, it is convenient to surround it with a metallic case connected to some point in the testing circuit such that the difference of potential between it and the coil is always very small. The iron core of the fixed coils should be connected electrically to the shield.

Several sensitive galvanometers have been designed and built following the ideas given above. The description of the construction and the performances will now be given :—

Galvanometer A.—The moving system of this instrument consists of a coil 8 mm. wide and 12 mm. high which has 27½ turns of 0·08 mm. (No. 40 American wire gauge) single silk-covered copper wire and a mirror 1 cm. in diameter and 0·6 mm. in thickness. The upper and lower suspensions are each about 5 cm. long and were made from 0·015 mm. copper wire rolled flat.

The coil was suspended in an air gap 10 mm. long between pole-faces 8 mm. square. The core of the fixed coil was made of laminations of good silicon steel. The exciting coil consisted of 1,560 turns of 0·51 mm. (No. 24) enamelled copper wire. With 120 volts at 60 cycles per second on this winding the current was 0·93 ampere and the performance was as shown in Table I. Here C is the capacity of the condenser connected to the terminals of the moving coil, T is the period of the instrument, R is the external critical resistance, and S_{60}, S_{180}, and S_{300} are the sensitivities to the fundamental, the third and the fifth harmonics, respectively. The prediction of aperiodic motion is borne out, but it is noted that the external resistance necessary to produce it is low.

Table I.—*Performance of Galvanometer A.*

C	T	R	S_{60}	S_{180}	S_{300}
$\mu f.$	Seconds.	Ohms,	mm/$\mu v.$	mm/$\mu v.$	mm/$\mu v.$
0	5·6	0·1	13·5	0·13	0·015
2	8·0	5·1	16·0	.....	.....

Approximate values of the intrinsic constants of this instrument are as follows :—

$K=0{\cdot}022$, $D=0{\cdot}001$, $U=0{\cdot}028$, $G_1=28{,}000$, $G_2=280$, $G_3=30$, and $r=14\times10^9$.

Galvanometer B.—This instrument was intended for use with apparatus in which the resistance between the terminals to which the galvanometer is to be connected is of the order of 100 ohms. A period of only a few seconds, a sensitivity of several millimetres per microvolt, and a periodic motion were required so that it was necessary to use a light coil. The coil consists of 100 turns of 0·08 mm. (No. 40) enamelled copper wire wound on a wood frame to make a coil 2 cm. long, 0·3 cm. wide, and 0·1 cm. thick. The wire is insulated with cellulose acetate, which is very thin. The coil was treated with potassium copper chloride to remove the magnetic impurities, and it was then washed, dried, and dipped into collodion, which bound the parts firmly together. The complete moving system is shown in Fig. 1. The fibre plug at the top fits into the case of the instrument. The moving system is easily removed, to be replaced by another of different constants.

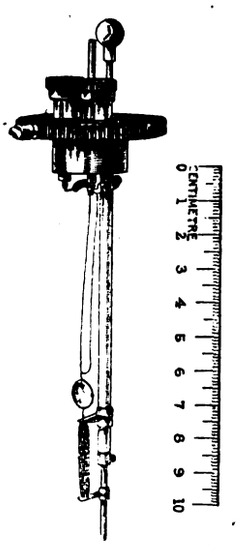


FIG. 1.—MOVING SYSTEM OF GALVANOMETER *B*.

The coil swings in a gap 0·6 cm. long in the laminated steel core 2 cm. by 0·8 cm. in section. There are two exciting coils each wound with 650 turns of 0·72 mm. (No. 21) enamelled copper wire, and the coils are arranged for either series or parallel connection.

Table II.—*Performance of Galvanometer B.*

f	Excitation.		C	T	R	S
∿/second.	Volts.	Ampere.	$\mu f.$	Seconds.	Ohms.	mm./$\mu v.$
0	2·6	0·4	0·00	1·7	25	2·3
0	3·9	0·6	0·00	1·4	60	1·2
60	29·0	0·4	0·00	1·9	30	2·6
60	29·0	0·4	0·22	4·2	100	5·7

The performance of this instrument under certain conditions of use can be seen from Table II. The intrinsic constants were found to be as follows :

$K=0{\cdot}006$, $D=0{\cdot}0003$, $U=0{\cdot}05+0{\cdot}2I^2$, $G=115{,}000I$, $r=25\times10^9$ and $c=0{\cdot}07$.

Digitized by Google

Here I is the exciting current in amperes (coils in series). The resistance of the two fixed coils in series is 6·4 ohms and the inductance is 0·18 henry. The insulation is such that 120 volts can be used for excitation.

Galvanometer C.—The fixed system of this galvanometer is the same as that of Galvanometer B. The moving system consists of a coil of 75 turns of 0·08 mm. (No. 40) single silk-covered copper wire wound to form a coil 2 cm. long, 0·5 cm. wide and about 0·15 cm. thick, and a mirror 0·8 cm. in diameter. The performance of this instrument is very satisfactory, the capacity effect being small and the coil being very free from magnetic impurities.

In order to check the theory approximately the quantities K, D, U and G were measured for various values of the exciting current and frequency. The results are given in Table III. It appears that the quantities K and U are real constants to the accuracy consistent with that of the determination of T_1, T_2 and λ_2. Further, the damping D and the moment of displacement G are constant for a given excitation. G is roughly proportional to the excitation current, as it should be. D increases with excitation in such a manner as to indicate the presence of a damping due to eddy currents.

Table III.—*Results of the Determination of the Intrinsic Constants of Galvanometer C at Various Excitations and Frequencies.*

I ampere	0·2	0·5	1·0	0·2	0·5	1·0	0·2
f ~/seconds.....	0	0	0	60	60	60	300
Observed Quantities.							
T_1 seconds	1·65	1·55	1·51	1·69	1·68	1·65	1·68
λ_1	0·05	0·07	0·12	0·05	0·06	0·10	0·05
T_2 seconds	1·70	1·65	1·65	1·73	1·67	1·65	2·30
λ_2	0·28	0·53	0·74	0·38	0·68	0·77	0·44
$(r+R_2)$ ohms	115·00	305·00	715·00	67·00	214·00	650·00	88·00
$(r+R_1)S$ mm/μamp.	35·00	74·00	125·00	33·00	75·00	135·00	33·00
Computed Quantities.							
K	0·01	0·009	0·009	0·01	0·012	0·011	0·011
D	0·0011	0·0016	0·0029	0·0011	0·0016	0·0027	0·0012
U	0·14	0·15	0·16	0·14	0·17	0·16	0·15
G	25,000	56,000	99,000	23,000	63,000	15,000	25,000

$r=17$ ohms.

Galvanometer D.—This instrument is the best of several designed for use as detectors of alternating E.M.F. of frequencies up to 2,000 cycles per second.

One of the first difficulties met with when the electromagnets were excited with alternating currents of these frequencies was a continual vibration of the coil when it was closed on a circuit of fairly low impedance. The disturbance increased with frequency, excitation, and with diminution of the impedance in the moving coil circuit, and was the result of the coil being in a non-uniform field.

In order to eliminate this disturbance the period of vibration of the coil back and forth in the gap was made small by the use of short suspensions. More care was also taken to make the magnetic field uniform. There is now no serious vibration of the coil at 2,100 cycles per second even when the moving coil circuit is very inductive.

Table IV. shows the performance of this instrument under various conditions of use. W is the power required for excitation. C is the capacity of the parallel condenser used in controlling the period, and S_1 is the current sensitivity. With a current of 0·5 ampere the motion is aperiodic when the external resistance is 16 ohms. The sensitivity is high and the motion is not far from being aperiodic. The air damping is larger in this instrument than in the others on account of the larger coil and closer proximity of the pole faces. This accounts for the reasonably satisfactory damping at the high frequencies where the electromagnetic damping is not large.

Table IV.—*Performance of Galvanometer D.*

f	I	W	C	T	R'	S	S_1
~/sec.	Ampere.	Watts.	μf.	Seconds.	Ohms.	mm/μv.	mm/μ ampere.
0	0·490	1·0	0·00	2·4	16·0	1·10	38·0
430	0·260	3·4	0·00	3·3	23·0	0·90	38·0
430	0·260	3·4	0·10	2·5	76·0	0·23	22·0
2100	0·068	1·2	1·00	1·7	11·00	0·09	2·7
2100	0·066	1·1	1·00	2·4	22·5	0·12	5·0
2100	0·063	0·9	0·25	2·4	42·5	0·08	4·9
2100	0·063	0·9	0·05	3·1	100·0	0·07	8·3
2100	0·151	6·8	1·00	2·2	23·5	0·23	9·8
2100	0·198	12·6	1·00	2·4	23·5	0·37	16·0
2100	0·210	14·2	0·05	1·5	94·0	0·058	6·6
2100	0·210	14·2	0·05	4·2	100·0	0·43	51·0

The intrinsic constants of this instrument are

$K=0·075$, $D=0·03$, $U=0·6$, $G=200,000\ I$ and $r=19\times10^9$.

The direct-current resistance of the exciting coil is 4 ohms. The apparent resistance to alternating current increases with current and frequency approaching the value 320 ohms at 2,100 cycles per second and 50 ohms at 430 cycles per second for currents above 0·1 ampere. For currents less than this the resistance seems to approach the direct-current value as the current approaches zero. The apparent inductance increases from the value 0·06 henry for small currents to the value of 0·1 henry for currents above 0·1 ampere. The apparent inductance is independent of frequency indicating that the eddy currents are not large.

USES.

Detector.—In general, the purpose of a detector in null methods of electrical measurement is to show when the current or the E.M.F. in a certain circuit is zero or does not change when certain changes are made in the testing current or voltage. Such conditions are brought about by an adjustment of some part or parts of the measuring apparatus.

The performance of the electromagnet moving coil galvanometer as a detector is thus similar to that of the direct-current moving coil galvanometer. If one is dealing with sinusoidal current or E.M.F. to be detected and non-inductive circuits, the only difference is due to the fact that the small E.M.F. or current may be out of phase with the magnetic field. Since the deflection is proportional to the component of the E.M.F. in phase with the magnetic field, zero deflection means only that the E.M.F., if it is detectable, is in quadrature with the magnetic field. In order, therefore, to be sure that the E.M.F. is zero, the phase of the excitation is changed. With non-inductive circuits the phase of the excitation can be adjusted once for all so that the maximum sensitivity is obtained.

Usually in alternating-current measurements we have to do with apparatus having both resistance and reactance so that the unbalanced E.M.F. may be of any phase whatsoever. There are usually two adjustments, the "resistance" and the "inductance" adjustments. A small change in one results in a change in the

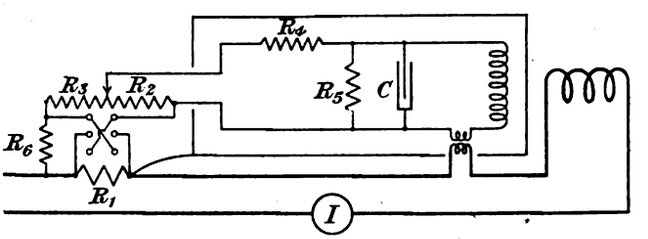


FIG. 2.—DIAGRAM OF CONNECTIONS USED IN CALIBRATION OF GALVANOMETER.

unbalanced E.M.F. with a phase approximately in quadrature with the change produced by the other adjustment. Now if the phase of the excitation be such that a large change in one adjustment produces no change in deflection, it is possible by shifting the phase of the excitation 90 electrical time degrees to make the one adjustment independent of the other. When such an adjustment of the phase of the magnetic field is not made the balance must be obtained by successive approximations.

Reversal of current is the most desirable method of testing for a balance, for then the impedance of the moving coil circuit remains constant and a permanent change in deflection can result only from an E.M.F. which reverses when the test current is reversed. In case the balance depends upon the frequency, reversal may cause a sudden motion of the coil due to the differences in the rates of decay and growth of the currents furnishing the balancing E.M.F.s. Care is also necessary if stray electric or magnetic fields are present.

In some measurements it is desirable that the detector be sensitive to currents of the fundamental frequency only. This is the case when sinusoidal supply is not available or when harmonics are introduced by the apparatus so that the comparatively large harmonic E.M.F.s must not cause deflections which will mask the deflection produced by the fundamental unbalanced E.M.F. The use of electrical resonating systems in the circuits has been discussed above. These, together with care as to excitation, will usually be sufficient to give ample selectivity. Constancy of the frequency is essential.

Other Uses.—The electromagnet moving coil galvanometer is inherently an instrument of the galvanometer type inasmuch as it is not feasible to know with precision the constants depending upon the separate excitation, which data would be needed if the current in the moving coil were to be measured accurately. For approximate measurements the instrument can be calibrated by using connections as shown in Fig. 2. A small E.M.F. approxi-

Digitized by Google

mately in phase with the magnetic field is obtained from the drop in potential across the low resistance r_1 by using the divided resistances r_2 and r_3. The resistances must be sufficiently non-inductive at the frequency used. With C, r_4, r_5 and r_6 adjusted to the values to be used in the measurement the change in the deflection on reversing the E.M.F. is noted. A simple calculation then gives the calibration factor. The resistance r_6 is very high in comparison with r_1 and is used to maintain the resistances r_2 and r_3 and hence the moving coil circuit at the potential of the shield when the switch is open. This is very necessary at high frequencies on account of the capacity current which would flow through the moving coil due to the capacity between the resistances r_2 and r_3 and the surroundings. If the apparatus containing the small E.M.F. to be measured is available it should be inserted so that the moving coil circuit will be the same during the calibration as during the measurement.

The electromagnet moving coil galvanometer can be used to measure inductance in terms of capacity and vice versa by a resonance method in which the inductance and capacity are inserted in series in the moving coil circuit.

A difference corresponding to 1 microhenry can thus be detected at 60 cycles per second.

THE ENGINEER IN NATIONAL AFFAIRS.*

There has been much discussion concerning the position of the engineer in modern times, but conditions are changing so rapidly and points of view are undergoing such a fundamental evolution that it is well from time to time to review the relations of the engineer to his surroundings and to secure if possible the proper orientation. The change and improvement in the engineer's position in the world in recent years have been so rapid as to surprise even those who were the optimists in the under-dog days of the engineering profession. The engineering profession is now coming into its own. To-day the engineer is being swept along by a tide which he himself has created with an irresistible force, and it is well therefore for the engineer to take his eyes off his work occasionally and to observe his constantly changing surroundings. In all the development period of the engineering profession during the last century the engineer has worked his way along alone and in silence, so to speak, seeking his reward rather in the joy of accomplishment and in the realisation of his dreams than in worldly recognition and accumulation. The very inherent greatness of the pioneers who have laid the foundations upon which we now build prevented them in a way from acquiring a more worldly position in affairs. In our general relations to intellectual development we may consider that we are just emerging from a classical period where tradition, custom, prejudice, ignorance and dogmatic religion were the controlling forces. For centuries before the dawn of the scientific and engineering era great changes took place throughout the world, but little real progress occurred. A constant change in point of view, which is so largely brought about through developments in scientific knowledge, seems to be necessary for progress in civilisation. Our civilisation to-day differs from that of a century ago in proportion to the scientific and engineering evolution which has taken place during the period through its reactions on life in all of its phases. Such discoveries in science as the law of gravitation, the evolution of species, the laws of electromagnetic induction, &c., have probably had a more profound effect upon the development of the human race than any other acts in history.

The Engineer in Human Affairs.—The engineering profession has passed through the preliminary stages of its growth and has reached a position where the engineer should work and act not only with proper attention to his work itself but with full consciousness of the important relation of his work to human affairs in general. Among the early pioneers in engineering were many notable instances of men of great breadth of view—men like Watt, Fulton, Whitney, McCormick, Erickson and others. Specialisation had not at that time begun to work its narrowing influences. Of recent years, however, under the stress of commercial development and economic conditions, increasing specialisation has taken place and the engineer has become obliged to compass his mind with an ever-narrowing horizon. This specialisation produces extraordinary proficiency in particular fields, but has the objectionable effect of narrowing the character and outlook of the man and of reducing his value as a citizen. We must take care lest commercial considerations and the modern mania for efficiency in the narrow sense force our engineers to lose sight of the world around them in their concentrated attention to the part rather than to the whole. It is interesting to recall in this connection the results of a recent canvass made by a joint committee on education on the qualities which, in the opinion of about 5,000 leading men, engineers and others, best fit a man for a successful career as an engineer. As a result of this vote only 13 points out of 100 were assigned to purely technical knowledge as an essential, the other 87 points being allotted to broader qualifications, such as judgment, character, human understanding, &c. This is merely a quantitative statement of the many general demands now being made of the engineer, and it illustrates how his work has broadened out. It is an interesting and encouraging symptom. A most significant movement of recent times in the engineering world has been the development of co-operative action among engineers of all classes, and this tendency will, I believe, serve to offset the evils of specialisation. It is the growing recognition of the fact that all branches of engineering are interdependent. We electrical engineers, I believe, are well aware how much we need the assistance of other branches of engineering for the successful fulfilment of our purpose.

The Engineering Council.—This co-operative movement has quite recently been given tangible expression in the formation of the Engineering Council, an act, I believe, of far-reaching consequence. Under this organisation as a beginning the Civil, Mechanical, Mining and Electrical societies, together with the United Engineering Society, are tied together for co-operative action through a joint body of 24 representatives. This body will meet at frequent intervals and will deliberate on matters of general interest to engineers. It is an encouraging beginning toward universal co-operation among engineers in all branches of work. In this Engineering Council we have for the first time an engineering body representing about 30,000 engineers of sufficient scope and standing to create an engineering public opinion. Its influence is likely to be far-reaching in building up the prestige of engineers in both technical and civic affairs. A further development which has reached full recognition only in recent times is the mutual appreciation which has grown up between the engineer on the one hand and the worker in pure science on the other. The engineer looks to the scientist to provide him with raw materials of knowledge with which to work out his applications, and the scientist must look to the engineer to make his discoveries so fruitful that the full effectiveness of his work on the frontier of research can be sustained. Both are working together in order to unfold nature in the most effective way for the benefit of man. We electrical engineers, I think, feel a particularly close bond with the pure scientist in that recent developments in physical science have disclosed an intimate relationship between electrical phenomena and the nature of energy and matter. All of the important movements taking place at the present time which centre around the engineer and his work mean, I believe, that the engineer is soon going to leave his position of isolation in independent fields of work and realise that he owes an obligation to the community broader than his daily engineering work and will contribute to the general welfare his talents and experience. It matters not whether the problems before him are political, sociological, industrial or technical, I believe that the engineering type of mind, if the proper breadth of view has been acquired, is best fitted to undertake them.

Resourcefulness and Imagination of the Engineer.—It is not necessary, perhaps, in important administrative positions to have civil, electrical or mechanical engineers as such, but we do need men in those positions who have had training of the type which engineering gives, with the mental balance, the power of analysis which such a training develops, the resourcefulness and the faculty of recognising and properly apportioning the various elements in a problem. There is a quality of mental honesty which engineering experience highly develops which is sorely needed in public life. The engineering mind also numbers among its characteristics a highly developed creative imagination and possesses to a high degree exactly those qualities of mind and temperament best suited to combat materialism. There have been many instances in history of great artists who have been great engineers and vice versa, and I believe that the two temperaments lie in close relationship. Furthermore, scientists and engineers as a class have a strongly developed spirit of international understanding and sympathy which may serve as an important safeguard against excessive nationalism and aggression.

And so I believe that we can confidently look forward to a new era for the proper fulfilment of the destinies of the engineer. The great engineering societies must realise the power of influence which they are developing in an ever-increasing degree in the community at large and the obligations which devolve upon them. So I hope that the American Institute of Electrical Engineers as it passes along from one administration to another will acquire an increasing realisation of its duty, not only in furthering the growth of science and engineering, but in furthering the influence of the engineer in the affairs of the country and of the world.

* Abstract of Presidential address by Mr. H. W. Buck at a special meeting of American Institute of Electrical Engineers.

Digitized by Google

The Electrician.
FRIDAY, AUGUST 10th, 1917.
Editorial and Publishing Offices:—
8, BOUVERIE STREET, LONDON, E.C. 4.
Telephone: City 9853 (4 lines). Telegrams: "Benbrotric Fleet London."

GREAT BRITAIN'S POSITION IN ELECTRICAL DESIGN.

Export measures prosperity, and in order that the prosperity shall endure, the supply of the thing exported must not be limited. It is important that the value of the thing exported should lie chiefly in its design and construction, and but little in its material. If the truth of this be granted—and it surely is self-evident—no further proof is needed of the high importance which a nation should attach to the development of the design and manufacture of machinery. To satisfy the needs of home users is not sufficient. Manufacturers should have a world-wide outlook, and should design with the definite object of attracting buyers in all countries.

We feel that this point of view is an important one to which too little attention has been given by British manufacturers, especially by manufacturers of electrical machinery and apparatus.

Commercial electrical engineering design is essentially of British origin, and the history of its early development makes appropriate for Great Britain nothing less than the foremost place in it. The fact that Britain does not hold to-day the foremost place is an anomaly, and we believe it has a sure remedy.

The view that the foremost place has been lost to Britain will not go without challenge, but if it be borne in mind that the question is that of design and manufacture judged from the standpoint of commercial success, the challenge will be recognised as a mere boast. If we exclude firms which, though nominally, or indeed actually, British, owe their strength to parent firms in other countries, it must be admitted that, with the single exception of the design of D.C. machines, British firms for some years past have taken but an unimportant part—or sometimes no part at all—in the great advances that have been made in electrical engineering.

Until quite recently it has been the case that, whilst America produces her 50,000 k.v.a. turbo-generator, we have produced our 10,000 k.v.a. unit; against transformers of 10,000 k.v.a. and even 50,000 k.v.a. we could but set 5,000 k.v.a. In high-voltage alternating-current transmission no system in Great Britain exceeds 40 kv., whilst other countries have their 100 kv. and 120 kv. systems. It is true that the two great systems—the Tata Hydro-Electric Power Co., transmitting at 100 kv., and the Victoria Falls & Transvaal system, using voltages up to 80 kv.—are British undertakings; but this makes only the more anomalous the fact that the generators and transformers used are of foreign design and manufacture. The least disconcerting explanation that can be given for our backwardness in these respects is that it results naturally from the smallness and compactness of our country. Great Britain has no occasion for long transmission lines; she is more economically served by a multitude of small stations equipped with small units than she could be by few stations having large units. The soundness of such an argument is, however, very questionable; our own desire is to hasten on the events which will prove it unsound and which we believe are already in sight.

The need for new types of plant such as we have mentioned, as well as of outdoor sub-stations and automatically-controlled stations, grows out of the developments that are called for by extensive systems of transmission and distribution. The same is true of switchgear, but by no means is it true of measuring instruments. Great Britain's position with regard to the latter is especially disquieting.

The remedy that we propose involves, first, a change in the point of view of manufacturers. In fulfilling a contract the manufacturer should look far beyond the contract, and should design his machines with an eye to distant countries and to the future. The ultimate reason that Siemens and the A.E.G. captured so much of the Victoria Falls and Transvaal contract (though finance may have had something to do with it), and the General Electric Co. of America so much of the Tata plant, lay in the fact that these firms had already won a reputation for plant of the desired rating, and that no British firm had yet made such plant.

We suggest that it is better for manufacturers to supply plant at a loss to themselves, looking to the future for their profit, than not to supply such plant at all, when it is a case of keeping in the forefront of advance. One or two bold efforts in this direction would have given British manufacturers the experience, and the consequent reputation, which alone were wanting to ensure to themselves certainly all the big contracts in the British Empire, and probably a good share of foreign contracts, too.

It will be said that such a policy as we are suggesting is not commercially sound. When difficulties are obvious, a plausible case can always be made out for impracticability, and with small firms it is true that the difficulties would be formidable. In such cases the solution indicated is amalgamation. A big well-organised firm would be prepared to spend (as, in fact, the General Electric Co. of America does spend), say, £100,000 annually on research. And what, after all, is the method we are advocating but research on a commercial scale?

In conclusion, we have a suggestion to offer with regard to a difficulty which is being considered by those manufacturing firms which are facing most earnestly this problem of British backwardness in electrical design—the difficulty, namely, of finding capable designers. We believe that the difficulty is largely imaginary. The assumption is being made that before undertaking the design, say, of a large 100 kv. transformer, a designer must be found who already has designed transformers of similar rating. And there is this amount of sound basis for the assumption—namely, that the successful design of such a unit depends upon the possession of data which no amount of available theory—or, indeed, of experience, unless obtained by the actual handling of apparatus of similar rating—can give. At the root of this lies ignorance of the theory of insulation and the impracticability, due to the great complexity of the process of heat dissipation, of theoretically predicting temperature rise. The rare possession, therefore, which is looked for in the designer is not so much theoretical knowledge, natural ability, or, indeed, any *quality*, whether inborn or acquired, as it is access to quantitative data obtained at the expense of a larger or better organised firm. Thus we feel that the difficulty of which so much is made is really one which British firms should be ashamed to countenance. A self-respecting firm can court prosperity in no way more successfully than by taking, and paying well, the young engineer whose record, though brief, is marked by high personal qualities, the ability to think straight, a sound technical education and good all-round experience. Great Britain has available a good supply of such men.

Digitized by Google

THE VECTOR ANALYSIS OF ELECTRICAL VECTOR DIAGRAMS.

BY A. PRESS.

Although the methods of the complex variable in the hands of a Steinmetz have given exceptional results, and although such Steinmetzian methods lead to vector diagrams it cannot be said that in dealing with the number complex $a+jb$ that one is really dealing with vectors.*

Since an increasingly greater interest is being displayed in vector analytical methods it may not be amiss to show the relationship of true vector methods to the time-phase diagrams growing out of the differential equations of electrical phenomena.

Time-phase Representations of Sinusoidally Varying Vectors.—In alternating-current phenomena vector quantities such as current, flux, E.M.F., &c., come into play, which are sine functions of the time. To indicate the proper time-phase relationship of the quantities involved pseudo space representations are really made use of.

In the equation,

$$L\frac{d\mathbf{I}}{dt}+\mathbf{I}r=\mathbf{E}$$

the impressed E.M.F. $\mathbf{E}$ is seen to be balanced by two forces. The one is the copper drop reaction $\mathbf{I}r$ and the other is the self-inductive drop $L\frac{d\mathbf{I}}{dt}$ due to the change of flux linkages about the conductor. The equation can also be operatively expressed by

$$\left(L\frac{d}{dt}+r\right)\mathbf{I}=\mathbf{E},$$

where the voltage and current can be taken as *parallel vectors* (in the isotropic medium), but subject to a time phase displacement.

For alternating currents we have

$$\mathbf{E}=\mathbf{E}_0 \sin (pt+\alpha),$$

where $\mathbf{E}_0$ is the vector amplitude of E.M.F., and then for a current amplitude $\mathbf{I}_0$,

$$\mathbf{I}=\mathbf{I}_0 \sin pt.$$

These two equations giving in fact the instantaneous values, will be found to satisfy the above differential equation, since on substitution (disregarding the vectorality because of parallelism) the only condition required to be fulfilled is

$$LpI_0 \cos pt+I_0 r \sin pt=E_0 \sin (pt+\alpha).$$

Developing the expression on the right and equating sin pt and cos pt terms (equivalent to taking $pt=0$, K/2), one must have for any moment t

$$LpI_0=E_0 \sin \alpha,$$
$$I_0 r=E_0 \cos \alpha.$$

The above immediately suggests a means for enabling one to represent the solution of the above differential equation by means of a "vector" or phase-diagram. Thus, in the time-phase diagram let the current amplitude be I_0, then with a constant time-phase displacement α the voltage amplitude $\mathbf{E}_0$ is to be drawn in a direction, making the angle α with the current amplitude $\mathbf{I}_0$. By projecting the values $\mathbf{I}_0$ and $\mathbf{E}_0$ upon either co-ordinate axis, then as the figure OAB revolves uniformly with the time about the origin O, a succession of values will be obtained which will necessarily satisfy the differential equation.

Differential Time-operators and Alternating Currents.—Having again regard to the equation,

$$\left(L\frac{d}{dt}+r\right)\mathbf{I}=\mathbf{E},$$

in forming the phase diagram it is seen that, firstly, for the instantaneous values of the variables $\mathbf{I}$ and $\mathbf{E}$, one must substitute the amplitude values $\mathbf{I}_0$ and $\mathbf{E}_0$. Moreover, since the two "vectors" $\mathbf{I}_0$ and $\mathbf{E}_0$ are to be so drawn that they make an angle α whose sine is given by

$$\sin \alpha=pL/r,$$

the operator $\left(L\frac{d}{dt}+r\right)$ is to be so understood that the quantity r is to be drawn in phase with $\mathbf{I}_0$, and for $L\frac{d}{dt}$ one is to substitute Lp, which is to be drawn at right angles to the vector $\mathbf{I}_0$.

In fact, one can readily see that if $\mathbf{k}$ is a unit vector drawn upwardly from the plane of the paper, *d/dt is to be replaced by the operator $pV\mathbf{k}$ ( ).**

Since when operating with a sine function :—

$$d/dt \sin pt=p \cos pt,$$
$$d^2/dt^2 \sin pt=-p^2 \sin pt,$$

it is easily seen that formally one has *with a sinusoidal operand*

$$(d/dt)^n=(ip)^n,\dagger$$

which indicates that with alternating currents of a single simple periodicity, to obtain the appropriate phase diagram, one is to substitute for the operator $(d/dt)^n$, the vector operator $\{pV\mathbf{k}()\}^n$. The following duality is, therefore, justified :—

Differential operator.	Vector operator.
$A\frac{d}{dt}+B$	$ApV\mathbf{k}()+B$
$A\frac{d^2}{dt^2}+B\frac{d}{dt}+C=-Ap^2+B\frac{d}{dt}+C$, &c.	$Ap^2V\mathbf{k}V\mathbf{k}()\ddagger+BpV\mathbf{k}()+C=-Ap^2+BpV\mathbf{k}()+C$, &c.

Application.—The Autotransformer Diagram.§—Let φ be the flux threading the primary and secondary coils of an auto-transformer. The variation of φ will, in general, set up two terminal voltages $\mathbf{E}_p$ and $\mathbf{e}_s$, whose amplitudes will be in proportion to the respective turns between the primary and secondary terminals. Thus, the differential equations are

$$-a\frac{d\varphi}{dt}=E_p,$$
$$b\frac{d\varphi}{dt}=e_s.$$

If, then, φ varies as a sine function of the time, for the phase diagram taking amplitudes, one will have

$$-aV\mathbf{k}\varphi_0=\mathbf{E}_0,$$
$$bV\mathbf{k}\varphi_0=\mathbf{e}_0,$$

since the variables are to be changed to vector amplitudes.

These two voltages will be opposed if $\mathbf{E}_0$ is the result of an impressed voltage $\mathbf{E}_i$ on the primary.

In this circuit one will have the usual equation,

$$E_i=IR+L\frac{dI}{dt}+E_p,$$

whereas for the secondary there will obtain :—

$$e_s=ir+1\frac{di}{dt}.$$

On the other hand, the flux φ threading the auto-transformer coil must be the resultant of the instantaneous magnetomotive force due to the currents I and i.

Rewriting the primary voltage equation,

$$\left(L\frac{d}{dt}+R\right)I=E^i-E_p=E',$$

or, drawing the vector $\mathbf{I}_0$ in the $\varphi_0\mathbf{E}_0$ quadrant the vector $\mathbf{E}_0'$ is obtained, which has to be added vectorially to $\mathbf{E}_0$ to give the amplitude $\mathbf{E}''$ of the impressed primary voltage $\mathbf{E}_p$. Naturally the secondary current i_0 and primary current I_0 must be so co-ordinated as to combine vectorially to produce a resultant M.M.F., giving the threading flux φ_0.

---

* *See* Heaviside's "Electromagnetic Theory," Vol. II., pp. 457, *et seq.*

* In the Gibbs-Wilson notation, which is that of Coffin, $V\mathbf{k}()$ stands for the "cross" product with the unit vector $\mathbf{k}$, and is written $\mathbf{k}\times()$. Really it implies that $V\mathbf{k}()$ is to be understood as symbolising the operation of turning the operand indicated by () through an angle of 90 deg. about the vector $\mathbf{k}$ as an axis.

† *See* Perry's "Calculus for Engineers," pp. 235-237. As will be seen later, it enables one to give an interpretation to the fractional operator $(V\mathbf{k})^{\frac{1}{2}}$.

‡ In ordinary language $V\mathbf{k}V\mathbf{k}()$ means turning the operand through $2\times90°=180°$. Since, by vector analysis, $V\mathbf{k}V\mathbf{k}()=\{\mathbf{k}.()-().\mathbf{k}\}\mathbf{k}$,
$=\mathbf{k}.()\mathbf{k}-().\mathbf{k}^2=-()$

§ Compare Steinmetz, "Alternating-current Phenomena," Fleming, "Alternating-current Transformer," Vol. I.

Digitized by Google

ELECTRICAL TRADE ANOMALIES.

BY J. M. M. MUNRO.

"Electrical Contractor," as a trade class name is not a very happy one. It gets shortened to contractor and ceases to be distinctive. In this it is like the word "undertaker," so beloved of provisional order draftsmen and by funeral men. Or like the word "unit," which may be any unit, as for example a British Thermal unit or a Board of Trade unit. It is more than true, by the way, that the latter term were officially replaced by the long delayed "kelvin."

Would not "electrician" be a better term than contractor and more in line with names of other trades? The public use it now. It has long ceased to suffice as a description of a man who professes electrical science or of one who deals in electro-medical appliances. The word "wireman" has every possible fault, unless as a sub-term denoting a certain kind of workman who can make no pretension to be anything else: and even he might prefer to call himself a "tube-hand" or an "electrical fitter."

Yet nowadays every registered plumber who controls a half-baked wireman calls himself a sanitary and electrical engineer. The wiring contractor and the plumber as such are no more and no less engineers than is a chair-maker or a jobbing tinsmith. If the electrician has served an adequate apprenticeship to mechanical engineering and has had experience in erecting engines and gearing and heavy plant he might call himself "electrician and engineer."

By electrician I mean one who is in business primarily as a retail dealer in, and erector of, electrical appliances generally. If he specialises, his business designation should also indicate his "line." Such a man should, for the protection of the public, know his business thoroughly, and his "association" ought not only to guarantee his work, but, as a preliminary thereto, guarantee the man. An electrician should be registered as a plumber is, and, as a corollary, it ought to be at least as illegal for a plumber to undertake electrician's work as for an electrican to supplant the plumber.

Although the main purpose of this article is to agitate for a reform in electrical trade discounts, it begins with a definition of trade and with the guarantee of efficient training and with the cohesion and elevation of the electrical business. This is because discount reform and trade protection generally are not in the least likely to mature until these preliminaries are first accomplished. The Electrical Contractor's Association and its magazines perform useful functions, and there are not lacking within them men who now and again call out for reform; but as a whole they do nothing effective and far-reaching to accomplish it. They are too anxious for mere numbers, or too afraid of the temporary competition of insiders who ought to be outsiders. In present circumstances they have some reason to fear, but every year shows an extension of the fields which must remain outside yet overshadow the legitimate trade of the electrician. It is not yet too late to provide a remedy, but the first thing is to enlist and organise a trained army within the mob.

An effect and cumulative cause of the unsatisfactory state of the trade is the fact that any warehouse, ironmongery business or huckster's shop is offered electrical goods at a discount equal, or practically equal, to that given to the electrical trade itself. Not only so, but any private consumer who keeps, for odd jobs, a man who calls himself a wireman or an electrician gets the like discount from manufacturers or wholesale dealers. In agreeing to the clause permitting this, the electrical trade was outwitted by the manufacturers. But more probably, in those days of German competition and methods, and in the absence of any really efficient organisation of the retail industry, no other course was then possible. We hope the German modes of business are at an end, and that competent organisation is immediately possible. If these things be so, the trade can demand and even yet secure that no trade discount and no goods shall be granted by the manufacturer or by his agent to any buyer *who does not buy for re-sale* (as is the custom in all other decent trades); also that shops other than registered electricians may buy, if they can buy at all, with distinctly lower discounts than those granted to electricians.

If this reform were agreed upon, the wholesale trade would no longer have reason to fear monetary delays and risks in dealing with electricians. The wholesale people first undermined the retail electrical trade and then complained of its instability. Reverse the process, and healthy natural growth will quickly cover the traces of the weeding out operation, and the goods of the Manufacturers' Association will get skilled treatment and fair play with the public, all of which will be of enormous benefit to the electrical trade generally.

As an example of one phase of what might be called German methods of trading, take the following:—Travellers from three agencies, A, B and C visit a small town in one week. There is in that town one good-class D, and two small electrician businesses, E and F. Messrs. D reject the class of goods offered by B and C but buy from A. Then E buys from B and F from C. But B and C tell D that this is the second time they have shown their goods in vain to him, and if they are not going to be supported by him they consider themselves free to offer their goods direct to consumers and others known to be D's chief customers. So in like manner do A and C to E and A and B to F. The goods ordered duly arrive; but the electricians then discover that their customers are haughty, and say "Oh! we have bought from a wholesale firm all we need in your line." So the electrician's goods lie in stock the while Messrs. A, B and C each begin to write indignant letters about their several accounts. This is but one example of many which might be given illustrating the present, or shall we say the recent, position of the electrical retail trade.

In many towns some manufacturers or wholesale dealers keep an open door and attractive windows, and call on every biggish consumer. Through their legitimate business with contractors, they get to know the names and requirements of these. So the electrician is gradually robbed of his chief clients and has to jostle the crowd of his remaining customers at the retail counter of the wholesale house when he goes to select his goods. But for the support given by electricians the wholesale man could not keep so attractive a variety of goods nor afford to sell so cheaply retail. Is it to be the same after the war?

Added to these difficulties is the desire of some town authorities to enter the trade on their own account. Much can be said by the advocates of a thorough-going socialism, but every disadvantage and every injustice is multiplied a hundred-fold by a piece-meal socialism. If a town is determined to enter upon the electrician's trade, let it treat the retail trade as it is forced to treat a rival supply company and adequately compensate those whom it seeks to displace as well as suffer the inevitable reduction in amount of rates and taxes. Some would refuse compensation to the liquor trade on the grounds that it had had plenty of warning and that it worked under yearly licences, while, in the opinion of the majority, the sale of intoxicants is not for the good of the community. Such defences are not available to towns which covet the electrical trade of some of their own citizens. Then to whose care is the city wiring work to be entrusted—to the City Electrical Engineers, than whom, if one may judge by indoor service-cable work, there is no body of men less capable of making it a success.

Definite suggestions towards an approved policy of trade defence may with advantage be deferred to afford opportunity of criticism of the points made in this article. But the trade must save itself, and its agencies are by no means inactive, and may apply to themselves the well-known lines,—

> "'Tis well! from this day forward we shall know
> That in ourselves our safety must be sought
> That by our own right hands it must be wrought."

THE I.M.E.A. AND THE ELECTRICAL INDUSTRY.

A circular letter from the hon. secretary of the Incorporated Municipal Electrical Association (Mr. H. Faraday Proctor) was recently issued to the members of the Association. After stating that the Council feel they should give as much information as possible to the members in regard to the future of the electrical industry, the circular proceeds:—

"It is a matter for great regret that full information cannot be imparted at the present time, owing to the withholding by the Government of the report of the Board of Trade Electrical Trades Committee (Sir Charles Parsons' Committee) and the interim report of the Coal Conservation Sub-Committee of the Reconstruction Committee. The Council are strongly of opinion that pressure should be brought to bear with the object of obtaining the immediate publication of these reports. This would release evidence which has now to be preserved in confidence, and enable more open discussion by those most concerned and best informed. The I.M.E.A. Council, on November 1, 1916, agreed several resolutions regarding the appointment of a Central Board of Control or Commission to take over the whole of the duties at present exercised by the Board of Trade, Local Government Board, Home Office and other Departments as far as they relate to the administration of the Electric Lighting Acts, such Central Board to have full powers, but not to be authorised to own or operate electricity works. The new Central Board will be a progressive body with the interests of the industry at heart, and should, therefore, have complete control—subject to Parliament alone—overall such matters as the granting of powers, approval of rates of charge, formation of rules now drawn up by the Board of Trade, &c. It was specified that the members of the Board should be whole time officers, who should sell out all securities owned by them in any electrical undertakings, so that the confidence of the country may be furthered by the assurance that those in control are entirely disinterested.

Digitized by Google

"The Council have come to the conclusion that, to secure the most economical production of electricity, generation in the nature must in the future be by large power stations, though not necessarily in every instance by new super-stations; that the large power stations can best be controlled and operated by District Boards consisting of representatives appointed by the present statutory undertakings (both local authority and company), and that the distribution shall remain with present undertakers, subject to suitable safeguards to protect consumers. The Council are fully aware that the idea of transferring to a District Board some of the powers now exercised in regard to the generating side of the business may not commend itself to some existing undertakings, but they are convinced that in order to secure a large and economical supply of electrical energy it will be necessary to adopt centralised generation with large units of plant, and the interests of all parties concerned are best met (so far as generation and transmission are concerned) by advocating joint control and operation by District Boards. In the event of the status or remuneration of an official of any undertaking being adversely affected through the formation of a District Board, such an official shall be entitled to compensation. A report of the Lancashire and Cheshire Linking-up Committee will be published within a few days, the details of which will prove of considerable interest in the fuller consideration of schemes for supply throughout the country.

"A resolution was transmitted to the President of the Board of Trade in accordance with the instructions of the annual general meeting. It is a matter of great regret that, although three additional members have been added to the Committee, these additions have been made without reference either to the I.M.E.A., which represents the municipal electrical interests, or to the individual municipalities concerned. The Council feel that further attempts to get the representation on the Committee adjusted at the present time would be futile, and do not therefore propose to take further action at present. As regards the giving of further evidence, Mr. Faraday Proctor having been deputed to give evidence for the Association, it is desired that any members having points of importance to be brought forward which have not been otherwise dealt with, should send particulars of the same to him immediately, with a copy or draft of information prepared for witnesses. It will be realised that many points have already been dealt with by your witnesses before Sir Charles Parsons' Committee, and by the witnesses of the Association of Municipal Corporations. At the annual general meeting of the I.M.E.A. on June 22nd several members stated that plant extensions by municipalities were being refused by the authorities while power companies appeared to be favoured in that matter. The Council will be glad if members will advise them of specific examples which have come within their personal knowledge of undue obstruction experienced by local authorities, and of undue assistance given to power companies in connection with extension of plant or mains, so that the information may be tabulated with a view of taking further action on the matter."

INDUSTRIAL FATIGUE.

In the recent report by Dr. H. M. Vernon to the Health of Munition Workers Committee much interesting information is given as to the injurious effects of excessive hours of labour, Sunday work, &c. It is proved that with a considerable reduction in the hours of labour and the enforcement of Sunday rest, the output may be actually increased.

Dr. Vernon holds that this increase is not due—as many works managers maintain—to the determination of the worker to earn as much as was the case under the longer-hour system, for in such a case the worker's output would be increased immediately the reduction of hours occurred, instead of the increase occurring gradually. Even if money-making were the true mainspring of action, it is obviously better both for the health of the worker and for the conservation of the machinery, that an eight-hour day should be worked instead of a twelve-hour day, provided that the total output is maintained.

From observations extending over a period of 13½ months upon the output of workers employed in making fuses showed that a reduction of working hours was associated with an increase of production both relative and absolute. The rate of production changed gradually and did not reach an equilibrium value before the expiration of four months. Thereafter it remained steady for 3½ to 5 months. The gradual change negatives the suggestion that the effect was a mere consequence of the desire to earn the same weekly wage as before.

Owing to the reduction of the working time, first by a change from a 12-hour day to a 10-hour day, and subsequently by the abolition of Sunday labour, it was possible to compare output under three conditions. A group of women (numbering from 80 to 100) engaged in the moderately heavy labour of turning aluminium fuse bodies, provided the following comparative results:—

(i.) When actually working 66·2 hours a week, and nominally 74·8 hours, their relative hourly production was 100, and their relative gross production 100; (ii.) when actually working 54·8 hours, and nominally working from 58·5 to 66 hours, their hourly production was 134, and their gross production 111; (iii.) when actually working 45·6 hours, and nominally working from 49·5 to 58·5 hours, their hourly production was 158, and their gross production 109.

It is, therefore, to be inferred that had these women been working uniformly a nominal 50-hour week their gross output would have been as large as when they were working a nominal 66-hour week, and considerably greater than when they were working a 77-hour week.

A group of 40 women engaged in the light labour of milling a screw thread on the fuse bodies improved their gross output by 2 per cent. when actually working 54·8 hours a week, the standard being their gross output when working 64·9 hours per week. A further reduction of actual working hours to 48·1 resulted in such an improvement of hourly output that the gross output was only 1 per cent. less than when the actual working time was 16·8 hours more.

A group of 56 men engaged in the heavy labour of sizing the fuse bodies improved their hourly output by 37 per cent. and their gross output by 21 per cent., when actually working 51·2 hours, the standards being the hourly and gross outputs observed when the actual weekly hours were 58·2.

Fifteen youths engaged in the light labour of boring top caps by means of automatic machines produced only 3 per cent. less when their actual weekly hours of work were 54·5 hours than when they were 72·5 hours.

In none of the operations studied was there any change either in the nature of the operation or of the type of machinery during the period under notice. The data was also so chosen as to eliminate any possible disturbances due to increasing skill.

A part of the improvement in output was due to the workers starting work more promptly when on shorter hours. At one period women engaged in turning fuse bodies lost on the average 37 minutes daily by starting work after and stopping before the nominal time. Nine months later, when their hourly output was 25 per cent. better, they lost only 26·5 minutes daily in these ways.

A rest from work on Sunday is followed by a relatively low output on Monday, and this output steadily rises in the course of the week, owing to the increased efficiency produced by practice. Generally the cumulative effects of fatigue neutralise and overpower this increased efficiency, and the output may fall after the second day (or night) of the working week if the hours are long and the work laborious, or not till after the third, fourth or even fifth day if the hours are shorter.

GOVERNMENT CONTROL OF TRADE.

The London Chamber of Commerce have approved a report of the Merchants' Committee of the Chamber on the action of the Government in controlling the sale and distribution of leading commodities of common necessity

In the report it is pointed out that since the commence ment of the war the Government has had powers to regulate the supply and use of any commodities necessary for the defence of the Realm, the effective prosecution of the war, &c. It is to be regretted that the Government has not uniformly availed itself of the services of the mercantile community, with its exceptional knowledge of sources of supply and its organisation, which has given the United Kingdom its unique position as an emporium for the production of the entire world. On grounds of public policy no objection is raised to the objects in view, but the methods adopted have, in the judgment of the committee, failed to produce the maximum of advantages to the State, with the minimum of interference with legitimate trade usages and organisation. The results of these methods have in many respects been subversive of the objects in view. The policy at present pursued appears to be based upon an imperfect appreciation of the principles upon which the import business of the country has been conducted, and of the means by which the natural resources of the country itself have been rendered serviceable for the needs of industry. It is only in comparatively recent times—outside the Ministry of Munitions—that the direct employment of trained business men has been availed of to any extent by the Government. The action of Controllers has in many cases conduced to high prices and ultimate scarcity.

Apart from mineral and other products exclusively drawn from home sources, the country has largely depended upon the energies of merchants to bring into the market and maintain stocks of certain essential commodities from oversea countries. These are attracted mainly through the manifest advantages of British markets in competition with the markets of the world, and consequently can only be effectively controlled by the Government on their arrival here. Any restriction upon the usual importations must therefore interfere with the flow of commodities to this country on a competitive basis. In other words, if the merchant is driven out of business the various agencies at home and abroad for the collection of commodities in anticipation of consumers' requirements, are reduced to a negligible quantity, and the State becomes virtually the sole importer, or buyer, without the means of influencing continuous supplies from abroad when stocks are exhausted from time to time. The serious shrinkage of their operations and stocks already experienced by merchants and brokers through State intervention and uncertainty under present conditions, has re-acted in a manner prejudicial to the best interests of the country in respect to supplies. There seems to be no adequate ground for dispensing with the services of the merchant, whose relations with suppliers, and expert knowledge of the goods involved,

Digitized by Google

should entitle him to be treated on reasonable terms by the State in a business with which he alone has had actual experience in the past. The conduct of this business also involves the question of finance, which influences the foreign producer in his choice of the British market. The merchant, moreover, is prepared to undertake great risks, whether in peace or war, and only asks that he shall have the opportunity of bringing into the country its essential requirements on terms which will leave a fair remuneration for these risks. The reasonable profits of bona fide distributors should be allowed, and these may justly include remuneration to the merchants or brokers whose business has been to handle the stocks they obtain from various sources before they reach the manufacturers or retail distributors. Subject to these considerations, the war requirements are best served by the State utilising the services of merchants to the fullest extent, and encouraging them in every way to maintain and increase supplies of all necessary commodities.

No Government can control all the world's trade when free markets in other countries attract the supplies at higher prices. Nothing raises prices more quickly than the knowledge that Government is buying. It is impossible that Controllers can possess anything like the knowledge of the ramifications of the world's trade, and of the extreme delicacy of the fabric of finance upon which it is conducted, which is at the disposal of the merchants of the City of London. Evidence is constantly forthcoming that many Government departments fail to appreciate the relative functions of the merchant and the manufacturer by assuming that the latter is quite independent of the former. The fact is that manufacturers are dependent upon merchants for continuity of orders for manufacture, and, in turn, for their raw material. Government tenders are frequently asked for "from manufacturers only," regardless of the fact that merchants hold large stocks and can frequently supply at lower prices. The aim of the Government should be to encourage merchants to attract supplies from all parts of the world. The effects of Government action in many cases has tended to stifle and partially ruin trade. It has certainly been a serious deterrent, at a time when, owing to the almost total extinction of German overseas trade, British merchants were "capturing" that trade and establishing themselves in the countries of production in a manner which would ultimately be immensely for the benefit of the Empire, and, after the war, would enormously strengthen its position as against enemy countries. The committee is of opinion that the same consideration should be shown to all trades when taken under Government control as was shown to the wheat and flour trades in seeking the co-operation of merchants in the supervision of the trade so controlled. The committee also desire to call attention to the glaring discrepancies between the treatment accorded by the Government to the different trades. The committee considers that the same consideration which is shown to one trade should as a matter of equity be shown to all. In cases where the Government confine their action strictly to control and exercise this control largely through representatives of the trade in question, without interfering with the existing trade organisation for handling and distributing the commodities, the committee are advised that infinitely more beneficial results have been obtained and much less harm has been done than in other cases where the Government have ignored trade organisations, and taken not only the control but the actual distribution into their own hands. This latter tendency, which is now most clearly marked, the committee regard as a grave and serious menace. They are forced to the conclusion that the Government look on the merchant community as practically useless to the Empire and generally unworthy of consideration, a view which even the most elementary study of history shows to be false. It is not too much to say that but for the merchant community the commercial supremacy of the British Empire would not exist. The main cause of the rise in prices has been the shortage of the world's supply combined with a shortage of shipping tonnage, and the only means of overcoming this is to stimulate production the whole world over by all possible means and to see that the tonnage available is used to the best purpose. This can best be done by encouraging ordinary trading in every way with a minimum of Governmental interference. If commerce is rendered impossible or unprofitable it will cease, with disastrous results both now and after the war. The committee, therefore, submit that the Government should confine their action strictly to supervision; they should centralise the controlling authority and disband and do away with the numerous un-co-ordinated departments which are now seriously restricting legitimate trade.

RECOMMENDATIONS.

The committee, having regard to the foregoing considerations, recommend:—

(*a*) That Government should cease to act as trading intermediary between producers and consumers, but should utilise to the fullest extent the services of the business community.

(*b*) That to this end merchants should be encouraged to continue to carry or import stocks of commodities essential to this country.

(*c*) That, so far as any control of imports and exports is concerned the quantities allowed should as far as possible be based upon a fair allocation of quantities amongst merchants dealing in particular articles, after consultation with representative trade organisations. Permits should only be granted to British and Allied subjects who are legitimate merchants and importers in the trade involved.

(*d*) That the various control departments should be co-ordinated so far as to secure a uniform system on questions of principle and to obviate present delays in dealings with licences and permits.

(*e*) The Control Departments should in all cases be assisted by representative business men nominated by their respective trades.

(*f*) That steps be taken to represent to the Government, to Members of Parliament, and the public generally, the views set out in the report of this committee.

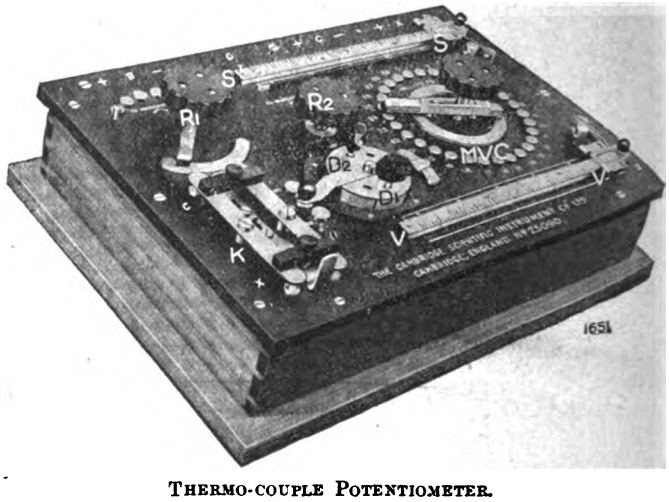
A THERMO-COUPLE POTENTIOMETER AND OTHER INSTRUMENTS.

Three recent lists issued by the Cambridge Scientific Instrument Co. deal respectively with recording and index thermometers (No. 912), the Cambridge measuring microscope (No. 134) and the Cambridge Thermo-couple potentiometer (No. 191).

The Cambridge measuring microscope is intended for workshop use, and enables lengths from 40 mm. down to 0·01 mm. (or by estimation to 0·001 mm.) to be conveniently measured.

As illustration of its utility for special purposes, the determination of the diameter of indentations made in Brinell hardness tests, the pitch of small screw threads, and the accurate measurement of test pieces after being subjected to mechanical strain may be mentioned.

In the H. & M. recording and index thermometers the steel bulb of the instrument is connected by steel capillary tubing to a special form of steel Bourdon spiral. The whole system is filled with mercury, and changes in temperature of the bulb give rise to corresponding changes of pressure in the system, and thus to small movements in the spiral, which are magnified and recorded or indicated by the usual pen or pointer mechanism.



THERMO-COUPLE POTENTIOMETER.

The Cambridge Thermo-couple Potentiometer is designed for the accurate measurement of small P.D.s not exceeding 20 millivolts; it is specially applicable for use in temperature measurement by means of thermo-couples. The complete potentiometer outfit comprises (1) the potentiometer, (2) single Weston normal cell, (3) Ayrton-Mather galvanometer, (4) galv. lamp and scale. The galvanometer preferred is of the moving-coil type, with a resistance of about 20 ohms.

Referring to the illustration, the wire *SS* is so graduated that the reading shown at any point on its length is equal to the P.D. between that point and a point *M*, provided the fall of potential in the main circuit is exactly 1 volt per 100 ohms circuit resistance.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Officer Commanding, Lieut. Colonel C. B. CLAY, V.D.

Orders for the Week.

Officer for the Week.—Platoon Commander P. Bowden.

Next for Duty.—Platoon Commander W. J. A. Watkins.

Monday, Aug. 13.—Technical Instruction (searchlight) for No. 3 Company, Right Half Company, at Regency street. Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' Drill, 6.30.

Tuesday, Aug. 14.—Lecture, 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, Aug. 15.—Drill and Elementary Bridge Construction, No. 1 Company, Right Half Company.

Thursday, Aug. 16.—Drill and Elementary Bridge Construction, No. 2 Company, Right Half Company. Ambulance Class.

Friday, Aug. 17.—Technical Instruction (searchlight), for No. 3 Company, Left Half Company, at Regency street. Drill, No. 3 Company, Right Half Company. Signalling Class. Recruits' Drill, 6.30.

Musketry.—All N.C.O.s and men who have signed the "A" and "B" agreements are required to attend during this month to re-classify, in order to enable the corps to obtain the capitation grant. Preference will be given to these men in firing.

Armlets.—The new issue armlets can now be obtained at headquarters, and every enrolled man must obtain one without delay, and all old (red) armlets must be returned to the orderly room.

Note.—Unless otherwise indicated, all drills will take place at headquarters (Balderton street, Oxford street).

Digitized by Google

MAKE SURE IT'S AN OSRAM

For the Munition Factory there are OSRAM G.E.C. Drawn Wire Lamps and OSRAM Atmos Half-watt Type Lamps.

See that every lamp you buy bears the words "OSRAM, G.E.C., made in England."

Osram
G·E·C
DRAWN WIRE
Lamps

Advertisement of the General Electric Co., Ltd. Head Office: Queen Victoria Street, London, E.C. 4.

Digitized by Google

DUCTER MEGGER DUCTER MEGGER DUCTER MEGGER DUCTER

BUY NO OTHER

before you have examined the unique features of the

Murday Recorder

You will certainly buy no other after you have done so.

List 113 will tell you all about it; post free on application.

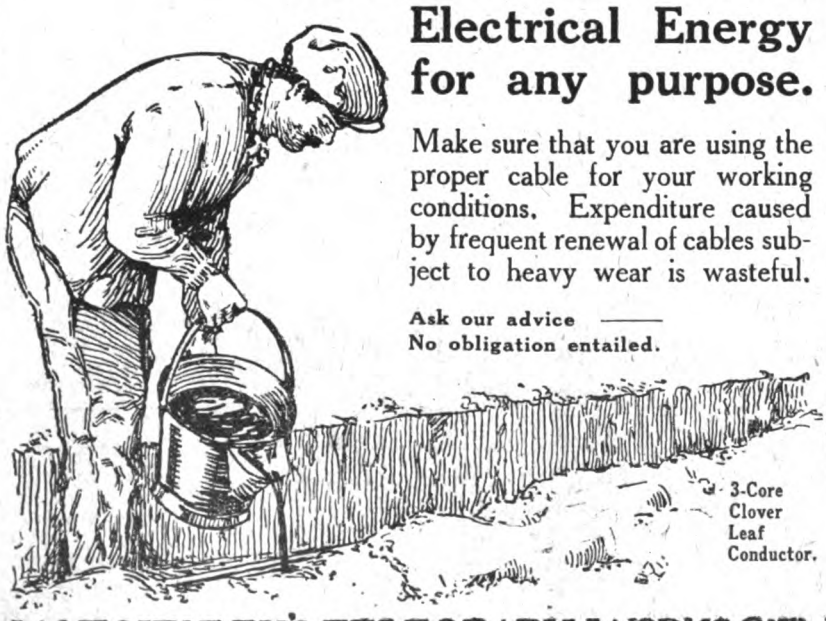
Sole Makers: EVERSHED & VIGNOLES, Ltd.,

Telephone: 1370 Chiswick (2 lines).
Telegrams: "Dorothea, Chisk, London." **Acton Lane Works, Chiswick, LONDON, W.**

DUCTER MEGGER DUCTER MEGGER DUCTER MEGGER DUCTER

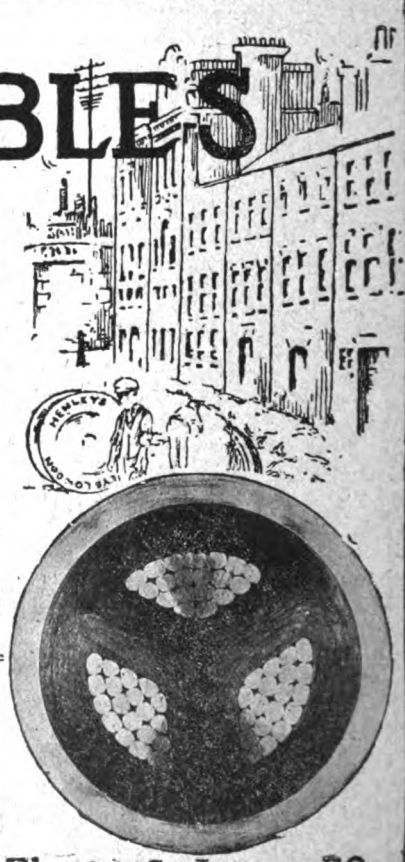
HENLEY'S CABLES

for the transmission of Electrical Energy for any purpose.



Make sure that you are using the proper cable for your working conditions. Expenditure caused by frequent renewal of cables subject to heavy wear is wasteful.

Ask our advice —— No obligation entailed.



3-Core Clover Leaf Conductor.

W. T. HENLEY'S TELEGRAPH WORKS Co. Ltd. Blomfield St., London E.C.

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

Commercial Libraries.

At Liverpool, on the 1st inst., Lord Parmoor opened the commercial library which has been provided by the Local Libraries Committee. In the course of his address, Lord Parmoor dwelt upon the supreme importance of looking forward to the necessary reconstruction of our commercial life in the future.

Lord Parmoor said it was no use to go on piling up statistics and holding inquiries unless the knowledge acquired was made accessible. He had always thought that there was a great loss through the particulars collected in our official documents not being sufficiently disseminated. It was important that a commercial library should be properly staffed, so that by careful indexing of the information collected it might be available for any particular purpose in a short time. It was desirable that the work of the commercial department of the Board of Trade should be decentralised, and that a city like Liverpool should have a commercial department as well as Whitehall. A commercial library such as that now established came between research on the one side and practical business on the other. He was a great believer in research and study, and also of collective action; but if it were to supersede individual energy and enterprise the advantage might be purchased at too high a rate. However much we might depend on research and knowledge, there was something in the individual on which we had in the past relied in our commercial enterprise, and which he hoped would not be less potent in the future. That library was not a school of commerce, but a place where people skilled in commerce could get the information they wanted; it was something like a post-graduate course. Dealing with the question of apprenticeship, Lord Parmoor said he though we ought to revert to a considerable extent to the old apprenticeship system.

* * * *

A Commercial Library at Norwich.

The City Librarian of Norwich (Mr. Geo. A. Stephen) recently reported to his Committee on the development of the Commercial and Technical sections of the library.

Mr. Stephen points out that British public libraries, if properly equipped, can render invaluable assistance in furthering British industry and trade, by providing commercial information for business men and text-books for their employees; and he states that committees of public libraries in several of the largest British cities and towns are initiating commercial libraries. The committee has adopted the City Librarian's recommendations for the development of the commercial and technical sections, so that they will ultimately contain:—A good collection of directories, comprising directories of the English counties, the British Colonies and Dominions, the United States and foreign countries, and the most important trade directories, gazetteers, atlases, statistical works, &c.; telephone directories issued by the Post Office, and the principal telegraphic codes; reports of the various Chambers of Commerce and trade associations; blue-books and other Government publications relating to trade, agriculture, labour, finance and other matters; Consular Reports, Colonial Reports and the Commerce Reports issued by the United States Department of Commerce; year-books and other official books issued by the British Dominions and Colonies; best books on the principal local industries (*e.g.*, boots and shoes, engineering, aircraft, wire-netting, silk, &c.); the full specifications of patents relating to the subjects of our local industries; best books relating to economics, commerce and trade, banking, exchange, commercial law, insurance, advertising, &c.; text-books for commercial students dealing with accountancy, book-keeping, arithmetic, shorthand, typewriting, office management, &c.; the printed information issued by the Commercial Intelligence department of the Board of Trade; technical periodicals, &c.

* * * *

Import Restriction Modification.

The Import Restrictions Department of the Board of Trade has under consideration, in consultation with the London Chamber of Commerce, the granting of a concession allowing the restricted importation of the following goods:—

Electric dry cells, arc lamp carbons, searchlight carbons and battery carbons. Firms who were importing these goods last year should communicate with the London Chamber of Commerce, Oxford-court, Cannon-street, E.C.4, asking for particulars as to the steps which should be taken to obtain licences.

* * * *

U.S.A. Copper.

The U.S.A. smelters turned out 1,928,000,000 lb. of copper in 1916, or 540,000,000 lb. more than in 1915. The refineries turned out 2,259,000,000 lb., an increase of 625,000,000 lb. Stocks at beginning of 1916 totalled 82,429,666 lb., bringing the total available supply last year up to 2,341,000,000 lb. Of this 784,005,486 lb. were exported, against 681,917,955 lb. in 1915, while 1,429,755,266 lb. were apparently consumed in the country.

American Export Trade.

The manufacturers and exporters of the United States of America are perfecting their organisations in order to expand their export trade, especially in South America, Europe and the Far East, and thus develop permanent trading relations which will afford continuity of output and render manufacturers independent of business depressions at home. At a conference at Springfield (Mass.), which lasted from June 23 to 30, various problems of the export trade were considered and discussed.

The consensus of opinion was that the best men should be drawn upon to build up the foreign field. Emphasis was laid upon the vital necessity of completely fulfilling specifications and promises to foreign purchasers, including shipments on dates agreed upon, and packing as required. Much time was also given to credit facilities available through enterprising American banks.

The "Electrical World" states some of the points brought out in the conference. The United States needs export trade because it is the greatest producing nation and must have foreign outlets for surplus products or suffer the evils of glutted markets at home to the detriment of capital and labour alike. From 1913 to 1916 the total exports of the country increased from $2,484,018,292 to $5,481,423,589. Total value of firearms, explosives, &c., exported in 1916 was $757,700,475. Manufacturing is not likely to develop rapidly in South America at present because of short coal supply, but hydro-electric power will come into play in the future. Exports to South America increased from $186,678,122 in 1913 to $266,895,330 in 1916. It is expected that alliances during the war will be effective for a considerable period in trade relations after the conflict. A powerful United States merchant marine is likely to be a feature in future years. For a long time this country will probably be a chief source of funds for development enterprises in the world. The Government should foster co-operative efforts by competitive manufacturers seeking foreign outlets. Long-time credits should be freely accorded to foreign buyers. Foreign trade agencies are the eyes of export business. The trade balance of the United States in 1916 was $2,080,000,000, compared with $435,000,000 in 1914. Relief from restrictive legislation is needed. Co-operation and standardisation are also needed in American manufacturing plants to meet foreign competition, including uniform system cost accounting where possible. Much would be gained by drafting successful business men for governmental positions. Personal travel is most important in developing trade. Foreign buyers are usually more accurate and particular than those in domestic trade. Manufacturers should not seek foreign trade which cannot be consistently carried on at all times. An attractive field for the loose leaf catalogue exists, the catalogue being printed in the language of the country concerned, and complete in ordering and shipping instructions, with typical examples. The field in South America applies particularly to capital of $100,000 and over, that for small capital being less favourable at present. Closer intercourse is most important with South America, including study of people and countries.

* * * *

Belgian and British Trade Relations.

The Government have appointed a Committee to investigate the means of promoting and advancing trade and commerce between the British Empire and Belgium. The members of the Committee are as under:—

Representing Foreign Office.—Sir Cecil Hertslet (*Chairman of Committee*), Mr. R. Macleay, Mr. M. Neville Kearney (*Secretary of Committee*).

Representing Board of Trade.—Sir W. H. Clark, K.C.S.I., C.M.G., Sir E. Wyldbore Smith, Mr. Percy Ashley.

Representing British Commercial and Financial Interests.—Sir Algernon F. Firth, Bart., Sir R. Vassar Smith, Bart., Lord Faringdon, and Messrs. E. F. Oldham, M. Cléminson and Frank Potter.

The members of the Committee (other than those representing the Foreign Office and Board of Trade) have been nominated by the bodies which they represent, at the invitation of the Government. The following are the terms of reference for the Committee:—

This Committee is established for the purpose of inquiring into all matters relative to trade between the British Empire and Belgium, with a view to increase and develop that trade by every desirable means.

It will be the duty of the Committee to investigate as far as possible all means to be adopted in order to attain the object set out in Para. 1. The Committee will examine into the supplies and requirements of the respective countries (in so far as they have relation to its scope) and give advice as to how trade between them can be best established, developed and increased. It will obtain information and evidence from all available sources and endeavour to render all possible assistance in regard to shipping, manufactures, imports and exports, and trade generally between the Empire and Kingdom.

It is particularly laid down that the purpose of this Committee shall be a general one, and that it shall not be part of its duties to foster the advancement of the trade of any particular individual or firm, nor to devote its assistance to any special branch of trade or industry, except in relation to the general principles for which it is established.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Chester.—The Corporation is recommended to extend the electric supply cables to the works of Messrs. Brook, Hirst & Co., at an estimated cost of £4,200.

Colchester.—The Council has adopted a report of the Electricity Committee recommending the erection of a new generating station on the banks of the river, the existing works to be converted into a distributing station.

Derby.—The British Cellulose & Chemical Mfg. Co. has acquired 5 more acres of land for extensions of their works. These additions will mean a considerable increase in the demand for electric power upon the Corporation electric supply department, which will entail putting in additional plant at the electricity works. The cost of laying down the necessary plant and making provision for the extra demand is estimated at £90,000, sanction to the borrowing of which amount is to be sought from the L.G. Board.

Dover.—The Council has resolved to extend the electric supply mains to a local hospital.

Knaresborough.—The Rural Council has been asked by the Harrogate Electric Lighting Committee to allow the extension of electricity mains to certain premises outside the borough boundary.

Leeds.—Application has been made to the Local Government Board for sanction to borrow £25,000 for extensions of mains and £25,000 for the erection and equipment of sub-stations.

Leek.—The Council has authorised extensions of the electric supply mains at an estimated cost of £650.

Luton.—The Corporation recently obtained sanction to borrow £4,000 for laying additional cables to give supplies of electric current to factories.

Stafford.—The Council has received sanction to a loan of £6,500 for an additional boiler and other plant at the electricity works. It is proposed to expend £4,000 in providing and laying high-tension mains.

GENERAL.

Birmingham.—At the meeting of the Corporation last week the Electric Supply Committee were authorised to revise and increase the scale of charges for the supply of electrical energy by approximately 15 per cent.

The chairman of the Committee (Ald. Jephcott) said the reason for the revision was due to the increases in wages, coal, &c. On this occasion they had decided to drop the percentages and go in for a money basis.

He said they were unable to go on with the permanent station, because the Government were not prepared to give them the necessary sanction. In order to safeguard the supply of current, the committee were doing their level best to prevent any stoppage by having the machinery in the best possible order and not taking on more consumers than they could manage. The difficulties thay had had with the tramways would not normally be expected to happen in the coming winter.

Bolton.—Mr. Robt. Baker, superintendent of the electric fittings dept., has resigned owing to ill-health, but the electricity Committee has retained him in a consultative capacity in connection with the fittings department at £62. 10s. per annum.

Bradford.—Last week the City Council considered the recommendation of the Electricity Committee to increase the scale of charges for electricity.

The chairman of the committee (Ald. Robinson) said that he disagreed with the minutes because the charge to the flat rate consumers had not been raised. The committee had found the extra cost to be so serious as to make it necessary to increase the charges. For the year ended March 31, 1917, the increased wages and salaries amounted to £6,582, allowances to soldiers' dependents amounted to £2,288, and the increase in the cost of coal was £15,298. Interest on loans was £3,272 more and income tax £9,832, or a total increase of about £37,000. If it had not been for the extra demand for power no doubt there would have been a loss on the department. The amount of electricity consumed by customers on the flat rate was of the value of £24,178, and if the price were increased in accordance with the proposal of the engineer the extra income in respect of the flat-rate supply would only be £2,417. The flat rate ought to have been raised years ago. Owing to the improvement that had taken place in lamps since the establishment of the undertaking as good a light as was first obtained could now be got at one-third of the consumption of electricity. He instanced other classes of consumers who should pay more, and ultimately the recommendation was withdrawn.

Chippenham.—The Council's offices are to be wired for the electric light.

Electrical Installations Inspection.—Last week the London County Council was informed by the Theatres and Music Halls Committee that recent inspections of the electrical and mechanical installations at places of public entertainment had disclosed a marked falling off in the standard of maintenance and repair, with a consequent increased risk of fire.

This is said to be due in part to the difficulty in getting repair work undertaken and in part to the employment of unskilled men to take the place of experienced men on war service or war work. Owing to the depletion of the staff of the fire brigade, a reduction in the frequency of inspections was approved in October, 1915. The Committee is now of opinion, in view of the facts stated above, that in the interests of public safety more frequent inspection of electrical installations on the part of the Council is necessary than is practicable with the existing staff. The Establishment Committee would deal with the question of the additional staff required, but the suspension of a resolution of Nov. 9, 1915, was recommended in order to enable more frequent inspection to be undertaken.

The recommendation was agreed to.

Electrical Apparatus Imports into Jamaica.—According to a recent report of the U.S.A. Consul (Mr. Ross Hazeltine), American manufacturers furnish most of the electrical supplies and equipment used in Jamaica. The "Electrical World" says there is no local manufacture of these products.

The imports are grouped separately under two headings, viz.: (1) Apparatus necessary for generating, storing, conducting, converting into power or light and measuring electricity, and (2) telegraph and telephonic wire and apparatus. The imports of both groups fall under the list of articles admitted duty free. During 1914 the imports of the first group amounted to $51,252 and in 1915 to $34,021, and the second group to $6,966 and $6,588 respectively. That the United States supplies such a large percentage of the electrical equipment imported into Jamaica may be attributed to the fact that in many instances the original installations consisted of American equipment. In general, the equipment is much the same as that in use in the United States, although somewhat antiquated.

Electric Power Supply Committee.—In May last the General Purposes Committee of the London County Council authorised the comptroller to give evidence upon the question of electricity supply in London before the Board of Trade Electric Power Supply Committee, on the understanding that the Council was not in any way committed as to its policy with regard to matters discussed at the Committee. At the meeting of the County Council last week the Special Committee on London Electricity Supply reported that they had considered the proof of the evidence proposed to be given, and had informed the General Purposes Committee that, subject to certain amplifications, they concurred therein.

The evidence deals with the matter merely from the historical point of view. The Special Committee are advised that it would be of great assistance to the Departmental Committee if the report dated July 14, 1914, of the "Technical Commission," consisting of the comptroller of the Council, the chief engineer and Mr. C. H. Merz, on the question of London electricity supply, were made available for their use. The document was, however, private and confidential, but in order that the document, while remaining private and confidential, might be submitted in evidence to the Departmental Committee, it was recommended that standing order No. 177 be suspended in order that the report on the subject of London electricity supply be submitted in evidence as a confidential document to the Electric Power Supply Committee.

This course was agreed to.

The London County Council has called a fresh conference of representatives of London electricity supply undertakers on the subject of electricity supply in London. In a recent communication by the London County Council to Stepney Borough Council it is stated that the Board of Trade Electric Power Supply Committee may finish taking evidence before the end of September, and the conference should be held as early as possible. Stepney Electric Supply Committee has appointed the chairman (Coun. Legg) and ex-Coun. Gordon to represent Stepney at the new conference.

Greencek.—At a special meeting of the Corporation on Monday it was reported that there was a net surplus of £10,831. 11s. 2d. on the past year's working of the electricity undertaking.

Increased Charges for Electrical Energy.—The charges for current are being increased at the following places:—

Sunderland Corporation is increasing its charges by 10 per cent. for lighting and small power consumers. A similar increase will be made for h.t. supplies under new or renewed contracts.

Tunbridge Wells Council is increasing its charges for current for lighting by 10 per cent., power and heating 25 per cent. and power for lifts 10 per cent.

Southwark (London) Council has decided to increase the charge to consumers for whom plant had been kept in reserve during the winter months by 1d. per unit, and to make increases of 2d. per unit during restricted hours and ½d. during unrestricted hours.

Edinburgh Corporation has increased its charges to 3¼d. per unit for lighting, and 1½d. for motor power, plus 10 per cent.

Linking-up in Staffordshire.—A conference of representatives of the Stoke-on-Trent, Leek and Newcastle electric supply departments

Digitized by Google

will be held in order to discuss the possibility of linking up the three undertakings.

Newport (Mon.).—Mr. A. Nichols Moore recently reported to the Electricity Committee in regard to the linking-up proposals for South Wales, his report being generally in line with that already submitted to the Cardiff Electricity Committee by Mr. Arthur Ellis and abstracted in our last issue.

Mr. Nichols Moore also asked for authority to go into the details of the scheme, and prepare estimates of costs to be submitted to the Committee at a later date in order that they may be able to form a considered opinion on the matter.

The Electricity Committee has now authorised him to do so, and take any further steps that are necessary to further the proposals on the distinct understanding that such steps as are taken shall in no way commit them to any scheme. Mr. John Moxon, chairman of the Electricity Committee, took the opportunity of placing before the committee his views upon the general question of interworking, and emphasised the importance of the Corporation taking an active part in any deliberations that might be on foot.

Provisional Order Extensions.—The Board of Trade has extended for one year from July 31 the periods of two years and 18 months respectively limited by the Knottingley Electric Lighting Order, 1914, for laying mains, &c., in specified streets and in the remainder of the area.

The Board has also extended by one year from July 8 the same periods limited by the Thornton Electric Lighting Order, 1914, for similar purposes.

The Board has also extended by one year from July 31, 1917, the periods of two years and 18 months limited by the Rickmansworth and Chorleywood Electric Lighting Order, 1914, for laying mains, &c.

The Board of Trade has also extended for one year the period for carrying out the provisional order of the York Electric Lighting (Extension) Order of 1914.

Stoke-on-Trent.—As the Electricity Committee has had notice that it is proposed to withdraw more men from the electricity department for National Service, the Town Clerk has been instructed to take all possible steps to prevent the further depletion of the staff. The Committee has been empowered to apply to the Board of Trade for permission to cut off supplies of current if the reduction in staff does not allow it to be supplied.

Tanfield.—A special meeting of the Urban Council has been called for the purpose of considering an electricity supply scheme.

Windermere.—The Council has been informed by the Windermere & District Electricity Supply Co. that it is afraid it will have to close down the works during daylight on Sundays owing to the depletion of their staff and in order to afford a weekly rest for the remaining portion of the staff.

ELECTRIC TRACTION.

Belfast.—On the recommendation of the Tramways and Electricity Committee the Corporation has transferred the control and management of the overhead equipment of the tramways from the electrical engineer to the tramway general manager

Burnley.—The Electricity Committee has decided that Burnley shall be included in the list of towns, published by the Electrical Vehicle Committee, which are prepared to supply energy for charging electrically propelled vehicles. The charge for the supply of energy will be 1½d. per unit.

The Borough Council has approved the recommendation of the Tramways Committee to increase the salary of the general manager of the tramways, Mr. Hy. Mozley, from £450 to £500 per annum.

Burton.—The fares on the local tramway have been increased and all transfer tickets have been abolished.

Dartford Tramcar Sheds Destroyed.—A fire, which broke out on Tuesday morning, destroyed the Dartford Council's tramcar sheds, with all the cars.

The origin of the fire is not known. The flames were first observed about 3 o'clock, and by 6 o'clock the fire was under control, but nothing remained of the sheds but a twisted mass of steel girders and the metal work of cars. Arrangements have been made for a number of L.C.C. cars to be sent into the district to cope with the traffic. The tramways belong to the Urban Council but are leased to Messrs. Balfour, Beatty & Co. So far as is known, no one was in the building after midnight and the current was off and the lights out.

Electric Vehicle Progress.—A company has been formed for the purpose of purchasing and operating electric taxicabs in Mexico City.

The "Electrical World" reports that progress is being made with a scheme for putting about 500 electric taxicabs on the streets of New York City.

The "Sunday Herald," of Boston, recently had an interesting article on the position of the petrol driven car, the quantity of petrol likely to be required in 1917 for military purposes, &c.

The article states that the war practically denuded European cities of petrol vehicles in the first year of the conflict, and the relatively small number of commercial electrics then available were in great demand. Since that time the demand for electrics has been greatly augmented, resulting in a 600 per cent. increase in England alone. The leading railroads, among them the Midland Railway, which had purchased over 100 electric trucks, many of them American built, have bought heavily. All over Great Britain the demand for electric lorries, and in fairness to all, for steam vehicles, too, is said to be greater than the supply. Petrol vehicles are still being built or imported in large quantities, but almost wholly for military purposes. The mortality among trucks pounding over the shell-shattered roads of France and Belgium is almost unbelievably high. Much the same situation obtains in France, Germany and Austria, the electric being given the preference in transporting mail and merchandise about the cities or between industrial centres. By its use petrol is conserved and many war-time economies made possible, among these the utilisation of women drivers.

Even well-informed business men do not always (it is pointed out) understand why electricity used for recharging truck batteries can be purchased for less than the electricity for an office building or residence. The reason is obvious if they will but consider the simplest of laws—commercial demand. At night many of the big generators are idle, many others producing but half their capacity. By midnight a few residences, hotels and electric signs are all that is left to consumer current. During the "off peak" hours then, say, from 7 until 7, the central station is hungry for business, and then is when the man with an electric truck or a fleet of them with depleted batteries can buy electricity for as low as one-third of what he might pay during the peak hours of current demand. So low is this rate in many cities (including Boston) that sufficient current to keep a 5-ton electric truck running all day can be purchased for what it costs to buy four gallons of petrol, or to feed a single horse for 24 hours. From the standpoint of motor trucking then electricity would seem to be the logical fuel for such trucks as confine their activities largely to the city and immediate suburbs. Intelligent conservation of petroleum and its derivatives is as important as that of grains and other products of the soil.

Glasgow.—The new scheme for raising money for war comforts on the Corporation tramcars was inaugurated on Monday last.

The only means of contributing will be by the purchase of penny tickets. A list of 40 war funds to which contributions have been allocated from previous collections will be exhibited in the cars. Each holder of a winning ticket will be entitled to choose any one of these funds to be the recipient of a percentage of the receipts. The number of tickets drawn will depend on the number of tickets sold. The holder of the ticket bearing the first number drawn will have the disposal of the largest percentage of the receipts. The draw will take place each Monday.

Gloucester.—In consequence of the depletion of staff the Cross and White Bridge tramway route will be closed down after the 11th inst.

The Sheriff, explaining the reason for the stoppage of the service, stated at the last meeting of the Council that within a week two more men would leave them, and since the subject was considered by the Committee their chief inspector had resigned to join the Colours. Five other motormen previously rejected had been classed as fit for service on re-examination, and after the end of July it would be impossible to continue the existing services.

Halifax.—The Board of Trade inquiry into the tramcar accident which occurred on July 15 was held last week.

The driver of the overturned car (Rowland Hodgson) said his training as a motorman commenced on Feb. 8, 1916, but in the following month he joined the Army, and did not return to the service until 12 months later. On Feb. 6 last he resumed taking instruction as a motorman, and on May 2 he was passed out as a motorman. Since then he had driven on various routes, and two days before the accident he was engaged on the Queensbury route. On July 15 he began duty on the latter route at 12.55 p.m., and the return journey on which the accident occurred was his eighth that day. Leaving Queensbury at 9.20 p.m., he brought the car to a standstill with the handbrake at Ford Hill on a gradient of 1 in 16. His next stop was at Oxford-road, and then proceeded down the gradient of Ambler Thorn Hill. When opposite Union Croft Chapel, just before reaching the end of Roper-lane, he tried to stop by means of the slipper brake, but it failed to pull up the car. He then turned to the hand brake, but it jammed in some way, and he could not bring it to full pressure. The car continued down the hill, and he tried the slipper brake again, but without success. Consequently he resorted to the electric brake, and though he applied it fully it only slightly checked the car. When he got to the loop at the bottom of the hill he was travelling about four miles an hour. The car passed through the loops on to the curve of the single track. He thought his speed slightly increased after entering the loop, although the gradient there was only slight. Suddenly he felt the car leave the curve of the single track and two or three lengths further on it fell on to its side. He had never before had trouble with his brakes, and he could not explain the sudden jamming of the hand-brake. He used sand but it was not effective. The weather had been wet, but it was fine at the time and the rails were not greasy.

Mr. W. J. GALLOWAY, tramways engineer, said that in his examination of the car 50 minutes after the accident he found the reversing handle on the controller in the reverse position. The adjusting bolt of the track brake was broken close to the top of the brake shoe, but he attributed that to the shoe having caught in the setts after the car had left the track. The wheel operating the track brake was released, as also was the handle operating the hand-brake. From the absence of marks on the setts for 3 yds. from where the car lay on its side, he was of the opinion that the car

Digitized by Google

had leaped forward after leaving the road. Later he tested the hand-brake and the electric brake with the car going down hill at 10 miles an hour, and the car pulled up easily. There was no trace of "flats" on the wheels, which would have existed if the car had been skidding. The car was overhauled as recently as May 12 last. In normal times cars were overhauled once in 12 months, but now only once in 18 months. The car had been in constant use since May 12. In his inspection of the car he found nothing to account for the driver's statement as to the brakes. With the reversing handle in the position in which he found it the electric brake would not be effective at all. That might have been caused in the overturning of the car, but he could not account for the controller being in the off position. It was possible that the handles could have become so placed during the overturning of the car, but he hardly thought it porbable.

Mr. James Lord, the borough engineer, and other witnesses gave evidence, and the inquiry closed.

Leeds.—The City Council authorised the Tramways Committee to appoint six women tramway inspectors, but this has led to friction and to a threat of a strike by the women conductors.

Nelson.—As the Ministry of Munitions refuse to sanction the importation of an electric wagon purchased by the Health Committee of Nelson from the Edison Accumulators (Ltd.), the Council has asked the Local Government Board to assist them in obtaining delivery of the wagon.

P.O. Tube Railway.—It is stated that the boring for this railway, which will link up all the long-distance offices by means of a letter and parcel railway, is practically completed.

There is now a boring extending from Paddington to Mount Pleasant, taking in the G.P.O. in its winding route. The cost of the project so far is well over £500,000. There will be a continual service of trains day and night, and along the line there will be a large number of stations.

Swansea.—The Board of Trade have extended for one year from Aug. 7 the time limited by the Swansea Corporation Act, 1912, for completion of tramways, &c.

Weymouth.—The Council are recommended to purchase an electric vehicle.

TELEGRAPHY AND TELEPHONY.

Radiotelegraphy in Italy.—The Italian Government propose to construct a powerful wireless telegraph station in Central Italy. It is stated that the station is being planned on a new system, and it is anticipated that it will soon be available for the transmission of news.

Transatlantic Wireless Service.—Marconi's Wireless Telegraph Co. has announced that as from midnight on the 3rd inst., in conformity with instructions received from the Government, their transatlantic service, both eastbound and westbound, has been discontinued until further notice. The closing of the service is not brought about by any fault of the company, either here or in Canada, but is purely a necessary war measure.

Wireless Air Raid Warning.—The "Daily Chronicle" reports that Mr. Thorp Hincks has devised wireless apparatus for giving warning of impending air raids.

It is claimed to be especially applicable to factories and public buildings. An electric resonator is placed on the roof, and on the sound of a given pitch being produced, the resonator causes a bell to ring in the building until it is stopped. It is said that large areas, such for instance as the whole of the City, can be simultaneously and instantaneously warned. Inquiries may be addressed to Mr. Thorp Hincks, 17, Wimpole-street, London, W.

IMPERIAL NOTES.

Australasia.—The Borough Councils of Devonport and Picton (N.Z.) have been authorised to erect and maintain electric transmission lines in the boroughs of Takapuna and Picton.

The Imperial Trade Correspondent at Hobart (Tasmania), Mr. A. H. Ashbolt, says it is expected that the works at Risdon of the company formed to produce zinc by the electrolytic process from ore from the Broken Hill Mines will soon be in operation.

Montreal Electric Pumping Scheme. It is proposed to increase the amount of hydro-electric power available in Montreal City.

A scheme prepared by Messrs. H. E. Vautelet, A. St. Laurent and J. B. McRae will provide for 13,000 h.p. in winter and 24,500 h.p. in summer. The engineers estimate that 13,000 h.p. will be required in summer and 8,750 h.p. in winter for pumping and 1,910 h.p. for filtration, with an excess of 2,520 h.p. This will have to be supplemented by an auxiliary steam plant. The total capital cost is $10,609,000, and the cost of operation $740,000. None of the schemes considered give enough power for electric lighting. The power companies will be asked to quote for a supply of power for pumping purposes for long periods, and if this cost is less than the city can supply it, it is proposed to enter into contracts. In the meanwhile the Council will be asked to give authority for the preparation of plans for an electric pumping station, the engineers having reported that the equipment of the station will be the same whether the city generates its own power or buys it.

FOREIGN NOTES.

Mexico.—Decrees have been issued imposing special taxes on electric lighting and telephone services.

The tax on electric light has been fixed at 10 cents (Mexican gold) per month for each light consuming up to 40 watts, and 10 cents extra for each light in excess of that power.

Telephones in private houses are to be taxed at 50 cents and shops, offices, &c., $1 (Mexican gold) per month.

Petrograd.—"Engineering" announces that on May 23 last the City took over the Belgian Co. for Electric Lighting, as well as the Helios Electricity Co., and the two concerns were to be worked for account of the city from that date. The St. Petersburg Co. for Electric Lighting, the largest concern of the kind in the city, will not be taken over by the municipality, but transformed into a new limited company, in the share capital of which the cities of Petrograd and Moscow will be interested to the extent of 15 per cent.

MISCELLANEOUS.

Alien Enemy Firms.—The "Daily Mail" of the 6th inst. contains some particulars of the progress made in the winding-up of firms and companies owned or controlled by alien enemies.

Our contemporary states that, with one exception, it is believed that all the leading German business firms which had established themselves in this country before the war have been put out of business. A number of smaller concerns are still in a state of suspense, and there may be a few unknown to the Board of Trade which are enemy in character or control, but have not yet been brought to the notice of the department. Under its statutory powers the Board of Trade has already ordered 481 firms and companies to be wound up. Before the war the manufacture of dyes was entirely in German hands. Most of the dyes used here were imported, but there were also two very large German firms making dyes in this country, Meister, Lucius & Bruning, of Port Ellesmere, and the Mersey Chemical Works (Ltd.). These have been wound up, their works and property have been sold to British firms.

The electrical industry was (it is stated) not so entirely in German hands before the war as some people had imagined. There were very large American interests. As a result of the war the British electrical industry has greatly benefited by the transfer of interests to British owners and the extinction of an important group of German companies, including the A.E.G. Electric Co., the A.E.G. Electrical Co., of South Africa, and the Electrical Co. The properties of these companies have been sold. They were not of very great cash value, the companies acting chiefly as importers and agents of German makers. The affairs of the Siemens Co. have been under supervision from the first, and its works have supplied very important war material. Offers made for the company's properties have so far not met with the approval of the Board of Trade, which hopes to see them sold to British owners who will develop the concern in the national interest.

In magnetos the Germans also had a monopoly. Magnetos were largely imported from Germany, and one firm (the Bosch Magneto Co.) turned out the bulk of those made in this country. This company has now been sold to a British concern.

There were very big German interests in the electric lamp trade before the war. The shares of the Osram Co. have been sold to British owners, and the Brimsdown Co. has been wound up. Many other smaller concerns have also been dealt with. Some small German firms, endeavouring to compete with strongly established British firms in the electric cable industry, have likewise been wound up.

In engineering, the most important German firm established in this country was the British Mannesmann Tube Co. Shares valued at £500,000 have been sold to British subjects, and the hope that Germany entertained of capturing the British engineering industry has been extinguished with the sale of this and the winding up of some smaller concerns.

Bristol Wiremen's Wages.—The dispute between the Bristol Electrical Contractors' Association and the Electrical Trades Union as to wages has been settled.

On and after the first pay-day following June 19, 1917, the rate for electricians, electrical fitters, cable jointers and armature winders has been agreed at 1s. 0½d. per hour. Charge hands will receive 1d. hour extra.

British Engineers' Association.—The fifth annual ordinary general meeting was held on the 26th ult., and was attended by a large number of members.

In moving the council's report and balance-sheet for the year 1916, the chairman (Mr. Wilfrid Stokes) reviewed the work done by the association during the past year, and dealt with the action which it was proposed to take in future. The new memorandum and articles of association had received the sanction of the courts and were now operative. The revision had been made in order to strengthen the relations between manufacturing engineers and those bodies and individuals with whom they were naturally brought into contact in the course of their business, as set out in the Manchester scheme for the organisation of the British engineering industry. Much interest had been shown in the election of the new council, and for the 30 seats on the council about 90 members (including retiring members) were nominated in the various districts, a total of 1,369 votes being recorded.

Digitized by Google

At the first meeting of the council held the same day, Mr. Wilfrid Stokes was re-elected president, and among the members of the council are the following: Mr. T. O. Callender, J.P., Capt. L. E. Mather, Mr. J. E. Thornycroft and Mr. Douglas Vickers (*vice-presidents*); and Messrs. H. Allcock, Dr. G. B. Hunter, A. Jacob, B. Longbottom, Hugh Lupton, C. P. Martin, J. C. Ward and A. P. Wood.

Cardiff Electrical Strike.—On the 2nd inst. about 300 members of the Cardiff Electrical Trades Union came out on strike, because they alleged that the employers refused to abide by the award made in June giving them an advance of 12s. per week over and above pre-war rates. On Saturday, however, the men decided to return to work, pending the decision of Sir George Askwith on the point in dispute.

First Aid in Metal Factories.—The Home Secretary notifies that he intends to make an order, taking effect from Oct. 1, requiring all blast furnaces, copper mills, iron mills, foundries, metal works and factories belonging to those classes, employing over 24 persons, to provide first-aid boxes, and in case of factories employing 300 or more persons an ambulance-room and ambulance carriage.

Inquest.—An inquest was held last week upon Geo. Ferd. Corfe (28), who was recently killed at Messrs. Bibby's Copper Works, Garston.

Deceased, who was working a pneumatic hammer, was found dead in a crouching position on the floor with a fuse holder in his left hand. It was presumed he had gone to the fuse-box to replace a fuse and had received a shock. It was no part of his duty to replace fuses, and the men were warned against interfering with the electric installation.

The jury returned a verdict of accidental death.

Military Tribunal Case.—At Birmingham last week the military representative appealed against the conditional exemption granted by the local tribunal to a man under 30 and passed for general service.

For respondent it was said that he had a secret process for the manufacture of very small lenses for electric lamps used for telephone switchboards. He was the only man in England who could do the work, which was of vital national importance. An order for over 50,000 of the articles had recently been received.

The appeal was disallowed, but leave was given to go to the Central Tribunal.

Nationalisation of Mines.—At the Miners' Federation Conference last week a resolution in favour of the nationalisation of mines was unanimously adopted.

Presentations.—Two interesting presentations were made at the head office of Messrs. Ellis & Ward (Ltd.), Portugal-street, Kingsway, W.C., on the 31st ult., the recipients being Mr. C. W. V. Clarke, London manager, and Mr. H. Fowkes, of the engineering staff, the former having completed 21 years and the latter 22 years of continuous service with the company.

The presentation, which took the form of gold half-hunter watches with engraved inscriptions, was made by Mr. H. Willoughby Ellis, managing director. Such length of continuous and devoted service was, said Mr. Ellis, truly eloquent of the good-will and efficiency which he was sure had largely contributed to the success which had been theirs. He might claim that they were one of the oldest established electrical contractors in the country, whose operations had extended continuously as the years went by.

Trade After the War.—Last week the Minister of Reconstruction, Dr. C. W. Addison, M.P., made an important statement in regard to trade after the War to representatives of the chemical industries of the country.

Dr. Addison said the after-war conditions of the chemical trades were profoundly affected by the creation of a large number of new factories in connection with war industries. They were producing large quantities of certain chemicals, which, let them hope, would not be wanted after the war, and in some cases in what appeared at present—unless we could find some other destinations for them—excessive quantities. Unless the Government took those things in hand now, they would find themselves, at the time when peace arrived, confronted with a number of social and industrial difficulties which might make the state of affairs worse for some time after the war than they were at present, so far as the industrial population was concerned. One of the most urgent and difficult matters which would arise after the termination of the war, or perhaps even before then, would be the supplies of essential raw materials—not only their manufacture, but their transport and use amongst the Allies, and in some of them, as they knew, there was at present a world shortage. Increased production was the only way in which we could pay for the war. We should aim at making three ears of corn grow where two grew before. We must aim at increasing the product of all the industrial plants in the country so far as we could, and that meant at the same time improving their processes.

He noticed from reports that the Germans did not deprecate the necessity of taking steps to deal with reconstruction problems. The Government Departments had supplied to them a great deal of information as to the steps which our enemies were taking to deal with industrial matters in the after-war period, and unless this country was to find itself defeated in some directions of commerce, whatever may happen after the war, we must take time by the forelock. Certainly our enemies were doing so in the most elaborate and painstaking detail.

In some of the industries in this country the experience of the Ministry of Munitions showed that we had allowed our British habit of "muddle and drift" to bring us into a position of extreme danger. There were many essential materials of which we were very short, and which for a long time after the beginning of the war we found ourselves in most serious difficulties in obtaining. "So I want you to join with us in taking steps in time to deal with the problems which will arise at the termination of the war. There are at the present time at least five different Government Departments which are concerned, in one way or another, with what will happen to the chemical industries at the finish of the war." He sincerely hoped in respect of one of them that we should be able to take steps to induce the British farmer to make a much greater use of fertilisers than he ever did before. The policy of the Minister of Reconstruction was not to interfere with their business. Their desire was to help, so far as they were able to help, and he could assure them that they need have no fear that he was at the Ministry of Reconstruction to promote nostrums of any sort or kind. He wanted to get to work to examine the problems fairly and squarely with the assistance of the hard work which had already been done by various committees and to take such steps as might mitigate any of the evils that might arise during the reconstruction period; and if they did not succeed in placing some British industries on a much firmer and more scientific foundation than they were before, it would be very discreditable to them as a nation.

He asked those present to try and bring about such understandings with labour as would give those engaged in their industries a direct interest in the introduction of improved methods. They should more and more make use of skilled supervision and assistance, and of the lessons of research, and endeavour to bring their manufacturing standards up to the highest pitch of perfection. He wanted to come to an arrangement whereby they could place at their disposal, in the interests of them all for the reconstruction period, not only the information they had obtained as to what the enemy was doing, but what they had learned themselves during the war. He believed there were other difficulties which, when they were considered carefully, they could help to remove—some connected with certain patent laws, and other matters associated therewith.

A general discussion ensued and an Advisory Committee was formed, four members of which were nominated by the Chemical Industries' Association, with Dr. Carpenter as chairman. Dr. Addison intimated that he would nominate certain gentlemen who would form a smaller committee to inquire into the subject and assist the Government.

EDUCATIONAL.

University of Birmingham.—The full courses at this university extend over four years, and students entering after matriculation and passing the examinations at the end of each year will be entitled to the degree of B.Sc. in engineering. The 1917-18 session commences on Oct. 2, and detailed syllabus, giving particulars of the university regulations, lecture and laboratory courses, fees, &c., can be obtained from the secretary.

University of Manchester.—Full particulars of the lecture and laboratory courses in physics, preparing for both the ordinary and honours degrees, can be obtained on application from the registrar. Prof. Sir E. Rutherford will meet intending students on Thursday, Oct. 4.

Armstrong College, Newcastle-on-Tyne.—The session 1917-18 will commence on Sept. 24. Full courses leading to the degree of B.Sc. in engineering are provided in mechanical, marine, civil and electrical engineering, naval architecture, mining and metallurgy, &c. Particulars can be obtained from the secretary, Mr. F. H. Pruen, M.A.

City and Guilds of London Institute.—The programme of the department of technology of the City and Guilds of London Institute for the session 1917-18 has been issued.

The book contains over 400 pages of regulations for the registration, conduct and inspection of classes and examination of candidates, and for the award of teachers' certificates in manual training and in the subjects dealt with. In all there are over 80 subjects in which examinations are held, though notice is given that, in the event of the continuance of war, it will not be possible to hold examinations in 1918 in a number of subjects, including Grade I. and final examination in electrical installation work. It may also become necessary owing to the war to suspend or modify other examinations and regulations.

We should again like to draw attention to the necessity for a drastic revision of the lists of text books and works of reference which are set out. Many of these are obsolete or out of print. The programme is published by Mr. John Murray, Albemarle-street, London, W. 1, at 9d. net.

Science in the Educational System.—An important memorandum on the teaching of science has been issued by the Senate of the University of London. The memorandum states that

Primary and secondary education should be directed towards making active and useful citizens, and should include the development of mind and character and instruction in the fundamental branches of knowledge. Literary, linguistic, mathematical and scientific studies should be regarded as fundamental branches of knowledge, and each pupil should receive some instruction in all these branches. In the case of pupils who pursue their education beyond the age of 16, these subjects should as a rule be continued, and public and secondary schools should not undertake specialised training in professional subjects. Opportunities for learning Latin and Greek should be given in one or more schools in every educational area.

Digitized by Google

2. The teaching of natural science (including physics and chemistry) should be compulsory in all secondary schools

3. All secondary schools retaining pupils beyond the age of 16 should be capable of providing instruction in the science subjects of the entrance examinations of the universities up to the standard required by these examinations.

4. Special technical day schools, in accordance with local needs, should be established in all industrial centres for boys and girls between 13 and 16 years of age who wish to enter the technical (including engineering, chemical and artistic) industries at the age of 16.

5. In order to secure for science teaching the position to which it is entitled, and which for the benefit of the nation it ought to occupy, the schemes under which the great public schools are administered should in each case contain provisions to the effect (*a*) that the governing body shall include a substantial number of representatives of the learned and scientific societies, and (*b*) that members of the governing body shall not hold office for life. Greek should not be a compulsory subject for entrance scholarships to these schools, and adequate facilities (including equipment) for learning science should be available for and accessible to all their pupils.

6. The number of branches in which a first university degree can be taken should not be unduly multiplied, but students who have taken a first degree in science should be encouraged by the institution of higher (M.Sc.) degrees, especially in technical branches, to specialise in particular branches of science or in their applications to industry. The paration for such degrees should include some training in the methods of research.

7. The present arrangement for the selection of first division clerks in the Civil Service should be modified so that on every occasion an adequate proportion of those appointed must have had mathematical or scientific training.

8. In all selections for the higher administrative posts for the Government Departments the work of which is of a scientific or technical character the official selected ought to have received such a scientific training as will fit him to understand the character of the work for the organisation of which he will be responsible.

TENDERS INVITED AND ACCEPTED.

Electrically-driven Turbo-Pumps.

MANCHESTER Waterworks Committee invite tenders for the supply and erection of two electrically-driven turbo-pumps, with automatic control and switchgears, &c. Specifications from the Secretary, Water Department, and tenders to the Chairman of the Waterworks Committee, Town Hall, Manchester, by Aug. 18.

Rotary Converter.

BERMONDSEY (London) Borough Council invite tenders for a 500 kw. rotary converter. Specifications from the borough electrical engineer, and tenders by noon Sept. 7 to the town clerk, Town Hall, Bermondsey, S.E.

Coal Bunker.

BOOTLE Corporation invite designs and tenders for erection of an Overhead Coal Bunker at Marsh-lane generating station (for at least 400 tons of coal). Particulars from the Borough Engineer. Tenders to the Town Clerk by noon Sept. 12.

PATI.—The Council has accepted the tender of the Underfeed Stoker Co. for the supply and installation of a stoker and fan at £491.

HAMMERSMITH (LONDON).—The Baths Committee has accepted the tender of Rutery, Owen & Co., for a 20 H.P. induction motor, at £125.

WALTHAMSTOW.—The Council has accepted the tenders of W. T. Henley's Telegraph Works Co. for cables, British Thomson-Houston Co. for switchgear, and British Electric Transformer Co. for a transformer.

LEYTON.—The Council has accepted the tender of the Tudor Accumulator Co. for maintenance of accumulators.

STOKE-ON-TRENT.—The Council has been recommended to accept the following tenders :—

British Westinghouse Co., turbo-generator, £18,805 ; G. & J. Weir, electrically-driven boiler feed-pump, £381 ; Aston & Co., extension of steam pipes, £85. 10s.

LONDON COUNTY COUNCIL.—An order has been placed with Callender's Cable & Construction Co. for the supply of vulcanised bitumen cable for the tramways department at £755.

The following tenders have been recently accepted by the London County Council :—

Babcock & Wilcox, 8,000 stoker links for the boilers at £277. 15s., and 4,000 links for chain grate stokers at £132. 17s. 6d. ; W. & T. Avery, overhaul of two coal weighing machines, £28. 16s. 3d. ; Pinchin, Johnson & Co., baking and air-drying insulating varnish, £65 ; Jenson & Nicholson, finishing insulating varnish, £230 ; Dick, Kerr & Co., for transfer of two rotary converters, with transformers, from Greenwich generating station to Woolwich, £265 ; Alfred Clare & Co., motor-driven taping machine for re-winding armature coils, £47. 14s. 4d. ; Edgar Allen & Co. and Hadfield's Limited, for supply of 75 driving wheel centres for tramcars ; William Beardmore & Co., 100 driving wheel axle forgings, £4. 17s. 6d. each.

GLOUCESTER.—The Corporation have accepted the tender of the D. P. Battery Co. (at £923. 14s.) for the supply of a new battery for the electricity works.

The company offered to replate the existing battery for £785. 5s., but the Electricity and Light Railways Committee thought that if suitable arrangements could be made it would be better to purchase a new battery.

APPOINTMENTS VACANT AND FILLED.

Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W. 1, notify in an advertisement that vacancies occur from time to time in the Government services in the Crown Colonies for men qualified as electrical engineers, electricians, wireless operators, telephone and telegraph foremen. Prospective candidates who are neither eligible for army service nor already employed on Government work, are invited to apply by letter.

An assistant constructional engineer is required by the City of Birmingham Electric Supply Department. Forms of application, which may be obtained from the secretary of the department, 14, Dale-end, Birmingham, should be sent to the city electrical engineer (Mr. R. A. Chattock) by Aug. 25.

Last week the Manchester City Council confirmed the recommendation of the Education Committee to appoint Mr. George Gerald Stoney, F.R.S., to the chair of mechanical engineering at the Municipal School of Technology, Manchester, at a salary of £1,000 per annum.

The Controller of Coal Mines has appointed Mr. Frank Pick, commercial manager of the London Electric Railways, as his assistant to deal with matters in connection with the London coal distribution scheme.

Mr. A. W. Ashton, D.Sc., M.I.E.E., has been appointed principal of the mechanical and electrical engineering department of the Stoke-on-Trent Central School of Science and Technology.

Dr. Ashton, who served his apprenticeship in the Royal Arsenal, Woolwich, was Whitworth exhibitioner in 1894. He obtained his B.Sc. in engineering with honours at the Durham College of Science. For two years (1898-1900) he was engaged in the Pender Electrical Engineering Laboratory, under Prof. Fleming, F.R.S., and for the succeeding six years he was assistant to the chief engineer of a large cable manufacturing firm. In 1906 he became assistant lecturer in electrical engineering at Leeds University, and from that year down to 1914 he was head of the electrical department of the Battersea (London) Polytechnic. Since then Dr. Ashton has been lecturing and superintending practical classes in mechanical and electrical engineering.

Mr. G. H. Lake has been appointed chief electrical engineer at Derby at £250 per annum.

BUSINESS ITEMS.

The offices of the Bombay Electric Supply & Tramways Co., Ltd., have been removed to 195, Strand, W.C. 2, as their old premises have been requisitioned by the Government.

Thos. Wm. Jefferson & Thos. Evan Jones (trading as the Economic Electric Co.), electrical and mechanical engineers, 127A, Oxton-road, and 1A, Hamilton-lane, Birkenhead, have dissolved partnership. Debts by Mr. Jones, who will trade as the Economic Electrical Co. at 127A, Oxton-road, Birkenhead. Mr. Jefferson will carry on business under his own name at 79A, Grange-road, Birkenhead.

John Francis Hall-Edwards and Mansel F. Emrys Jones, medical electro-therapeutists and X-ray specialists, 141A, Great Charles-street, Birmingham, have dissolved partnership. Debts by J. F. Hall-Edwards.

Plant for Sale.—The Victoria Electric Plant Co., Spencer-street, Westminster, S.W. 1, have for sale a bi-polar motor-generator.

Plant Wanted.—Mr. John Jardine, Deering-street, Nottingham, advertises for a vertical gas engine for town gas, 75 H.P. to 250 H.P.

LIQUIDATION.

Best's Safety Lamps (Ltd.) is being wound up voluntarily, and Mr. N. D. Vine, C.A., 59, Pearl-chambers, East-parade, Leeds, has been appointed liquidator. A meeting of creditors will be held to-day (Aug. 10) at the Law Institution, Albion-place, Leeds.

CATALOGUE.

CABLE FITTINGS, &C.—List No. 431 of Messrs. George Ellison, of Birmingham, which has just been issued, gives particulars and prices of cable fittings, pipe flanges, ceiling and dividing boxes, &c., supplied by them for attachment to ironclad switchgear of the industrial type.

A feature of the "Ellison" cable adapters and fittings is the patent cone clamp for the armouring, which can easily be cut on site to suit any ordinary cable. No special drilling on site is required, and the cone clamp affords efficient means of bonding the armouring or other cable covering to the switchgear case for earthing purposes. Those interested may obtain copies of the list on application to the firm.

Digitized by Google

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Belfast.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £450,258 (increase £113), of which £18,120 has been redeemed, and the sinking fund amounts to £123,848.

Revenue was £136,228 (compared with £113,456 in the previous year), and total costs were £100,678 (£69,175), leaving gross profit £35,550 (£44,281), to which is added bank interest £990. Redemption contributions were £10,952, dividends on stock £13,022, income tax required £4,595. £10,000 was placed to reserve, and £5,000 devoted to relief of rates. Average prices obtained per unit were: 3·633d. (3·26d.), power 1·58d. (1·32d.) and traction 1·35d. (0·793d.), and total costs were 1·26d. (0·864d.). Units generated were 21,389,765 (20,859,237) and sold 19,180,541 (19,204,433). Combined load factor was 19·4 (20·2) per cent., and total maximum demand was 11,289 (10,840) kw.

Chester.—For the year ended March 31 the tramway traffic receipts and sundry revenue amounted to £13,878, compared with £13,520 in 1916.

The expenditure was £8,085 and the gross profit £5,820, against £5,244. The number of passengers carried was 3,282,797, against 3,252,227.

Glasgow.—The gross capital expenditure of the tramways department at May 31 was £3,846,455 (increase £11,298), but the whole of the borrowed capital has been redeemed.

Revenue was £1,260,115 (compared with £1,157,336 in previous year), and working expenses, including war expenditure, were £838,065 (£773,442). Interest required £78,846 (£90,473), and sinking fund £114,377 (£109,614), leaving net profit £160,984 (£43,548), which has been handed over to Common Good Fund. Average total revenue per car mile was 11·728d. (11·127d.), and working expenses, including power works cost and war expenses, were 7·799d. (7·436d.). Average fare charged per mile was 0·44d. (as in previous year). Passengers carried were 388,294,876 (362, 71,464), car miles run 25,786,047 (24,963,309), and units used 39,326,948 (36,611,255) = 1·52 (1·47) per car mile.

Leith.—The accounts of the electric supply department were approved by the Council last week.

The past year's income was £31,456 and the expenditure £35,056, leaving a deficit of £3,630, which, added to last year's loss, made a total deficit of £5,349, against an estimated deficit of £326. The increased charges for current and the ordinary growth of output will, it is expected, wipe out the deficit in due time.

Beginning the year with a debit balance of £1,482, the tramways finished up with a debit of £3,252, due mainly to increases under the head of wages, current, repairs and income-tax.

Swansea.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure out of loans £238,075, exclusive of cost of issuing stocks, &c. (increase £3,827), of which £179,917 is outstanding.

Revenue was £39,016 (compared with £38,295 in previous year), working expenses were £20,658 (£20,190) and interest required £7,346 (£7,665), and repayment of principal £6,600 (£5,496), leaving net profit £4,412 (£4,944). Works costs were 1·18d. (1·37d.) per unit sold, capital charges were 0·80d. (0·89d.), and average price obtained was 2·06d. (2·48d.). Units generated were 5,504,470 (4,499,570) and sold 781,887 (498,611). Total maximum supply demanded was 1,730 kw. (1,890 kw.) for lighting, power, &c., and 870 kw. (440 kw.) for tramways.

Capital expenditure on the tramways and light railways departments is £119,650, of which £22,811 is paid off or in sinking fund. Income was £7,309 (£7,475) and expenditure (loan charges, &c.) £5,926 (£5,918) leaving surplus £1,383 (£1,557).

During the year an agreement with the local tramways company for the Corporation to supply the whole of the current for the tramways was entered into, and this has materially assisted the financial results. The Corporation took over the Company's generating station, and will repay the company's capital interest therein by annual payments of £400 during the next 26 years.

Mr. J. W. Burr (borough electrical engineer) says in his report the station load factor of the electricity department's station was 22 (24·2) per cent. Average price of coal was 19s. 6d. (17s. 1d.) per ton. The showroom and publicity department has more than justified its existence. Heating connections increased 328 kw. and power connections 228 kw., and this obviated the necessity of increasing the rates for private lighting. The time is ripe for putting in a new boiler, &c.

Walsall.—The accounts of the electricity undertaking for the year ended March 31, which were recently approved by the Council, show gross capital expenditure £249,353 (increase £35,648), of which £24,271 has been repaid.

Revenue was £30,568 (compared with £29,573 in previous year) and working and general expenses were £26,115 (£18,789), leaving gross profit £4,453 (£10,784). Interest required £5,798 (£4,936) and sinking funds £7,642 (£6,747), the net deficit therefore being £8,987 (£899). Working expenses were 1·54d. (1·17d.) per unit sold and capital charges were 0·79d. (0·73d.), while revenue was 1·80d. (1·84d.). Total maximum supply demanded was 2,035 kw. Units generated were 5,835,690 and sold 4,080,977.

COMPANIES' MEETINGS AND REPORTS.

BURMA CORPN. (LTD.)—At the recent meeting the chairman (Sir T. R. Wynne) said that their production of refined lead was 60 per cent. greater. The crushing machinery for 700 to 800 tons per day capacity for the new mill was en route from America. The purchasing of concentrator tables and the flotation machinery had been deferred pending the arrival of the construction crew. The 1,000 H.P. Diesel electric generating set was started up in September, and at the end of the year some 16 electric motors were in operation. A second Diesel set had been ordered, foundations and extension of building were being put in, and it was hoped that it would be in operation by the end of the year. A satisfactory arrangement had been completed with the Government for the use of Mansam Falls, and preliminary work had been started. Their geological department had been extended and was now undertaking the mineral reconnaissance of the surrounding country, and had done valuable work in reconnaissance for ironstone flux, other minerals and coal. Their smelting plant had been remodelled and added to; their production of lead and silver had been influenced by shortage of roasting capacity and ironstone fluxes, as well as stores. With the present production of the Bawdwin mine smelter, Burma now ranked among the 10 largest lead-producing countries of the world and among the first 15 in silver. They were conducting research work in their researchplant at the property with a view to realising on the zinc content of their lead concentrates, and, perhaps, ore, by leaching and electrolytic or other precipitation.

CROMPTON & CO. (LTD.)—Mr. Carleton F. Tufnell, who presided over the annual general meeting last week, expressed regret that they were not able to present the accounts for the year ended March 31. In deciding to postpone their publication they were following the example of many other companies which were "controlled establishments." He was, however, able to say that the turnover showed a very satisfactory increase on that of the previous year. Unexecuted orders at the works at the close of the year represented a very large amount—greater, in fact, than the total annual output a couple of years ago. The company's profit-earning capacity likewise continued to expand. With their increasing turnover, and with the continued rise in price of material, the board still found it necessary to be conservative in the matter of the distribution of profits, quite apart from the fact that they had the important question of war taxes to bear in mind. Nevertheless, they felt quite justified in recommending a distribution of 5 per cent. on the ordinary shares, in addition to the preference dividend. The relation between the company and its employees had been entirely satisfactory, and if ever there was a period in the company's history when the employees merited their thanks it was in respect of the work done in the past year. With regard to the future, they had plenty of work in hand, and that in a well-conducted business such as theirs should mean satisfactory profits for the current year. As regarded war taxation, it should be borne in mind that this country was, in effect, a gigantic trading concern, and one result of the war was to dissipate a very large amount of the working capital of that trading concern. When the working capital of a business was reduced it was no longer able, with its smaller working capital, to do the volume of business that it previously carried on without embarrassment. When the war was over very great efforts would be required of the commercial community to restore and augment the trade of the country He could not help feeling that the Government, in their policy of war taxation, were paying too little attention to the all important matter of the future rehabilitation of the country's trade.

DORMAN, LONG & CO. (LTD.)—Mr. A. J. Dorman presided over the meeting last week and, after giving an analysis of the accounts for the past year, said that they had entered into an agreement for increasing their production of steel and consequently they had decided to build new steel works at Redcar. The scheme consisted of a 400-ton mixer, 10 large steel furnaces, a cogging mill and two large plate mills, and the cost would be about £2,000,000. Good progress was being made with those extensions. Already three furnaces were at work, giving results fully up to their expectations. When completed those new steelworks would produce from 300,000 to 400,000 tons of steel per annum, bringing the total capacity of their combined concerns up to an annual output of 1,000,000 tons. In order to produce the whole of the pig-iron required it would be necessary to introduce very great changes at the blast furnaces at Redcar. He also gave particulars of the company's investments in the new Channel Steel Co., &c. Mr. Dorman's remarks as to the future relations between capital and labour are reported in another column.

ELECTRIC LIGHT & POWER SUPPLY CORPN. (SYDNEY) (LTD.)—The profit for the past half year was £12,348, and after meeting debenture interest (£1,876), a sum of £10,472 was available for allocation. A dividend at rate of 8 per cent. per annum (£7,404) was paid, and £3,067 was placed to reserve for depreciation of plant and machinery. A sum of £1,862 was transferred from the general reserve to the depreciation of plant, &c.

HONG KONG ELECTRIC CO. (LTD.)—At the recent annual meeting, Mr. A. O. Lang, who presided, said the net profit was $509,940, and with $110,558 brought forward the total was $620,499. Out of this a dividend of 22½ per cent. and a bonus of 75 cents per share were declared. Every endeavour had been made to procure locally such plant as would enable the company to continue accepting new business, but all that was available was two small steam sets with which addition it was hoped

Digitized by Google

to carry on until the new station was ready. But for the outbreak of war the new station at North Point would have been running; a considerable portion of the new plant on order in England had been completed but was commandeered by the Minister of Munitions.

METROPOLITAN RAILWAY OF PARIS.—The total receipts for the year 1916 were 57,799,840frs., against 59,841,370frs. in 1915: the expenditure was 30,552,870 frs., against 25,989,520 frs., and the ratio of expenditure to receipts increased from 43·96 per cent. to 47·14 per cent. The net receipts, after allowing for the proportion payable to the City of Paris were 11,654,360 frs., against 11,073,650 frs. The cost of coal amounted to nearly £250,000. There are 78·8 kilometres (nearly 49 miles) of double track open with 171 stations.

MOND NICKEL CO. (LTD.)—At the meeting last week the chairman (Mr. R. Mond, M.P.) said that the fourth unit at Clydach had been in successful operation, the erection of the fifth unit was progressing favourably, and preliminary steps were being taken towards the erection of a sixth unit. They had also acquired an adjoining farm of some 300 acres, which would enable them to extend when desired. In Canada the increase of the smelter in preparation for supplying the matter necessary for six units, and the corresponding development of the mines were nearing completion. The Lorne Power Co., in which they held all the shares, had successfully put into operation a new power plant at Nairn Falls, on the Spanish River, and provision had been made for all the electrical power required for the increased output in Canada.

PERNAMBUCO TRAMWAYS & ELECTRIC POWER CO. (LTD)—At the meeting last week the chairman (Mr. Follett Holt) said the undertaking was in its development stage. Notwithstanding that the gas works were under reconstruction and the Brazilian Street Railway line was being converted to electric traction, their net earnings had increased by 10 per cent. The exchange throughout the year was against them, and the prices of materials had been very high. They had now a right to expect that the gas works and the telephones would each provide in the future their fair quotas to the revenue account, and so aid the electric tramways to bring prosperity to the company. With regard to the electric light and power supply, they had only touched the fringe of the task and the possibilities before them. It was a difficult matter to purchase and to finance new electrical plant and materials at present, but under urgent pressure from their friends at Pernambuco they had felt called upon to make a step forward in that new field, and they hoped that during 1918 they would see some good results from the development of that branch. They had already passed their acute troubles, and, providing that no financial crisis in Brazil intervened to affect the present rate of exchange, they hoped to be able to show for some years steadily improving results. The war had given an extraordinary stimulus to some of the exports of Brazil, such as manganese ore, meat and beans. According to cable advices, the results in sterling for the first five months of the year showed an increase of 27 per cent. in gross and 30 per cent. in net compared with the same period of last year.

TUDOR ACCUMULATOR CO. (LTD.)—The annual meeting was held on July 25. The chairman (Mr. B. M. Drake) said it would doubtless be satisfactory to municipalities and others who used Tudor accumulators to know that the company was now in British hands. The directors were pleased to have been able to conclude agreements by which the services of the managers both at the head office and the works were retained. He referred to the very liberal war allowances which amounted last year to no less than £5,025, and he anticipated that the company would obtain a fair share of available work now that all enemy interests, which had acted as a deterrent in the past, had been effectually removed. The board as now constituted is as follows: B. M. Drake (chairman), E. J. Clark, W. C. Johnson, Capt. T. Prestige, C. R. D. Pritchett and G. E. B. Pritchett, with A. B. Pescatore and E. Jacob as managing directors.

NEW COMPANIES, &c.

NEW COMPANIES.

COSMOS LAMP WORKS (LTD.) (148,045)—Private company. Reg. July 23, capital £50,000 in £1 shares, to acquire (by permission of Board of Trade) the undertaking of the Brimsdown Lamp Works, Ltd., the books and documents of which are liable to inspection under the Trading with the Enemy Act), and to carry on the business of manufacturers of and dealers in electrical lamps, fittings and appliances, &c. The articles of association contain provisions relating to British control. First directors are N. B. Dickson, P. A. Lang, W. W. Blunt, G. Layton and J. H. Tearle. Reg. office: Westinghouse Building, Norfolk-street, W.C. 2.

ENTERPRISE MANUFACTURING CO. (LTD.) (148,059).—Private company. Reg. July 24, capital £5,000 in £1 shares (2,500 pref.). Electrical merchants, suppliers on sale or hire of electric lamps and fittings, &c. Agreement with C. H. Roberts and H. Ashdown. First directors are:—C. H. Roberts and H. Ashdown. Reg. office: Gun-street Electrical Works, Bishopsgate, E. 1.

KORTING BROS. (1917) (LTD) (148,041).—Private company, reg. July 21, capital £15,000 in £1 shares, founders, electrical, mechanical, gas, heating and ventilating engineers, &c. First directors are:—F. A. Robinson, E. H. Beckett and O. Lindermann. Reg. office: 53, Victoria-street, W.

MEREDITH & CO. (LTD.) (148,074).—Private company. Reg. July 25, capital £4,000 in £1 shares, to take over the business of motor and cycle accessories manufacturers and patentees, tool-makers, stampers and piercers, &c., carried on by Meredith & Co., and the business of metal label manufacturers, &c., carried on as the Birmingham Label & Stamping Co. First directors are:—John E. Meredith, Ada A. Meredith, E. E. S. Meredith, H. J. P. Meredith and Beatrice A. Meredith. Reg. office: Dynamo Works, Woodcock-street, Birmingham.

PIGGOTT ELECTRICAL CO. (LTD.) (148,132).—Private company, reg. Aug. 1, capital £5,000 in £1 shares, to take over the business of the Piggott Electrical Co., the Piggott Conduits & Cable Co., and the Piggott Electrical Lift Co., carried on by Geo. and Sarah Piggott. Permanent governing director: Geo. E. Piggott. Reg. office: 24, New Bridge-street, E.C.

RANSOMES (TIPTON) (LTD.) (148,120).—Private company, reg. July 31, capital £50,000 in £1 shares, civil, mechanical, electrical, chemical, hydraulic, pneumatic, aerial, tramway, consulting and general engineers, manufacturers of and dealers in motor cars, &c. Agreement with (1) J. M. Ver Mohr and (2) with A. E. White. First directors are:—J. M. Ver Mohr, H. G. Blackmore and J. E. Hobbs; J. M. Ver Mohr may retain office while holding 500 ordinary shares.

THOMAS C. KEAY (LTD.) (9,899)—Private company. Reg. July 20, capital £20,000 in 10,000 preference shares and 10,000 ordinary shares of £1 each, to take over the business of engineers, mill furnishers, &c., of Thomas C. Keay. Agreement with Thomas C. Keay and the company. First directors are T. C. Keay and W. F. Keay. Reg. office: 15, Baltic-street, Dundee.

VOLTALITE (LTD.) (148,069).—Private company. Reg. July 24, capital £3,000 in £1 shares, manufacturers of and dealers in self-generating electric cycle lamps and other electric cycle or engineering appliances, &c. First directors are:—H. O. Farrell and A. Lowe. Reg. office: 91, Beverley-street, Moss Side, Manchester.

COMPANY REGISTERED OUTSIDE THE U.K.

ETABLISSEMENTS DE DION BOUTON SOCIETE ANONYME. (1596F).—Particulars filed July 28, 1917. Reg. in France Jan. 28, 1908, to exploit and develop the factories and undertakings founded by De Dion Bouton & Cie., and carry on the business of manufacturers of and dealers in motors, mechanical implements, motor chassis, &c., and also to carry out transactions in metallurgy and various branches of the electrical industry. British address: 10, Great Marlborough-street, W. Messrs. Kenneth Brown, Baker & Baker, of Lennox House, Norfolk-street, W.C. 2, are authorised to accept service.

CITY NOTES.

ALDERSHOT GAS, WATER & DISTRICT LIGHTING CO.—The directors' report for the half year ended June 30 states that the electricity supply department continues to expand, the increase in the consumption of electric current for the half year being 153¾ per cent.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—An interim dividend at rate of 5 per cent. per annum has been declared for the half-year ended June 30 on the ordinary shares.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units sold to consumers during the five weeks ended June 1, 1917, amounted to 2,700,256, compared with 2,482,756 units in the corresponding five weeks of 1916.

CONSOLIDATED ELECTRICAL CO. (LTD.)—The available sum for the year ended March 31, after providing for general charges and including £3,159 brought forward, is £6,716. A dividend of 2½ per cent. has been declared, leaving £3,066 to be carried forward.

HONGKONG TRAMWAY CO. (LTD.)—An interim dividend of 9 per cent. (less tax) has been declared.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—The directors have declared an interim dividend of 3 per cent. on the ordinary shares for the half year ended June 30.

LONDON & SUBURBAN TRACTION CO. (LTD.)—The directors do not propose to pay an interim dividend on the preference shares for the half-year ended June 30.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY (LTD.)—An interim dividend of 5 per cent. (6d. per share) has been declared on the ordinary shares.

MONTREAL TRAMWAYS CO. (LTD.)—A further dividend of 2½ per cent. making 10 per cent. for the year ended June 30 has been declared.

NATIONAL BOILER & GENERAL INSURANCE CO (LTD)—An interim dividend of 12s. per share has been declared.

NATIONAL GAS ENGINE CO. (LTD.)—The directors have declared an interim dividend at rate of 7½ per cent. per annum (less tax) on the ordinary shares for the six months ended June 30.

VICKERS (LTD.)—The directors announce interim dividends for half-year ended June 30 as follows:—2½ per cent. (less tax) on the preferred stock and the preference shares, and 1s. per share (tax free) on the ordinary shares.

WASTE HEAT & GAS ELECTRICAL GENERATING STATIONS (LTD.)—An interim dividend of 2½ per cent. (less tax) on the issued share capital has been declared in respect of the half year ended 31st ult.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.)—The directors recommend an interim dividend at rate of 8 per cent. per annum (less tax) for the half-year ended June 30.

Digitized by Google

THE ROUND TABLE.

By "KVA."

Event of the Week.—The Transatlantic Wireless service, "Eastbound and Westbound," is discontinued until further notice.

* * * *

From an advertisement :—

Wanted, Competent Electrical Engineer, able to take charge of the installation of generators, switchboard and all electrical appliances in large electric power station. Energetic men only need apply. Salary, £5.

The energy is evidently to be derived from the switchboard and not from the "salary"!

* * * *

Electrical Terms Illustrated according to *Glover's Almanac*.
"A Pear Switch!"

* * * *

A correspondent calls my attention to the following in the "Daily News" :—

In view of the increasing need of by-products obtained from the carbonisation of coal at gas-works, the Minister of Munitions urges the public to use gas rather than any other means of obtaining light, heat or power.

If this is the way "Winnie" is starting his new career he will have to have a little enlightenment! He has quite overlooked the scarcity and high price of matches. Perhaps he would like to see powder factories using gas in the national interest; if he insists then certainly there'll be no lack of by-products!

* * * *

The "Electrical Review and Western Electrician" reports that an electrically charged rod for driving cattle is being introduced on some of the ranches of Western Texas. It is said to be specially suited for making rebellious cattle enter dipping vats, branding pens and other enclosures into which it is ordinarily a difficult matter to drive them. The rod is supplied by four dry batteries and coil, and is fitted with a button by which the current may be turned on when it is desired to apply it to an animal. Here is an idea which Mr. Britton or Mr. Kerr might adapt in connection with their electro-culture experiments. Why not dispense with the batteries and attach the cow ticklers to the mains.

THIRTY-SEVEN YEARS AGO.

[From The Electrician, August 7, 1880.]

The Atlantic Cable Companies.—We believe that negotiations between the rival companies have been successful in bringing about an amicable working arrangement.

Cool, but not Considerate.—A fortnightly contemporary still continues to fill its columns with matter extracted from The Electrician, but it forgets to acknowledge the source of its information.

Electric Railways.—The firm of Siemens & Halske has laid before the municipality of Berlin a new project for the establishment of electric railways in that town. They propose that all the railway termini in Berlin, and the stations of the metropolitan railway, should be placed in communication by the electrical railway. It is proposed also that a line should be constructed from the Skalitzerstrasse to the terminus of the metropolitan railway and to the Zoological gardens, passing by the station of Potsdam and Anhalt, and that a second line should be laid between the Brandeburg gate and Charlottenburg.

ELECTRIC VEHICLE'S LONG RUN.

That the electric automobile is admirably adapted for long runs has been proved by an inter-city run made from Atlantic City to New York City on June 19th, under the auspices of the New York Electric Vehicle Association.

The test was conducted purely to demonstrate the electric vehicle's speed and endurance, and to show that it is not only the ideal city car, but it is also a road car, a capable and hardy machine. Its performance compared creditably with the best performances of the petrol-driven cars over the same route. The run was made in a new model Baker R. & L. stock car (model Bx 7), the feature of which is that it is lower hung, offering consequently less wind resistance and increased battery space. The car left New York on Monday morning, June 18th, driven by Mr. Edward Smith, of the Baker R. & L. Co., with Mr. Waldo W. Sellew a passenger, as official observer for the New York Electric Vehicle Association. The trip to Atlantic City, which was chiefly to investigate road conditions, was made in the comfortable time of less than eight hours no special effort being made to make a record in speed, the plan being to make the speed effort on the return trip. The run from Atlantic City to New York was made in five hours and 58 minutes actual running time, with a boost of one hour and a half at Lakewood. The mileage covered by the car from Atlantic City to New York was 123¼ miles, making the average running time 20¼ miles per hour. The entire distance was covered with the car running at fifth and sixth speed. One of the startling features brought out by the trip was that the current used to drive the car from Atlantic City to New York cost less than half the price of enough petrol to drive a gas car over the same route. 283 ampere-hours were used in the run, an average of 2·29 per mile, the cost of which at a five cent kilowatt-hour rate, which is the maximum charging rate in New York City, would make the cost $1.55.

PARLIAMETARY INTELLIGENCE.

Royal Assent.—On Aug. 2 the Royal Assent was read to the following Acts of Parliament: Companies (Particulars as to Directors) Act, Electric Lighting Orders Confirmation Act, Ashton-under-Lyne Corporation Act, Sheffield Corporation Act.

Clerical Staff of Electric Light and Gas Companies.—In the House of Commons last week Sir H. Dalziel asked the President of the Board of Trade why so many clerks of military age in the offices of electric lighting and gas companies were allowed to be badged and classified by the companies as skilled workers.

In reply, Mr. Kellaway said all war service badge certificates were withdrawn on May 7 last. The protection from recruitment of the clerical staff of electric lighting and gas companies was dealt with in some cases under the Schedule of Protected Occupations; in other cases by local tribunals. The schedule provided that in electrical and gas undertakings certified by the Ministry of Munitions under the Munitions of War Act, technical staff and clerks possessing high technical knowledge should be protected from the age of 25 upwards, and other clerical staff from the age of 32 or below that age if they were not fit for general military service (category A). He was not aware that any category A clerks below those age limits were being protected in undertakings dealt with under the schedule.

L.P.S. INSULATING SLEEVING.
BRITISH MADE & ALWAYS IN STOCK.
A most efficient insulation for all internal connections in electrical apparatus.
An excellent substitute for perishable rubber tubing.
Very flexible, water and oil proof; and of high dialectric strength.
Write for Particulars:—
THE L.P.S. ELECTRICAL COMPANY, 14, Howick Place, Westminster, S.W.

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

Digitized by Google

SIEMENS

IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars

Distribution Boards

Main Switchboards

Write for particulars to —

SIEMENS BROTHERS DYNAMO WORKS LIMITED
Head Office: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: Western 6349. Telegrams: "Siembralos, Kens, London."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: City 5350 Telegrams: "Siemotor, Cent., London."
HOME BRANCH ADDRESSES:
Birmingham—Central Ho., New St. | Manchester—196, Deansgate.
Bristol—30, Bridge Street. | Newcastle—64-68, Collingwood Bldgs.
Cardiff—89, St. Mary Street. | Sheffield—22, High St.
Glasgow—66, Waterloo Street. | Southampton—46, High Street.
Branches in Principal Towns Abroad.

FOR

High and Low Tension SWITCHGEAR

THE

NEW SWITCHGEAR CONSTRUCTION CO., Ltd.

SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

Manufacturers of

PHOSPHOR BRONZE,

GUN METAL, MANGANESE BRONZE

TRADE MARK.

Brass & Copper Tubes and Sheets.

BRASS CONDENSER TUBES FOR STANDARD SHIPS, &c.

CHARLES CLIFFORD & SON, LTD.,

BIRMINGHAM.

TASMANIAN HYDRO-ELECTRIC WORKS.

The second annual report (for 1915-16) of the Government electrical department has been issued.

The chief engineer and manager (Mr. J. H. Butters) states that the construction works in connection with the first stage of the hydro-electric scheme have been so far completed as to enable operations to be commenced. The pipe-line was completed and made thoroughly watertight. The construction work in connection with the power-station equipment proceeded very slowly and owing to shipping difficulties the last item of the equipment arrived in June, the result being that the plant was only ready for continuous operation within a few days of the end of the year. The transmission line was completed with the exception of the three special towers at Bridgewater. In all, 560 towers were erected and the complete insulator and cable equipment affixed. On the completion of the construction, and after the preliminary tests, the line was put into service in the month of May. It was possible to bring the line up to full pressure within eight hours of it being connected to the power end, and that not a single defect showed itself in the course of the operation. In view of the fact that the opening of the scheme had been planned for the first week in May, and that the necessary material for the Bridgewater crossing could not possibly arrive from England for several months after that date, he was forced to erect temporary structures to carry the cable across the Bridgewater Bridge. Whilst it had been possible to complete the step-down station at New Town to enable operations to be commenced, a few small items remain uncompleted. The remaining items were on the water and would arrive in a few weeks. Difficulty experienced in obtaining an efficient water-supply for cooling the transformers had been successfully overcome. The New Town and Hobart sub-stations had been constructed and the necessary machinery had, with the exception of a few small items, been erected. Unfortunately, those small items prevented the sub-stations being put into operation during the year. The necessary material to complete the equipments, as well as the transformer equipment for the Macquarie-street sub station, had also arrived and had been erected. On May 6, 1916, the turbines were started up by the Governor-General, and the switching through of the power to Hobart was also performed. The only items of equipment remaining to be erected at the end of the financial year were as follows:—The special towers and crossing at Bridgewater; portion of the transmission-line ground wire; the special high-tension telephones at the two ends of the transmission line, together with portable telephone sets for operation purposes; the water cooling plant for the New Town step-down station, and a few sundries in connection with the local sub-station.

During the period under review the Bill to purchase the electrical undertaking of the Hobart Gas Co. received the Royal Assent and on Dec. 7, 1915, the actual transfer took place, when the Department reduced the scale of charges, viz., from 6d. to 5d. per unit for lighting and from 2d. to 1d. for domestic power; whilst a modification was effected in the motor-power charges. With active publicity and canvassing the business rapidly increased and the returns for the period under review are more than satisfactory. The number of consumers connected on Oct. 1, 1915, was 1,474; whilst on June 30, 1916, it was 1,999 an increase of 35 per cent. in a period of nine months. Their hopes that the hydro-electric scheme would have been connected to the system before the end of the year were not realised, and the steam plant had to be operated for the full period. In June an accident occurred to one of the steam boilers, but the hydro-electric equipment was sufficiently advanced to enable a temporary supply to be obtained from the Great Lake and immediately the breakdown occurred steps were taken to bring the lake plant into operation by connecting it to a portion of the city area. That enabled them to meet the emergency, pending the repairs to the boiler. The cost of repairs, services, maintenance, &c., increased considerably owing to the war, whilst the fuel costs had increased, due to increases in the price of coal, and the minimum wage being raised 6d. per day. The principal event of the year was the entering into a power contract with the Amalgamated Zinc (De Bavay's) Ltd., of Broken Hill and Melbourne, for a supply of 4,000 H.P. in the first instance, and an additional supply of 26,000 H.P. on notice. The power is required for the purpose of manufacturing metallic zinc by electrolytic methods, from the concentrates to be obtained from the company's mainland works. A commencement has been made by the company with the erection of its works at Risdon. The contract is destined to be the precursor of a revolution in the industrial life of the State, and it would be the forerunner of many large industrial enterprises in Tasmania, which will require a large amount of hydro-electric power and bring increased prosperity.

In view of the fact that it has been so extremely difficult to get supplies of electric fittings, and even when obtained the prices are so high, both to the department and to the contractors, as to be almost prohibitive, and that the cost of reticulation material has been so high as to make it commercially uneconomical to take business which at normal times would be remunerative, the financial results of the first period of working more than justified the acquisition of the retail portion of the department's business at Hobart. Designs are being prepared for extensions to the scheme to North-West Bay and to Risdon, and also of extensions to the headworks, to enable that additional 7,500 H.P. to be dealt with.

Mr. Butters states that from conservative information available it had been established that 70,000 H.P. could be developed from the Great Lake scheme after the Ouse diversion had been effected. The policy of the department should be not to load the scheme up to its full capacity until a number of years' readings had been obtained of actual discharge

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

Patent No. 8722/17.

No! This is not a further example of frightfulness; but merely an illustration of how our new Self Aligning Contacts adapt themselves to extreme conditions.

In spite of the unusual aberration of the clips, conductivity is not impaired.

Much of the trouble experienced with fuse contacts is due to imperfect alignment, resulting in high resistance, and consequent heating, followed by permanent deterioration of the clips, all of which are obviated by our new device.

BRITISH INSULATED & HELSBY CABLES.

Cablemakers and Electrical Engineers, LTD.,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED **SECOND HAND**

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.

Phone: Victoria 4026. Grams: Viamaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh.

See our Illustrated Advt. last week.

Digitized by Google

through the Great Lake sluiceways, but rather to recommend the development of power in one of the other schemes, which, in its turn, would be loaded up to, approximately, three-fourths of its calculated capacity, and so on. That process would conduce to the most satisfactory working of their most important asset. The contracts already secured would load up the southern line, and further large contracts would necessitate the building of additional transmission-lines in some direction or other. In the general development of the State the department would use its utmost endeavours to induce manufacturers to establish in divergent centres, such as Launceston and the West Coast, thus spreading the benefits of hydro-electricity throughout the State; but it must be borne in mind that the deciding factor in settling the site would be the manufacturers themselves. It had frequently been stated that the advent of hydro-electric power would be the means of inducing the influx of manufacturing industries to the State, and it had been suggested that power could be sold with greater benefit to small industries than to large metallurgical industries. The position, however, was quite the contrary. The industries which would be likely to establish themselves in Tasmania were ones whose electric power costs represented a large proportion of their total annual costs, and which required a very large amount of electrical energy, which made the power costs the most important factor of their operations. The only industries of such a nature were electro-chemical and electro-metallurgical industries, all of which required very large blocks of power. That might be emphasised when it was noted that the whole of the requirements of the City of Hobart and its suburbs amounted at present to less than 2,000 H.P., whilst one contract alone for an electro-metallurgical industry would require 30,000 H.P. Those electro-chemical and metallurgical industries would be the first fruits of the hydro-electric investment and they, in their turn, would induce a large growth in existing secondary industries, and also the establishment of additional secondary industries, &c. These secondary industries, however, would neither require nor expect electric energy at prices very much below what could be obtained on the mainland; in fact, it might be stated that there were very few such secondary industries whose principal market was outside Tasmania which would come there even if power were supplied free, as the extra shipping and marketing charges would more than outweigh the concession. The prosperity of the State, therefore, clearly depended upon their being able to induce large primary industries to establish themselves there, and that being achieved consequent results would follow.

The total capital expended to date is £465,441 and the revenue of the hydro-electric department for nine months to June 30, 1916, was £14,103. The costs of generation, distribution, public lighting, management expenses, &c., amounted to £10,821, and after taking into account the value of current sold under contracts not maturing until the first quarter of 1916-17 (£1,600) the total profit was £4,882. Interest required £4,050, leaving £832 available for depreciation. The retail supply records of the Hobart district show that there were 1,999 consumers (against 1,305 in 1915) with the equivalent of 59,420 30-watt lamps connected (against 49,003); 1,152,387 units were sold (against 964,000) and the gross revenue was £17,864 (£16,686), the working costs being £12,898 (£10,698).

ELECTRIC SERVICE FOR U.S.A. ARMY.

Judging by reports in a recent issue of the "Electrical World," the electric supply companies of America are making great efforts to give an efficient electrical service to the new army cantonments.

The Des Moines (Ia.) Electric Co. reports having secured instruction from the War Department to proceed with the work necessary to furnish electricity for the cantonment camp to be located in the city. The camp grounds are about 8 miles from the company's nearest high-voltage circuit. The company has begun the construction of an 8-mile transmission line, energy to be transmitted at 13,200 volts and delivered to the camp grounds and to the Government at this voltage. The Government is to supply and has ordered three 350-kw. transformers, stepping down to 2,300 volts, which will be used as the distributing voltage throughout the camp grounds. The estimated lighting, peak load, will be about 700 kw., in addition to which about 200 H.P. or 300 H.P. in motors will be required, chiefly for pumping the water supply, sewage disposal and refrigeration purposes. Contracts for the general construction of the cantonment camp have been awarded to Messrs. Charles Weitz & Sons, who represent the allied contractors of the city.

The Virginia Railway & Power Co. (Petersburg, Va.) proposes to supply the local cantonment camp with a three-phase, 60-cycle, 13,200-volt service. To furnish this service it will be necessary to re-build one of the company's 4,000-volt lines, bringing it up to standard for 13,200 volts, a distance of 3 miles, and make an extension of the line 2 miles to reach the centre of the camp. The source of supply is from the water-power generating station just west of Petersburg in Dinwiddie County, Va., also a 33,000-volt transmission line connecting Petersburg and Richmond power houses together. The company proposes to install three 1,000-k.v.a. 33,000-volt to 13,200-volt transformers to supply service to the camp. The Government is asking for about 1,350 kw., on account of lack of material.

The Union Light & Power Co. (Junction City, Kan.) has furnished electrical energy to Fort Riley for several years for interior and exterior lighting, also for power. It has installed a duplicate 2,300-volt, three-phase, 60-cycle transmission line from its power house in Junction City to the reservation, about 4 miles away. This line has a rating of approximately 600 kw.; also, it has a 33,000-volt transmission line along the railway, which connects Junction City and Fort Riley, thence along right-of-way of the Manhattan inter-urban railway, connecting Fort Riley and Manhattan to a point near Manhattan thence several miles north of Manhattan connecting with the Rockyford hydro-electric plant. One-half of the cantonment will be supplied from the Union Co.'s 2,300-volt line and the other half from the 33,000-volt transmission line. The total connections will be equivalent to about 1,000 kw. or 1,200 kw. The United States Government owns and maintains all the lines and equipment, with the exception of the meters, which the Union Light & Power Co. will be expected to install. All new construction work in the way of distribution system will be carried out through the contractors by the Government, it being necessary only for the generating

THE GREAT CENTRAL RAILWAY passes from the Metropolis Northwards through the centre of industrial England, throwing out its branches Eastward and Westward to the Coast.

¶ Its Lines run over the Great Midland Coalfield (of over 4,000 square miles area) which extends into the Counties of York, Nottingham, Derby and Lincoln. This Coalfield is the largest in the British Isles, and is estimated to contain not less than forty-nine thousand million (49,000,000,000) tons of coal.

¶ The important Coalfields of Lancashire and North Wales are also traversed by the Company's lines.

¶ There is thus afforded an easily accessible source of fuel supply.

¶ The New Eastern Port of Immingham should particularly attract traders, as its modern equipment and accessibility at any time of the day or night, irrespective of tides, are important time and labour saving factors.

¶ Adjoining the Great Central Railroad at various parts of the system are situated Valuable Sites for Works, where, by the introduction of siding accommodation, goods can pass right into and directly out of the works, which greatly assists the Manufacturer to attain his desired position in the World's Markets.

¶ For information please communicate with the G.C.R. Publicity Office, 216, Marylebone Road, London, N.W.

¶ Owners and Agents of LAND and BUILDINGS for SALE or TO BE LET near the Great Central Railway are requested to send particulars to the G.C. Estate Office, 12, Paton Street, Piccadilly, Manchester.

SAM FAY, General Manager.

ADMIRABLE SITES FOR NEW WORKS, FACTORIES, &c.

BUYERS of every description of Scrap Metals, viz: COPPER, BRASS, GUN METAL, BRONZE, ALUMINIUM, LEAD, ZINC, &c. All descriptions of RESIDUES.

ESTABLISHED 1867.

METALS. J. B. GARNHAM & SONS, 132, UPPER THAMES ST., LONDON, E.C.

Telegraphic Address: "Garnham Cannon London." Cables .. .. .. "Garnham London." Telephone .. .. Bank 5726. ABC Code, 4th and 5th Editions and Lieber's Code.

ENQUIRIES SOLICITED.

SELLERS of COPPER and BRASS SHEETS. PLATES, TUBES, RODS, WIRE, &c., &c.

Digitized by Google

FERRY **FERROZOID**

CONSTANTAN **CHRONIC**

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:

HENRY WIGGIN & CO., Ltd.
George Street, Birmingham.

TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."

AGENT:

LIONEL ROBINSON,
3, Staple Inn, London, W.C.

TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

JOSEPH SANKEY & SONS, LTD. ALBERT ST. WORKS, BILSTON, STAFFS.

Telegrams: "SANKEY, BILSTON." Code: LIEBER'S. Telephone: 115 BILSTON.

Manufacturers of SHEETS and STAMPINGS of all descriptions for Dynamos, Motors, Transformers, &c., and for Electrical Work generally.

Registered Trade Marks

"STALLOY."
"LOHYS EXTRA."
"LOHYS."
"HYPERBIL."
"INSULINE."

STALLOY Telephone Receiver Diaphragms.

MAKERS OF

STALLOY

(PATENT)

LOW HYSTERESIS. LOW EDDIES. HIGH RESISTANCE.

Representative - ROBERT JENKINS, 57, Bishopsgate, LONDON, E.C.

Telegrams: "PERMEABLE, LONDON." Telephone: 8205 CENTRAL.

The CONCORDIA ELECTRIC WIRE Co., Ltd.

Telephone— 1984 & 5360 Hampstead.

THE WIRE WORKS,
CROWN PARADE, CRICKLEWOOD LANE, LONDON, N.W.

Telegrams— "Pellenite, Cricklo, London."

WIRES

FOR COOKING AND HEATING APPARATUS.

"CONCORDIN" (Nickel Chrome), Round and Flat, for Units.
"ASBESTIN" Insulated Wires, Heat Resisting, for Internal Connections.
SPECIAL HEAVY FLEXIBLES, Multiway, for Leads, with or without Earth Wires.
PURE NICKEL WIRE OR RIBBON, Bare or Asbestos Covered.

CATALOGUES AND SAMPLES ON APPLICATION.

Digitized by Google

THEIR lasting qualities, and the fact that they retain to the end their initial brilliance, make them equally suitable for Street Lighting, Factory Lighting, Train Lighting, the Hotel or the Home.

For Street Lighting

POPE

ELASTA

(British Made)

WIRE LAMPS

Strong Brilliant Economical.

Advt. of Pope's Electric Lamp Co., Ltd., Hythe Road, Willesden, N.W. 10.

EVERY INSTALLATION ENGINEER

Should join his Trade Protection Organisation,

THE ELECTRICAL CONTRACTORS' ASSOCIATION

(Incorporated)

Inquiries cordially invited by the Secretary—

L. G. TATE, 20, Bucklersbury, LONDON, E.C.

GENUINE

M & M VULCANISED FIBRE.

MOSSES & MITCHELL, 122 & 124 GOLDEN LANE, LONDON, E.C.

INSULATION BEADS

HOLDER-HARRIDEN

company to furnish step-down transformers for 33,000 volts. The cantonment structures will be two stories high, and each building will house approximately 250 men. It will be necessary to provide new buildings to take proper care of 70,000 men.

The Louisville Gas & Electric Co. is furnishing temporary service for construction, and is preparing to extend two high-tension feeders to the site of the camp. One of these extensions will be about 2½ miles long and the other about 1½ miles.

ELECTRIC SMELTING OF IRON ORES.

The "Iron & Coal Trades Review" gives an abstract of a memorandum by Mr. J. A. Leffler (taken from a recent issue of the "Jern-Kontorets Annalen"), in which is investigated a proposal put forward in March, 1916, by the Committee appointed by the Administration of the Association of Swedish Technologists to instal electric furnaces in the North of Sweden for smelting pig-iron. The Committee recommended the installation of four-plants with six furnaces in all to produce 65,000 to 70,000 tons of pig-iron per annum, using from 110,000 to 120,000 tons of ore and about 25,000 tons of charcoal.

In his investigation the author makes the assumption that to smelt one metric ton of pig iron from the Luleä or Gellivare ores, 1·6 ton of ore and 0·4 ton of charcoal are required, and 0·272 kw. year of electric current. As explained, such a low consumption of current can only be attained by installing four furnaces of a total of 9,000 kw., one as a stand by and three working continuously as this would make it possible to utilise 92 per cent. of the purchased power, while with one furnace only the useful percentage would only be 83 per cent., which is the average result attained during the three years' working in 1913-1915 at the "Jern-Kontoret's" experimental plant at Trollhättan. The capital outlay at Luleä would be about £85,833 for the plant itself and about £20,833 for dwellings for officials and workmen, while for Gellivare the corresponding figures would be £94,444 and £23,333 respectively. The assumed output at each place would be 30,000 metric tons per annum. For the cost of production of one metric ton of electric pig iron the author submits the following estimates :—

	At Gellivare.	At Luleä.
	£ s. d.	£ s. d.
1·6 metric ton of ore*	0 18 3	1 1 7
Limestone	0 0 8	0 0 5
0·4 metric ton of charcoal	1 0 10	0 18 1
0·272 kw. year	0 14 5	1 0 4
Electrodes	0 1 10	0 1 8
Repairs and upkeep	0 3 8	0 3 4
Wages	0 6 6	0 5 5
Management and sundries	0 2 3	0 1 11
Royalty	0 1 5	0 1 5
Sinking fund	0 3 7	0 3 3
Rents	0 5 9	0 5 5
Carriage to Luleä	0 4 10	—
Total cost	4 4 0	4 2 10

* 50 per cent. of ore and 50 per cent. briquettes.

The freight from Luleä to Gävle and unloading the iron into railway trucks would cost another 4 kr., say 4s. 6d. per ton. It will thus be seen that the northern pigs would cost at Gävle about £4. 8s. per ton, and therefore could not compete with the pig iron obtainable there from the blast furnaces at 65 kr. to 70 kr. (about 72s to 77s. 6d.) per ton for basic, and at 70 kr. to 75 kr. (about 77s. 6d. to 83s.) per ton for acid open hearth pig iron.

FIXATION OF NITROGEN IN NEW ZEALAND.

Mr. J. Orchiston, chief electrical engineer to the Post and Telegraph Department, has been asked to report fully on his proposal to establish works in New Zealand for producing nitrates from the air.

Mr. Orchiston thinks that electricity can be generated as cheaply as in Norway or Italy by utilising any of the large falls in the south-western sounds of New Zealand. One of the simplest propositions is that presented in utilising the Bowen Falls, in the Milford Sound. It is estimated that, after making full allowances for all contingencies, energy could be produced for one-fiftieth part of a penny per unit, or 1 H.P. for about £1 per annum. For the fixation of nitrogen from the air, Mr. Orchiston doubts if there is a more favoured spot in the world, for at the Bowen Falls there is deep water close to the side of the sound, and perfect shelter in all kinds of weather.

BASTIAN METERS FOR DIRECT CURRENT ONLY.

Made in ENGLAND with

BRITISH CAPITAL and BRITISH LABOUR.

THE BASTIAN METER COMPANY, LTD., BARTHOLOMEW WORKS, KENTISH TOWN, N.W.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,048. [Vol. LXXIX. No. 20] FRIDAY, AUGUST 17, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 767
Arrangements for the Week 769
The Electrification of the Riksgrans Railway. Illustrated 770
An Alternating Current Bridge Method of Comparing Two Fixed Inductances at Commercial Frequencies. By T. Parnell, M.A. Illustrated 771
Notes on the Design of Electromagnetic Machines. By Stanley Parker Smith, D.Sc. Illustrated.—*Continued* 773
Conversion of Light into Electrical Energy. By Theodore W. Case 776
Chemical Composition Versus Electrical Conductivity. By C. G. Fink 777
Industrial Democracy: With Particular Reference to the Relations Between Capital and Labour. By George Weston 778
SOME AMERICAN VIEWS OF CAPITAL AND LABOUR 780
The Production and Distribution of Power and its Influence on the Development of Irish Industry. By J. F. Crowley, D.Sc., B.A. Illustrated 783
Halifax Corporation Electricity Department. Illustrated 784
CORRESPONDENCE 785
Characteristics of Small Dry Cells. By C. F. Burgess 786
Registration of Directors 787
PARLIAMENTARY INTELLIGENCE 788
LEGAL INTELLIGENCE 788
Patent Record 788
Volunteer Notices 788
COMMERCIAL AND INDUSTRIAL SECTION 791
Electricity Supply 792
Tenders Invited and Accepted 794
Financial Matters 795

NOTES.

National Education.

MR. FISHER'S proposals in regard to education on Friday last show that progress has undoubtedly been made since the outbreak of war towards a more enlightened outlook on this subject. True, the proposals do not carry us as far as many people would desire; probably they fall short of what Mr. FISHER himself would like to accomplish, but at least in the present circumstances they give hope of better things. Among other proposals it is suggested that the employment of child-labour below the age of 12 should be prohibited, that "half-time" and exemptions below the age of 14 should cease, that local education authorities should have the option of continuing education to the age of 15, and that compulsory continuation schools should be introduced up to the age of 18 for those who have not had a full-time education up to 16 years. It is these measures for continuity of education that will generally be regarded as most important. The great defect in existing education has been the sudden stoppage of training after children leave the elementary school. Children enter industrial life and promptly abandon the habits of reading and learning that have been forming during school life. They lose the stimulus to study at the very time when their developing minds are most in need of training, and this has bad results both in industry and in national life. Mr. FISHER'S proposals should do something to bridge this gap, but the time allotted to such continuation classes, eight hours per week, hardly seems sufficient when one considers that a portion of this time is to be rightly devoted to physical training, swimming, &c. Still, the mere fact of children continuing to study and to develop interests outside their daily work means something. The great thing at this period of life is to foster the desire for knowledge and the spirit of inquiry. If this can be done we shall have fewer workmen who are mere machines incapable of rising from the rank and file of labour, and we also hope that better educational facilities will lead to a wider outlook on industrial problems and do something to mitigate the constant strife between capital and labour which has been such a disturbing phenomenon in recent years.

Power Direct from Sunlight.

THE obtaining of power from sunlight has always been attractive and has led to a certain amount of speculation. The subject is raised once more by Dr. J. F. CROWLEY in a Paper read before the Irish Technical Instruction Congress, and in a different form by Mr. T. W. CASE. Taking the solar constant as 1·93 calories per sq. cm. per minute, it follows that the power received per acre of the earth's surface on a clear day, assuming the rays to be normal, is about 5,000 H.P. Very little has been done so far to make any use of this energy, owing to the obvious difficulties which it presents. A small solar plant has been worked in the Sahara, where undoubtedly the conditions are about as good as can be expected, but in countries where the sunlight is by no means so uniform, greater difficulties would be experienced. There is the disadvantage that the source of heat is only available during the bright hours of daylight, and the still greater objection that what may be described as the density of the received energy is so low. An acre is a very large area for the generation of 5,000 H.P., particularly when the power can only be obtained intermittently. The extent of the area would not be important if land were the only material involved, but for the utilisation of the energy it would be necessary to cover the land appropriated to the purpose with comparatively expensive plant. It is doubtful, therefore, whether very much can be expected from the utilisation of solar energy direct for the production of steam.

An Electrolytic Method.

ANOTHER method of looking at the problem is that which has been investigated by Mr. CASE and on which he has carried out experiments in Florida. In this instance, voltaic cells have been used in which the plates are oxidised copper coupled with polished copper. The difficulty with any device of this kind is that the specific output so far obtained is very low. No doubt some consolation may be obtained by comparing the efficiency of such a cell with the efficiency of sunlight in the growing of crops. The efficiency of solar energy used for agricultural purposes depends very much on the assumptions that are made and, therefore, the figure so obtained is a vague sort of result and of doubtful value. Nevertheless, on certain assumptions, it may be shown that the efficiency of an electrolytic cell is of the same order as the agricultural figure. It must be borne in mind, however, that we are not concerned so much with the total electrical energy produced as with energy that is available in the external circuit. Moreover, in considering matters from the commercial standpoint, any cell in which the E.M.F. stands at the low figure of 0·1 volt is at a very great disadvantage, more particularly if the current available from such a cell is also low. It would, of

Digitized by Google

course, be rash to say that such cells are commercially impracticable, but so far it must be admitted that they are by no means promising.

Testing Flash-Light Cells.

DURING the last few years, due largely, no doubt, to the efficiency of the small tungsten lamp, as compared with the carbon lamp, flash-light cells, which are simply small dry cells, have come very largely into use. In fact the manufacturers' yearly output of these small cells is probably much greater than that of the larger cells used for bells and similar work. Nevertheless the smaller cells have received much less attention from the point of view of testing. From this aspect, a Paper read by Mr. C. F. BURGESS before the American Electrochemical Society is of considerable interest, more particularly as it embodies the results of tests of about 4,000 cells. The method adopted is to discharge a cell through a resistance of 4 ohms, this resistance being approximately equal to the resistance of the lamp per cell of battery. The discharge is taken to a limit of 0·5 volt, and is carried on intermittently for periods of eight hours per day. Although opinions expressed by so well-known an authority as Mr. BURGESS certainly carry a good deal of weight, we must confess that we do not like the basis of his method. For larger cells various tests have been adopted, that most commonly used being the continuous discharge through a 10 ohm resistance. Flash-light cells being so very much smaller, the natural tendency would be to discharge them through a larger resistance. On the other hand, considering that such cells are used under conditions that are really much more severe, it is not unreasonable to attempt a test which need not be very lengthy and which complies more with the actual conditions of use. This, no doubt, Mr. BURGESS attempts by using a much smaller resistance, but it appears to us that an intermittent test need not be unduly long, and would give much more satisfactory results. The chief objection, however, to the test as adopted appears to us that it includes a lengthy break after running for eight hours. Since a good many cells do not survive the first eight hours, this gives a great advantage to any cell whose life exceeds this period owing to the long interval which it has for depolarisation. We agree with Mr. C. A. GILLINGHAM, who, in the discussion, gave some interesting figures, that a discharge of five minutes per day should give considerably more valuable results. This method, however, may cause the test to become too prolonged to be convenient, and we suggest that it might be worth while to adopt a test in which a discharge takes place for five minutes every hour.

The Tribunal and the Generating Station.

WE are afraid that the Ministry of Munitions in some instances is failing to recognise the importance of the generating station and that tribunals are consequently failing to exempt men who are necessary for this particular work. For example, at Eastbourne recently an application was made to the Ministry by the Corporation to certify their electricity supply undertaking, in which case all employees would be automatically protected. This request, however, has been declined as only one-third of the total supply is required for factory purposes. It may well be that a rule of this kind is desirable, but if so we hope it is realised what such a rule may entail. Undue depletion of staff may very well result in an adequate supply being rendered impracticable. It is for this reason, no doubt, that the Electricity Committee of Stoke-on-Trent has applied to the Board of Trade for permission to cut off supplies of current if the reduction in staff renders this course necessary. It must be remembered that an electricity works generally provides a means for utilising coal and other fuel more efficiently than such fuel can be used by private persons. It follows, therefore, from the national point of view, that it is a bad policy to render the service of the supply authority unstable. We think it would be well if this point of view were impressed upon the tribunals concerned.

Linking-up in Lancashire and Cheshire.—A second report of the Committee for the Interconnection of the Lancashire and Cheshire Electricity Supply Systems has just been issued making certain recommendations. We hope to deal with this report in our next issue.

The Russian Exhibition.—At the Russian Exhibition now being held at the Central Hall, Westminster, a number of interesting maps and diagrams showing the distribution of soil, forest, mines and oil, fisheries, &c., throughout the Russian Empire are being shown. Other diagrams show the course of railways, the chief centres of distribution, &c. A visit to this exhibition will give some impression of the vastness of Russia, and the extraordinary variety of its resources. These, it is safe to say, have only been very imperfectly developed as yet, one of the greatest needs being better methods of transportation. Manufacturers are invited to inspect the exhibits and apply for any further information. There should be great opportunities for British trade with Russia after the war. At the same time the measures, coinage, customs and economic conditions in Russia require careful study. Commercial success can only be attained in this country by those who are willing to examine the local conditions and familiarise themselves with Russian methods of doing business, which include, among other things, the giving of credits for much longer periods than are customary in other European countries.

Astronomical Consequences of the Electrical Theory of Matter.—To the current issue of the "Philosophical Magazine" Sir Oliver Lodge contributes a Paper on this subject. The arguments in the Paper are summarised by the author as follows :—

1. That motion of matter through æther has a definite meaning, apart from relative motion with respect to other matter.
2. That an extra inertia due to this motion is to be expected at high speeds, in accordance with the FitzGerald-Lorentz contraction.
3. That this extra or high-speed inertia is not part of the mass, but is dependent on the æther and hence is not subject to gravity.
4. That from this reasonable hypothesis astronomical consequences follow which may be detected when cumulative.
5. That under certain specified conditions merely a small change in eccentricity is to be expected as the chief result, in certain others an apsidal progress or regress is to be expected
6. That the outstanding discrepancy in the theory of the perihelion of Mercury would be accounted for by attributing a certain value to a component of the true solar motion through the æther in the direction of the planet's aphelion path.
7. That using this value for the solar-plus-stellar drift, viz., two or three times the earth's orbital velocity, a result can be obtained for the perihelion of Mars, subject to a hypothesis about direction.
8. That by discussion of discordances in the elements of different planets an estimate may be formed of the magnitude and direction of the locomotion of the solar system in its invariable plane.

Resistance of Oils to Emulsification.—A bulletin on the above subject (No. 86) has been issued by the Bureau of Standards (Washington). When oil is used over and over again, as is the usual practice in large power plants, it may emulsify in a few days, if it is not of good quality, and have to be thrown away, as it will not pass through the filters. In order to avoid the waste of time and great inconvenience of actually trying the oil in a turbine or other machine, a laboratory test has been devised, by means of which it may be predicted whether or not the oil would give satisfaction in service. The test consists of violently stirring a small sample of the oil with water under standard conditions. Then the oil which will separate out from the water the most rapidly is the best oil for turbine lubrication, other things being equal. It is found that most of the oils on the market are either very bad or very good, and that there is no difficulty in finding turbine oils which will settle out from the water in a minute or less after stirring as above described. For some other purposes it is desirable

Digitized by Google

that oils should emulsify readily, and the test shows that oils of this class, when subjected to the same treatment as the turbine oils, will not separate at all in one hour, nor completely separate in one year. When turbine oils are used for months or years, without renewal, they gradually deteriorate until they emulsify readily, even though they are very good oils to start with. An engineer, by the use of this test, could keep track of the deterioration of his oil, and thus discover when it is time to clean out his lubricating system. Those interested can obtain a copy of this bulletin on application to the Bureau of Standards.

The Civil Service. — The committee appointed by the Treasury to consider the present scheme of examination for Class I. of the Civil Service has issued its report.

It favours the principle of competitive examination, as securing impartially-made appointments, but makes important changes in the examination. In all there will be 59 subjects from which candidates may make a selection, and modern languages are to be placed on an equal footing with Latin and Greek. The new scheme of examination covers, besides classics, mathematics, history and natural science, a great range of university studies—political, legal, economic and philosophical—which have not, as yet, so far as the committee know, been consolidated into one honours school. Of these studies, they say, they have "greatly increased the individual and collective weight," though not enough to make one of them itself a sufficient passport to success, as they "do not consider it desirable that candidates for the Civil Service should study exclusively either politics, law, economics or philosophy."

For Latin and Greek, as well as French, German, Italian, Russian or Spanish, the maximum is 400 marks (200 for translation and 200 for history); for engineering and for lower and higher mathematics the maximum is 400 marks each, but for chemistry, physics, botany, geology, physiology and zoology only 200 are awarded in each grade. For the two periods of European History (1494-1763 and 1763-1914) 400 marks are awarded. In view of the great importance of chemistry and physics we think the marks awarded to these subjects are too low. There is a singular omission from the list of subjects, for we see no reference to Colonial History, and we also think that History generally, Constitutional Law and Politics, do not get the credit they deserve in the revised scheme of examinations.

All candidates must take a section which does not test the "results of university study alone." To qualify in this candidates must be able to "use the English language skilfully and accurately, and to grasp its meaning readily and correctly." The "essay" will, therefore, be obligatory. The committee also propose a Paper on modern "subjects, social, political and economic." They also propose to "give substantial advantage" in the competition to "those candidates who, by whatever means, have obtained and retained a sound knowledge of some of the principles, methods and applications of science, and are able to give a lucid and intelligent account of their knowledge." No change in age limits is suggested, and the viva voce is retained.

British Prisoners of War and Their Studies.—Gratifying evidence of the good work which is being done in the way of enabling British prisoners of war usefully to employ their time during internment is furnished by a letter (typical of many) which has been received by Mr. A. T. Davies, C.B., of the Board of Education, chairman of the British Prisoners of War Book Scheme, the War charity which provides British prisoners interned in enemy or neutral countries with books for the purpose of study.

The letter is dated June 1 from Mr. G. R. Munday, chief petty officer, R.N.D., who is confined at Doeberitz. Mr. Munday says: "I wish to specially thank your committee for the most excellent work they have done and are doing. In this camp since early 1915 we have had a splendid general library, but we lacked educational books. Your scheme has altogether remedied this defect. I have made many applications to you for all varieties of educational and instructive literature, and there has been no case where the want has not been supplied, immaterial of what branch of trade or study was referred to."

Through the instrumentality of the organisers of the Book Scheme arrangements have been made, and in some cases have been in operation for a considerable time, whereby examinations have been held at a foreign camp of students who have been desirous of taking their examinations notwithstanding their internment. Such examinations have been (or are being) conducted on behalf of the University of Edinburgh, University of London, Board of Trade (Marine Department), Law Society, Royal Society of Arts, London Chamber of Commerce, &c. Increasing use, too, is being made by the prisoners of the "Form of Record" prepared by the Committee of the Book Scheme, which enables the regular studies in any subject of a "Student captive" to be duly recorded and certified with a view to the record assisting him on his return from captivity at the close of the war.

Contributions in aid of the scheme are urgently needed. In the technical and scientific sections the prisoners' demand for books is very large, but the works asked for are rarely obtainable as gifts, as the owners generally need them for their own use, while second-hand copies sufficiently up to date are proving increasingly difficult to procure. In these circumstances the Committee are compelled to make large purchases of new copies of up-to-date books of the above character, and for this ample funds are essential. Offers of books (which should always be accompanied by a detailed list) are also invited, and should be addressed to Mr. A. T. Davies, C.B., "Prisoners of War," Board of Education, Victoria and Albert Museum, South Kensington, S.W. 7.

Committee on Neglect of Science.—A Report, covering the period since the meeting held at Burlington House on May 3, 1916, has been issued by the above Committee. The Report recalls the interview with Lord Crewe in June, 1916, when the appointment by the Government of a Committee on the subject of a scientific education in secondary schools was announced, and evidence subsequently submitted to this Committee by Sir Ray Lankester and others. In this evidence the resolution passed on May 3, 1916, recommended that natural science should be made an integral part of the educational course in all the great schools of the country, should form part of the examinations for Oxford and Cambridge University and the newer universities, and should be required in the examinations for the Indian and Home Civil Service and for Sandhurst. It was suggested that data should be collected relating to the number of hours per week devoted in schools to science, mathematics, English language and literature and French, the number of masters engaged in teaching various branches of knowledge, &c. An account is also given of a conference between representatives of the Classical, English, Geographical, Historical & Modern Language Association. While it is generally agreed that more attention should be devoted to natural science, the conference does not appear to have reached agreement regarding the division of hours of study among different subjects. The suggestion is made that examinations in the Home Civil Service should be divided into (*a*) a qualifying examination and (*b*) a competitive examination. It is interesting to observe that the same problem has been exciting attention in Germany. A translation is presented of a letter from the Institution of German Engineers to the Chancellor, desiring fuller representation of science and pointing out that at present "the course of study laid down for the lawyers is at the same time and without change also the course of study for the officials of the Civil Service." (This letter appeared in THE ELECTRICIAN, Vol. LXXVIII., Oct. 13, 1916, p. 50.) Accompanying the Report is a reprint of a paper by Sir E. Ray Lankester on "The Need for Science in Education," in which the wide influence exerted by science and scientific method in other fields of knowledge is discussed.

OBITUARY.

W. HAROLD TINGEY.—We regret to record the death of Mr. W. H. Tingey, of 63, Chancery-lane, London, W.C., on Aug. 3, following an operation. Mr. Tingey, who was only 47 years of age, was an enthusiastic wireless amateur, and indulged in numerous scientific pursuits, especially in X-ray photography. He had also carried out many interesting experiments and tests with resistance materials. His eldest son, Capt. Robert Tingey, R.E., is in France.

R. HEBER RADFORD.—The death occurred at Sheffield on Saturday last of Mr. R. Heber Radford, M.I.Mech.E., a well-known consulting and inspecting engineer of Sheffield.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported:—

Capt. Jas. G. Cunliffe, M.C., has died in action. He was 32 years of age, and was formerly assistant electrical engineer in the Manchester tramways department, and subsequently occupied a similar position at Birmingham.

Second-Lieut. Frank Fullerton (Loyal North Lancashire Regt.) has been killed in action. He was educated at the Huddersfield Technical College, and received the Armitage prize for chemistry.

Sergt. John Thomas (Welsh Guards), who was killed on July 1, was formerly a tramway conductor at Cardiff.

PERSONAL.

On Thursday last Capt. G. D. Coe (R.G.A.), who was formerly employed at the Blackburn electricity works, was married to Miss L. H. M'Adam, at Blackburn.

WAR CASUALTY.—Pte. J. C. Codd and Driver G. Springall, formerly engaged in the gutta percha department and the general office respectively of the India Rubber Co., have recently been wounded.

Digitized by Google

THE ELECTRIFICATION OF THE RIKSGRANS RAILWAY.

PORJUS POWER STATION.

Porjus has many interesting features from the hydraulic engineering point of view, but this side of the subject falls outside the scope of the article.

The power station, Fig. 1, is partly located underground at a depth of 50 metres. Five vertical penstocks feed the turbines, from which a common tail-race tunnel returns the water to the river basin.

Space has been provided in the machinery hall for five turbines, of which four have been installed, two being connected to single-phase generators for railway service, one to a three-phase generator and one to a spare set consisting of a three-phase generator and a single-phase generator connected together. Each turbine is of 12,500 H.P. Later it is hoped to enlarge the machinery hall to make room for five additional sets.

Single-phase Generators.—The following data are given :—

Output: 6,250 k.v.a. continuously, 10,000 k.v.a. peak load, at 0·8 power factor. *Speed*: 225 revs. per min. *Cycles*: 15 per second. *Voltage*: The machines were to be compounded in accordance with Danielson's system, so that the voltage at 10,000 k.v.a. would be 20 per cent. higher than at no-load. *Flywheel capacity*: GD^2=3,600,000 kgm^2. *Runaway speed*: 85 per cent. above normal revs. per min. *Ventilation*: Enclosed with combined self-ventilating and air-blast systems. A maximum of 25 m.^{3} air per second required. *Guarantees*: efficiencies at different loads; K.v.a. 9,400, 6,250 and 3,100; efficiency: 94, 93·4 and 90·1 per cent. respectively. Other guarantees in accordance with V.D.E. Standardisation Rules.

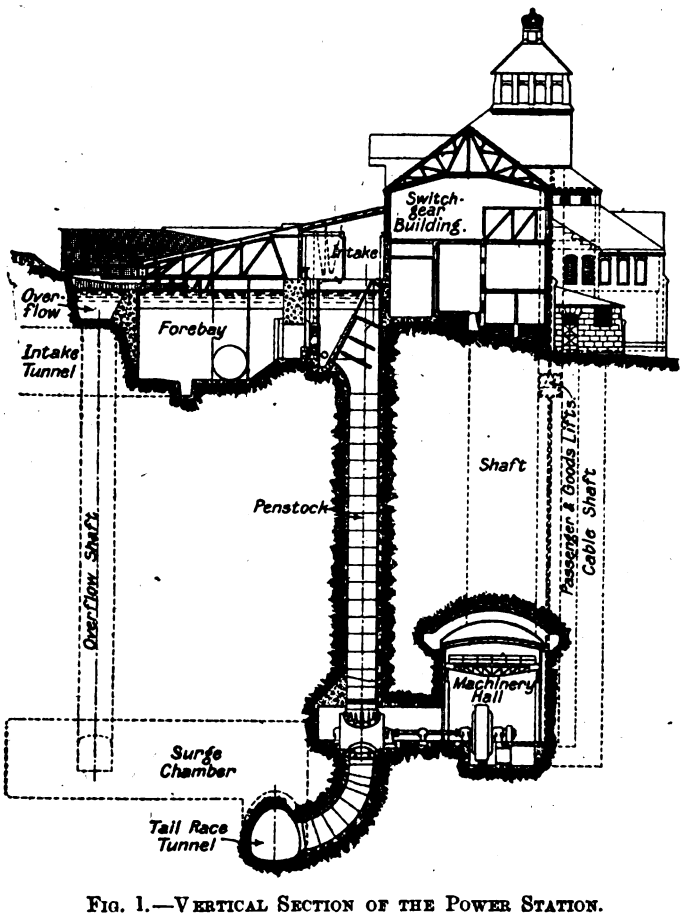


FIG. 1.—VERTICAL SECTION OF THE POWER STATION.

The electrical dimensions were so selected that the normal voltage of the machines would be about 4,000 volts. In this way a good bar winding was secured, which was very desirable in order to secure safety against deformation on short circuits. A voltage of 3,400 was selected for no-load and 4,150 volts for 10,000 k.v.a. load.

All electrical constants were selected amply liberal in order to secure safety against possible unexpected overloads on account of the hard climatic conditions.

The compounding is arranged indirectly, *i.e.*, the compounding converter is connected to the field winding of the exciter and not to the alternator field. In this way both the compounding transformer as well as converter are reduced in size, and it is easier to secure good commutation in the latter.

The field coils are made of copper strap wound on edge. In the pole shoes are arranged heavy *amortisseur* windings mounted spirally and fastened to copper rings outside the poles.

Regarding the compounding, it was determined from calculations that the lag in the field changes on account of self-induction in the magnetic circuit would be of considerable importance. In order to compensate as much as possible for the disadvantage of the lag in the voltage regulation, a quick-acting voltage regulator is connected in parallel with the compounding arrangement.

The machines also offer some details of interest mechanically.

The stator is strongly designed with wide clamping flanges furnished with tapered fingers by means of which the punchings are held under pressure all the way out to the air gap. The armature has a bar winding with braced bow-shaped end connections. The bars have rounded corners fitting snugly to the slot section, and are divided through the centre in two parts, insulated from each other, so as to reduce the eddy current losses. The slot insulation consists of mica.

The rotor consists of several discs with pole cores cast *en bloc* and assembled on a spider of cast-steel. The pole shoes are secured to the poles by a sort of bayonet joint, in which angular flanges in the underside of the pole pieces engage in corresponding milled slots in the pole cores.

The poles are furnished with laminated shoes. The short circuiting rings of the *amortisseur* winding press against collars on the sides of the pole pieces in such a way that ventilating ducts are formed.

Ventilation is assisted by means of fan blades on the pole ring, air being drawn through an axial intake under the floor. The air is forced out through openings in the lower part of the stator. To ensure an even division of the temperature the rotor is furnished with two radial ducts.

The weight of each generator is approximately 200 tons, the weight of the rotor alone being approximately 85 tons.

On test, the efficiency at full load was found to exceed the guarantees by nearly 2 per cent. The temperature rise was found to be considerably lower than the allowable rise. Short circuit tests were made direct on the terminals at 4,000 volts without injury, although the instantaneous rush of current was approximately 15 times normal current.

Three-phase Generators.—These were designed on the basis of the following data :—

Output: 11,000 k.v.a. continuously at 0·8 power factor. *Speed*: 250 revs. per min. *Cycles*: 25 per second. *Voltage*: 10,000 to 11,000 volts. *Flywheel capacity*: GD^2=4,200,000 kgm.^{2} *Regulation*: maximum 22 per cent. when throwing off 11,000 k.v.a. at 11,000 volts and 0·8 power factor. *Ventilation*: totally enclosed with combined self-ventilation and air-blast systems. A maximum of 18 m.^{3} air per second required.

Efficiencies at

11,000 k.v.a.	at 0·8	power factor	= 96·0	per cent.
5,500 ,,	,,	,,	= 93·5	,,
8,800 ,,	1·0	,,	= 96·3	,,

The three-phase generators are designed to the same outer dimensions as the single-phase generators, with the exception that they are somewhat narrower. The construction is practically the same as for the large generators previously built for Trollhättan and Rjukan.* The stator winding is insulated with mica. The rotor is assembled from steel discs, and the pole shoes are secured to the pole cores by means of stud bolts. The ventilation is arranged in the same way as for the single-phase machines.

Excitation Machinery.—The exciters for the single-phase generators are direct-connected to their respective units. The compounding converters are built together with the exciters in such a way that their stators are fastened in cradles on the exciters' stators and can be turned with respect to same, while the rotors are mounted on the outer ends of the exciter shafts. Since the relative position of the stators is adjustable, it is easy to adjust the compounding by tests on overloads or short circuits. The exciters have eight poles and are furnished with commutation and compensation windings. The converters are furnished with laminated poles with *amortisseur* windings but otherwise without field windings. The excitation for the single-phase generators varies approximately in the relation of 3 to 1, and this places very exacting demands on the ability of the exciters and converters to commutate sparklessly at all loads.

The compounding transformer belonging to the generator is designed with adjustable transformation ratio, and it is short-circuited automatically when the main oil-switch opens.

* THE ELECTRICIAN, Vol. LXXVI, p. 343.

Digitized by Google

For the three-phase system a separate turbo-driven exciter unit is provided, which is connected in parallel with a storage battery.

Switchgear.—The transformers and switchgear are housed above the machinery hall. Directly under the tower is arranged a lift-shaft, through which the largest parts of the machines can be handled by means of a crane. The control room is common to both the single and three-phase systems.

The single-phase switchgear extends through two floors. In the lower is arranged the 4,000-volt switchgear, connected to the incoming cables from the machinery hall, which run through the ventilation shaft. Here are also located the transformers and high-voltage protection for the generators. Each generator is connected to two series water-cooled transformers whose common connection is grounded through an oil-insulated resistance. Each generator with its transformer forms an inseparable unit, and the circuit can be opened first on the high-tension side of the transformer, where the generators are also synchronised.

The high-tension oil-switches and also the oil-insulated resistances and the high-tension relays are installed in the second floor of the switchgear house. All the conductors on the 80,000-volt side consist of 20 mm. copper tubes, which were selected on account of mechanical strength and for preventing corona formation.

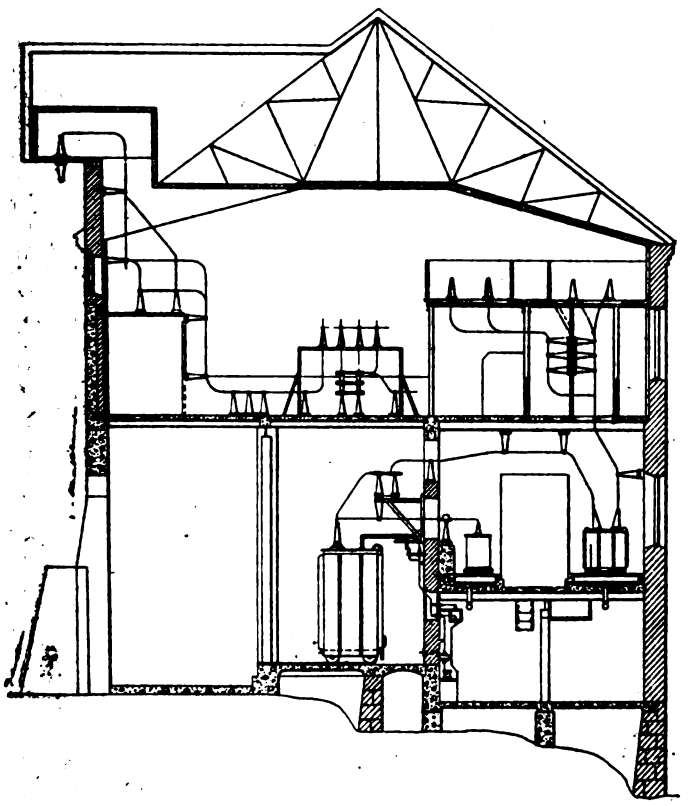


FIG. 2.—SECTION OF SWITCH-HOUSE.

The pin insulators for 80,000 volts have a height of 600 mm. A couple of flanges are placed immediately below the top support for the conductors, but otherwise the insulators are smooth. Both the top and bottom supports are secured by means of clamps.

The oil-insulated resistances are of two types, the one intended for grounding the middle point of the transformer groups just described, and the other for the 80,000-volt horn-gap arresters. The former are connected in series with overload relays, and are furnished with contact thermometers and with signal devices which start to operate when the temperature of the oil exceeds 90°C. The horn-gap resistances are insulated for full line voltage, and are also furnished with thermometers and signal device.

The high-voltage relays consist of a motor magnet. The movement of the armature being translated to the contact device by a vertical shaft of non-conducting material in the centre of the insulator. All vital parts are thus totally enclosed. On the second floor are also arranged current transformers and relays for the outgoing lines.

On the upper floor are installed 'bus bars with disconnecting switches and high-voltage protection for the outgoing lines. These are two in number and are connected in parallel, but if necessary they can be operated separately, and have entirely independent operating devices for connecting them to either one of the two 'bus bar systems. The generators can in their turn be connected to either one of the 'bus bars by means of disconnecting switches.

The high-voltage protection apparatus consists of several horn-gap arresters connected in parallel between the line and ground, and between which choke coils are arranged in series with the line.

Scagliol partitions are placed between the high-tension switchgear. No wall or ceiling bushings are used indoors, the connections between the different floors being drawn through clear openings in the floors. The only through-bushings are on the station terminals for the outgoing lines. All insulators were tested in the factory with 200,000 volts.

The control room is located on the second floor. The switchboard for the single-phase system consists of four panels, one for each generator and one for the outgoing lines. In an adjacent room are installed recording volt, ampere and watt meters for the outgoing lines, all driven by common clockwork.

The three-phase equipment has been supplied to plans furnished by the Water Falls Commission. The transformers are placed on the lower floor, and there is one transformer for each phase. The voltage is transformed from 11,000 to 70,000 volts for transmission to Gellivare and Kiruna.

Oil switches are installed between the generators and transformers. The characteristic feature of the 70,000-volt oil-switches is that for each phase there is a complete single-pole switch mounted on wheels and standing on the floor. The cover of the oil-tank supports the contact device and a dustproof operating mechanism, which parts together form a mechanical unit. The three switches belonging to a three-phase group are connected to each other through a lever system placed in the floor and operated from a common operating pillar. The switches are furnished with a two-step charging resistance.

Otherwise the switchgear for the three-phase system is similar to the single-phase system. A difference is found in the arrangement of the upper floor, where all the gear is mounted on iron framework without partitions. The whole of the three-phase gear will be moved at a later date into the right wing, which has not as yet been built.

On the switchboard in the control room for the three-phase system are at present mounted complete one generator panel and one outgoing line panel. For the exciter generator and for the storage battery, operated in parallel therewith, is also installed a switchboard in the control room.

(To be concluded.)

AN ALTERNATING CURRENT BRIDGE METHOD OF COMPARING TWO FIXED INDUCTANCES AT COMMERCIAL FREQUENCIES.*

BY T. PARNELL, M.A.

The simple Maxwell inductance bridge cannot be used conveniently for the comparison of fixed inductances on account of the tedious double balance necessary. By making use of a current detector whose deflections depend on the component of the current in quadrature with the E.M.F. applied to the bridge, it is, however, possible to make the condition for no deflection depend either chiefly on the inductances or chiefly on the resistances.

The arrangement of the bridge is shown in Fig. 1. In series with the bridge is placed either a non-inductive resistance, R, or a condenser, K. If R, r and s are all large compared with p, q, g, $P\omega$ and $Q\omega$, it will be shown that, with R in circuit, the balance depends chiefly on the inductances P and Q, and that with K in circuit the balance depends chiefly on the resistances.

With R in circuit, s is adjusted for no deflection; this gives an approximate balance for the inductances. Then, with K in circuit, q is adjusted for no deflection; this gives an approximate balance for the resistances. The process is repeated, and after a few balances values of s and q are obtained that give a balance with either R or K in circuit, in which case the bridge is completely balanced, and

$$P/Q=p/q=r/s.$$

In this way an unknown inductance can be balanced against a standard to one part in a few thousand in a few minutes.

As detector a sensitive moving-coil galvanometer and rotating commutator may be used. In this case the commutator is mounted on the axle of the small alternator or rotary converter that supplies the bridge current, and the brushes of the commutator are adjusted till no deflection is produced when the E.M.F. used on the bridge is applied through the commutator to a high non-inductive resistance in series with the shunted galvanometer, thus showing that the

* Abstract of a Paper read before the Physical Society.

Digitized by Google

commutator is in quadrature with the E.M.F. When the commutator is thus adjusted the deflection of the galvanometer is approximately proportional to the component of the current in quadrature with the E.M.F. applied to the bridge.

A more convenient detector is the Sumpner reflecting electrodynamometer, manufactured by Paul.

The suspended coil moves in the field of a laminated iron electromagnet excited by a field winding with a large number of turns; the resistance of this field winding is small compared with its reactance, and therefore the total flux through the field coils is approximately in quadrature with the applied E.M.F. The flux density is sensibly constant throughout the air-gap and proportional to the total flux. When, therefore, the moving coil is connected across the bridge, and an E.M.F. in phase with the E.M.F. used for the bridge is applied to the field coils, the mean torque on the moving coil is approximately proportional to the component of the current in quadrature with the bridge E.M.F.

If the mutual inductances between the various conductors and also their capacities and the inductances of R, r and s are negligible, the final balance is independent of wave-form and frequency. The preliminary balances depend on wave-form and frequency. An approximate knowledge only of the conditions for these preliminary balances is required; an approximate calculation of the current through the detector, therefore, is sufficient, and it may be assumed with a sufficient degree of accuracy that the mean torque on the moving coil is proportional to the component of the current in quadrature with the bridge E.M.F.

The author demonstrates this result mathematically. Since the final balance is independent of frequency and wave-form, the effect of the higher harmonics in the case of the E.M.F. obtained from an ordinary machine may be neglected, for it can be shown that the preliminary balances will be much less than that of the fundamental.

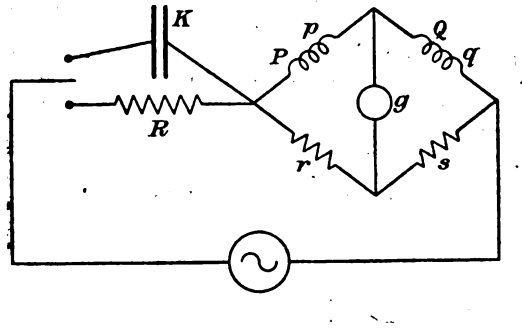


FIG. 1.

If this preliminary balance is obtained by varying s with R alone in circuit the balance depends chiefly on the inductances. If in this balance q is too small for a resistance balance the value of s is too great. Similarly if the value of q is too great, the value of s obtained will be too small.

If a balance be now obtained by varying q (or p) with K alone in circuit the balance depends chiefly on the resistances. If in the first balance q is too small, a value of s too great for a true inductive balance is obtained. The next inductive balance will give too small a value of s, which means that the next resistance balance will give too small a value of q, and so on.

Two series of values of s and q respectively are thus obtained whose terms are alternately too great and too small, and these terms rapidly converge to final values corresponding to a balance of both inductances and resistances, *i.e.*,

$$P/Q = r/s = p/q.$$

Some experimental results are quoted to illustrate the use of the method and to show the agreement of the above theory with experiment.

In these measurements P was a standard inductance, and Q the coil to be measured. An inductive balance was first obtained by varying s, then a resistance balance by adding resistance to the arm containing Q, or to the arm containing P, by means of a dial box and graduated non-inductive rheostat, which could be switched into either arm.

One example of the use of the rotating commutator is given; the other measurements were made with the electrodynamometer as detector, the agreement between the two methods being satisfactory.

Measurements of a number of coils with various values of the voltage and of R, K and r gave results consistent within 1 in 1,000. As a further test of the accuracy of the method, two coils were placed a considerable distance apart, and their inductances (including the leads) measured in situ, singly and in series. The results of two such measurements are given below:—

Inductance of A	[illegible] M.H.
Inductance of A'	[illegible] M.H.
Sum of inductances	[illegible] M.H.
Inductance of A and A' in series	[illegible] M.
Inductance of B	[illegible]
Inductance of B'	[illegible]
Sum of inductances	[illegible]
Inductances of B and B' in series	[illegible]

Reversing the connections of A' or B' did not appreciably affect the final balances.

Owing to the presence of R or K, it is necessary to use high voltages in order to keep up the sensitiveness. The value of r need not be known with much accuracy, so that any reasonably large non-inductive resistance may be used, and as r and s are large compared with p and q, the voltage is limited only by the permissible current through the inductance coils. In the measurements made, voltages from 10 to 85 were used, and the higher voltages were found the most satisfactory.

The mutual induction between R and the rest of the bridge is liable to produce considerable error; it is necessary, therefore, to keep R some little distance away.

Leakage to earth and electrostatic capacity effects gave some trouble. The detector was kept permanently in circuit, and the alternating-current supply connected to the two terminals of the bridge through a pair of tapping keys; the apparatus was manipulated until putting down either key alone gave only a negligible deflection. In obtaining a balance the two keys were put down simultaneously. The "false zero" obtained by keeping the detector in circuit fluctuates to some extent, but little difficulty was experienced from this cause, as it was always sufficiently steady to enable the final balance to be made accurately.

When the rotating commutator was used it was found that the best results were obtained by taking the bridge current from a small transformer, with secondary well insulated and shielded from primary connected to the machine. The galvanometer was connected to the brushes bearing on the split part of the commutator and the bridge to the brushes on the rings. When the core of the transformer, the frame of the machine and one of the rings of the commutator were earthed the stray effects due to leakage, capacity, &c., were reduced to a negligible amount.

In setting the brushes of the commutator, the current from the transformer was passed through the commutator and the suitably shunted galvanometer in series with R, and the brushes adjusted for no deflection. This allowed for any change of phase occurring when the bridge current was taken from the transformer. It was found that great accuracy in the position of the brushes was not necessary. If the setting was not sufficiently exact, the defect was noticed at once, as the values of s and q did not alternate in the manner described above.

The use of the rotating commutator was found much more troublesome than that of the electrodynamometer, and the results obtained were somewhat less consistent.

When the electrodynamometer was used as detector, the currents for the bridge and for the field were taken from a small transformer having two secondaries well insulated and shielded from one another. It was found that with this arrangement electrostatic and capacity effects could be reduced to a negligible amount by earthing the core of the transformer and one terminal of the moving coil. Voltages from 40 to 75 volts were employed on the field coils.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"The Trade of To-morrow." By E. J. P. Benn. (London: Jarrold & Sons.) Pp. 232. 2s. 6d. net.

"Heat Drop Tables, Absolute Pressures." By H. Moss, M.Sc. From the Formulæ and Steam Tables of Prof. H. L. Callendar, M.A. (London: Edward Arnold.) Pp. 63. 5s. net.

"Correction Tables for Thermodynamic Efficiency." By C. H. Naylor, A.M.I.C.A. (London: Edward Arnold.) Pp. 59. 5s. net.

"Practical Costing." By A. H. Gledhill, A.M.I.M.E. (London: The Gledhill-Brook Time Recorders, Ltd.) Pp. 72. 3s.

"List of Members of the Institution of Civil Engineers." (London: The Institution of Civil Engineers.) Pp. 267.

"How to Make High-Pressure Transformers." By Prof. F. E. Austin. (Hanover: Prof. F. E. Austin.) Pp. 46. 2nd edition. 65 cents.

"The Public School System in Relation to the Coming Conflict for National Supremacy," by V. Seymour Bryant, M.A. (London: Longmans, Green & Co.) Pp. xviii.+78. 1s. 6d. net.

"How to Make High-Pressure Transformers," by Prof. F. E. Austin. 2nd edition. (Hanover: Prof. F. E. Austin.) Pp. 46. 65c.

Digitized by Google

NOTES ON THE DESIGN OF ELECTROMAGNETIC MACHINES.*

2. ALTERNATING-CURRENT GENERATORS.

BY STANLEY PARKER SMITH, D.SC.

(*Continued from page 737.*)

4. M.M.F. OF THREE-PHASE WINDINGS.

In the vector diagram in Fig. 2, the ampere-turns AT_r producing the main flux in a synchronous machine on load were shown to be the resultant of the pole ampere-turns AT_p and the armature ampere-turns AT_a. We must now determine the magnitude of AT_a, and justify the assumption that it can be regarded as constant in value, and revolving synchronously with the field ampere-turns AT_p.

To do this, we first find the distribution over the armature periphery of the magnetomotive force produced by a three-phase winding. Taking the normal winding with full-pitch coils and each phase spread uniformly over 60 deg., or one-third, of each pole-pitch, we get the well-known pointed and flat-topped curves shown in Fig. 7, when a sine-wave current flows through the winding. A simple way of obtaining these curves, which represent the extreme positions assumed by the M.M.F., is to draw first of all the distribution of the ampere-conductors or electric loading over the periphery, as shown. In doing this, care must be taken to label corresponding vectors and coil-sides properly, in order to remove all doubt as to signs, &c. By integrating these curves of alternating-current distribution, so that the resultant curves are symmetrical with respect to the datum line, we get the AT curves, to which the M.M.F. curves are proportional.

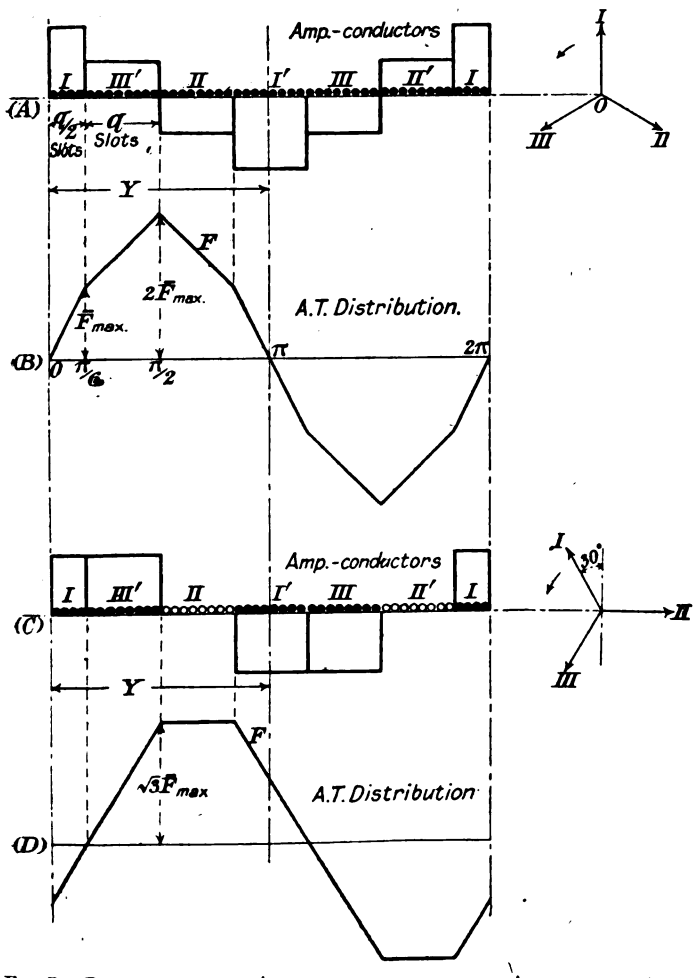


FIG. 7.—DISTRIBUTION OF AMPERE-CONDUCTORS AND AMPERE-TURNS IN THREE-PHASE WINDING.

(Diagrams (A) and (B) refer to one extreme position, whilst (C) and (D) refer to the other extreme position.)

The older way of finding the magnitude of the armature M.M.F. was to proceed graphically by measuring the area of one or both of the above shapes, but when dealing with the trapezoidal curves for the field M.M.F. of a cylindrical rotor some time ago,* it occurred to the author that such simple mathematical shapes could be better dealt with analytically. Later he extended the same treatment to the M.M.F. curves of the three-phase winding shown in Fig. 7 (*see* "Calculation of the Magnetising Current of Three-phase Induction Motors," by S. P. Smith and W. H. Barling, THE ELECTRICIAN, October 16, 1914); and since that time a post-graduate student in electrical engineering, Mr. B. Hague, was encouraged by the author to make a complete analytical investigation of the whole subject of armature M.M.F.s, to include the effect of phase-spread, coil-span, slots, current, wave-shape, &c., for any number of phases.†

At present we shall only consider the ordinary three-phase winding with full-pitch coils carrying a sine-wave current. To find the equation for the M.M.F. of such a winding, we have merely to add together the M.M.F. curves of the three phases, which are trapezia 120 deg. apart in space and pulsating between $\pm\bar{F}_{max.}$.

For a trapezium of *constant* height $F_{max.}$, the ordinate F at angle θ is given by (*see* Fig. 8) :—

$$F=\frac{4}{\pi}\frac{F_{max.}}{\alpha}\left(\sin\alpha\sin\theta+\ldots+\frac{1}{n^2}\sin n\alpha\sin n\theta+\ldots\right), \quad . \quad . \quad (5)$$

$$=\frac{8}{\pi}\frac{F_{max.}}{\sigma}\left(\sin\frac{\sigma}{2}\sin\theta+\ldots\frac{1}{n^2}\sin n\frac{\sigma}{2}\sin n\theta+\ldots\right),$$

$$=\frac{8}{\pi}\frac{F_{max.}}{\sigma}\Sigma_{n=1}^{n=\infty}\frac{1}{n^2}\sin n\frac{\sigma}{2}\sin n\theta, \text{ where } \alpha=\sigma/2.$$

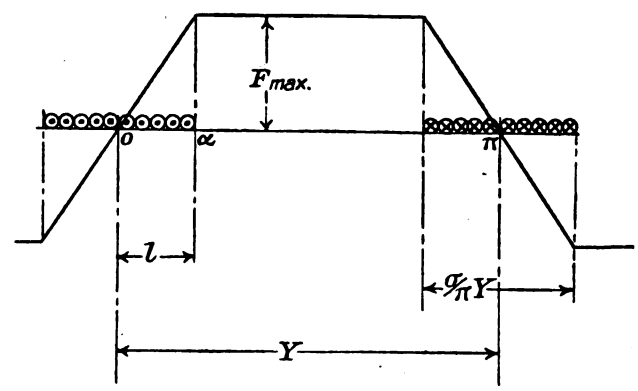


FIG. 8.—M.M.F. CURVE OF A WINDING DISTRIBUTED UNIFORMLY OVER PART OF POLE-PITCH.

Introducing the time variable $i=\bar{i}\cos\omega t$ or $F_{max.}=\bar{F}_{max.}\cos\omega t$, and taking the angular phase-spread $\sigma=\pi/3$, we get for the M.M.F. of the three phases I., II. and III. :—

$$F_I=\frac{24}{\pi^2}\bar{F}_{max.}\cos\omega t\,\Sigma_{n=1}^{n=\infty}\frac{1}{n^2}\sin n\frac{\pi}{6}\sin n\theta,$$

$$F_{II}=\frac{24}{\pi^2}\bar{F}_{max.}\cos\left(\omega t-\frac{2\pi}{3}\right)\Sigma_{n=1}^{n=\infty}\frac{1}{n^2}\sin n\frac{\pi}{6}\sin n\left(\theta-\frac{2\pi}{3}\right),$$

$$F_{III}=\frac{24}{\pi^2}\bar{F}_{max.}\cos\left(\omega t-\frac{4\pi}{3}\right)\Sigma_{n=1}^{n=\infty}\frac{1}{n^2}\sin n\frac{\pi}{6}\sin n\left(\theta-\frac{4\pi}{3}\right);$$

* The first article of this series dealt with Continuous-current Machines and the first part of the article appeared in THE ELECTRICIAN of June 2nd, 1916 (Vol. LXXVII., p. 280).

* "The Non-Salient Pole Turbo-Alternator and its Characteristics." By S. P. Smith. "Proc." I.E.E., Vol. XLVII., p. 562.

† "Proc." I.E.E., Vol. LV., p. 489.

Digitized by Google

whence the resultant M.M.F. of the three phases at any angle θ on the periphery at instant t will be :—

$$F=F_I+F_{II}+F_{III},$$

$$=\frac{24}{\pi^2}\bar{F}_{max.}\sum_{N=I}^{N=III}\left\{\cos\left(\omega t-\overline{N-1}\,\frac{2\pi}{3}\right)\sum_{n=1}^{n=\infty}\frac{1}{n^2}\sin n\frac{\pi}{6}\right.$$
$$\left.\sin n\left(\theta-\overline{N-1}\frac{2\pi}{3}\right)\right\}$$

Changing the order of summations, inserting $n=1, 3, 5$, &c., successively, and evaluating the resulting expressions, gives finally

$$F=\frac{18\bar{F}_{max.}}{\pi^2}\left\{\sin(\theta-\omega t)+\frac{1}{25}\sin(5\theta+\omega t)-\frac{1}{49}\sin(7\theta-\omega t)\right.$$
$$\left.-\frac{1}{121}\sin(11\theta+\omega t)+\ldots\right\}. \quad (6)$$

It will be noticed that the terms of this expression are of the form $\sin n\left(\theta\pm\frac{\omega}{n}t\right)$, which signifies that they are moving at speeds proportional to the reciprocal of their order, since terms of the form $\sin(n\theta\pm n\omega t)=\sin n(\theta\pm\omega t)$ move at fundamental frequency. The terms indicated by $-\omega t$ move in the same direction as the fundamental—*e.g.*, the 7th, 13th, 19th, &c.; whilst those indicated by ωt, such as the 5th, 11th, 17th, &c., move in the opposite direction.

It is thus seen that all harmonics vanish whose order is a multiple of three, and the resultant M.M.F. wave consists of a number of rotating waves of rapidly decreasing amplitude.

Now the resultant of a number of waves moving at various speeds is a wave of changing shape moving at irregular speed. Thus, at the instant $\omega t=0$, the M.M.F. wave has the shape of the *pointed* curve shown in Fig. 7(B), for which equation (6) becomes

$$F=\frac{18}{\pi^2}\bar{F}_{max.}\left(\sin\theta+\frac{1}{25}\sin 5\theta-\frac{1}{49}\sin 7\theta-\frac{1}{121}\sin 11\theta+\ldots\right).$$

By putting $\theta=\pi/2$, the height of the curve is found to be

$$\frac{18}{\pi^2}\bar{F}_{max.}\left(1+\frac{1}{5^2}+\frac{1}{7^2}+\frac{1}{11^2}+\frac{1}{13^2}+\frac{1}{17^2}+\ldots\right)=2\bar{F}_{max.}.$$

This is one of the limiting shapes assumed by the M.M.F. wave.

The other limiting shape is assumed when the wave has advanced in space through an angle $\pi/6$, which occurs when $\omega t=\pi/6$, as seen from Fig. 7 (D). By putting $\theta=\theta'+\pi/6$ in equation (6), the expression for this *trapezium* becomes

$$F=\frac{18}{\pi^2}\bar{F}_{max.}\left(\sin\theta'-\frac{1}{25}\sin 5\theta'+\frac{1}{49}\sin 7\theta'-\frac{1}{121}\sin 11\theta'\right).$$

The height of this trapezium is obtained by putting $\theta=\pi/2$, or $\theta'=\pi/3$, whence we get the same series as for the pointed wave multiplied by $\sqrt{3}/2$, so that the height $=\sqrt{3}\,\bar{F}_{max.}$.

The analysis of these curves teaches us that the fundamental of the M.M.F. wave of a three-phase winding is constant and moves synchronously with the field system, whilst the effect of the harmonics on the mean value is negligible. Thus we are justified in replacing the actual M.M.F. curve by its fundamental, and representing it by a uniformly rotating vector.

The amplitude of the fundamental of the resultant M.M.F. is $18\bar{F}_{max.}/\pi^2$, or, expressed in ampere-turns, $AT_a=\frac{18}{\pi^2}\frac{q}{2}\bar{a}\bar{i}$ $=\frac{18}{\pi^2}\frac{1}{\sqrt{2}}quI$ ampere-turns per pole $=\frac{18}{\pi^2}\sqrt{2}quI$ ampere-turns per pole-pair.

The corresponding value for a two-phase winding is $\frac{16}{\pi^2}\sqrt{2}quI$ ampere-turns per pole-pair, but here the harmonics are not so small, the third being equal to one-ninth of the fundamental. For further information on the M.M.F. of armature windings, Mr. Hague's paper* should be consulted.

Reduction of Armature to Field Ampere-turns.—Since the armature and field windings in an alternator are distributed differently, it is necessary to find how many ampere-turns on the field are equivalent to the armature ampere-turns, or to the armature reaction proper, as it is often called. In reducing the stator ampere-turns to the rotor there are two cases to consider—

(i.) The non-salient pole or cylindrical rotor,
(ii.) The salient pole rotor.

The former case is the simpler, owing to the absence of a large air space, or polar gap, between adjacent poles.

(i.) *The Non-salient Pole Rotor.*—Ignoring the effect of the slots, the mean M.M.F. distribution over the periphery of a non-salient pole rotor is a trapezium, as shown in Fig. 8, whilst the ratio of the wound part of the pole-pitch to the whole pole-pitch usually lies between two-thirds and four-fifths. If we denote this ratio by $\beta=2l/Y$, equation (5) for the trapezium can then be written :—

$$F=\frac{4}{\pi}\frac{F_{max.}}{a}\left(\sin a\sin\theta+\ldots+\frac{1}{n^2}\sin n\,a\sin n\,\theta+\ldots\right)$$
$$=\frac{8}{\pi^2}\frac{F_{max.}}{\beta}\left(\sin\beta\frac{\pi}{2}\sin\theta+\ldots+\frac{1}{n^2}\sin n\,\beta\frac{\pi}{2}\sin n\,\theta+\ldots\right)$$

In the present case, of course, $F_{max.}$ is constant, being due to a continuous current.

By referring to the author's Paper on the non-salient pole turbo-alternator, quoted above, it will be seen within the practical range of $\beta=2l/Y$ of 0·66 to 0·8 the harmonics are very small. Thus, for $\beta=\frac{2}{3}$, the third harmonic is zero, whilst the fifth is only 4 per cent. of the fundamental; for the other extreme, $\beta=0{\cdot}8$, the third harmonic is 7 per cent. of the fundamental, whilst the fifth is zero. All higher harmonics are less than 2·5 per cent. Thus, it is allowable to ignore all the harmonics in the field M.M.F. in the same way as in the armature M.M.F., and we are left merely with the fundamental, the amplitude of which is

$$F_{1max.}=\frac{8}{\pi^2\beta}F_{max.}\sin\beta\frac{\pi}{2}.$$

We can now find the number of ampere-turns on the field equivalent to the ampere-turns on the stator, if we replace the M.M.F. $F_{max.}$ by the corresponding ampere-turns AT_a, and equate the amplitude of the fundamentals.

$$\frac{8}{\pi^2\beta}AT_a\sin\beta\frac{\pi}{2}=\frac{18}{\sqrt{2}\pi^2}quI,$$

whence it follows that to produce the same effect as the armature ampere-turns, the number of ampere-turns AT_a on the field must be

$$AT_a=\frac{2{\cdot}25}{\sqrt{2}}\frac{\beta}{\sin\beta\pi/2}quI \text{ ampere-turns per pole.}$$

For a complete magnetic circuit (pole-pair) the equivalent ampere-turns are

$$AT_a=\frac{4{\cdot}5}{\sqrt{2}}\frac{\beta}{\sin\beta\pi/2}quI \text{ ampere-turns per pole-pair} \quad (7)$$

The constant is tabulated in Table III. for practical values of β.

Table III.

$\beta=\frac{2l}{Y}$	$\frac{4{\cdot}5}{\sqrt{2}}\frac{\beta}{\sin\beta\frac{\pi}{2}}$
0·6	2·36
0·66	2·45
0·7	2·5
0·75	2·58
0·8	2·68

(ii.) *The Salient Pole Rotor.*—In salient pole machines, a difficulty arises due to our ignorance of the shape of the distribution of the field M.M.F. For this reason we make the two simple assumptions that the field M.M.F. is a rectangle extending over the polar arc (Fig. 9) and that the area of this rectangle is equivalent to the area of the part of the sinu-

* "Proc." I.E.E., Vol. LV., p. 489.

Digitized by Google

soidal armature M.M.F. above the pole-shoe. Defining the ratio of the pole-arc to the pole-pitch by α—*i.e.*, $\alpha=b/Y$—we have then with the above assumptions,

$$AT_a\times\alpha\pi=2\int_0^{\alpha\pi/2}AT'\cos x\,dx,$$

$$=2AT'\sin\alpha\frac{\pi}{2},$$

so that the equivalent ampere-turns,

$$AT_a=\frac{2}{\pi}\,\frac{\sin\alpha\pi/2}{\alpha}\,AT',$$

where $AT'=\frac{18}{\pi^2}\sqrt{2}quI$ ampere-turns per pole-pair in a three-phase winding.

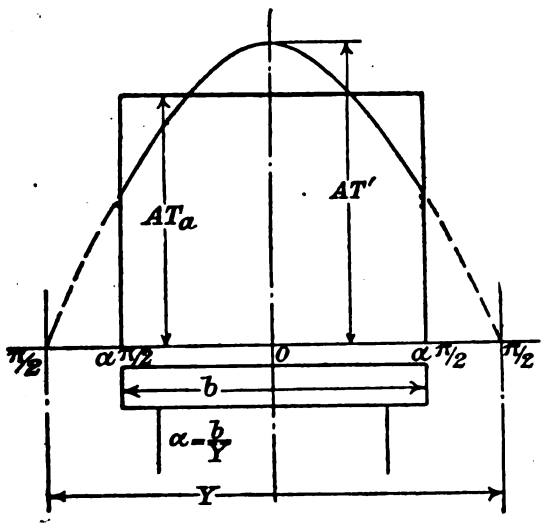


FIG. 9.—ASSUMED DISTRIBUTIONS OF M.M.F. IN THREE-PHASE SALIENT-POLE ALTERNATOR.

In standard practice it is customary to make the ratio of pole-arc to pole-pitch approximately equal to two-thirds. Inserting $\alpha=\frac{2}{3}$, we get

$$AT_a=2{\cdot}13\,quI \text{ ampere-turns per pole-pair.} \quad . \quad . \quad . \quad (7A)$$

This expression gives results in close agreement with tests.

5. INDUCTANCE OF THREE-PHASE WINDINGS.

The inductance of a circuit depends on the number of interlinkages when a current flows through it. If the lines of induction pass through iron, then the inductance decreases as the current is increased, otherwise the inductance is constant and depends only on the physical properties of the circuit, such as the number of turns, the reluctance, &c.

Consider a simple circuit formed by a coil of T_c turns all linking the same flux Φ, produced by the current of i amperes flowing through the coil. The number of magnetic interlinkages associated with the coil is, then, $T_c\Phi$. If we now write

$$L\times i=T_c\times\Phi\times10^{-8},$$

the E.M.F. of self-induction will be

$$e_x=-T_c\frac{d\Phi}{dt}10^{-8}=-\frac{d}{dt}(T_c\Phi)10^{-8}=-\frac{d}{dt}(Li),$$

$$=-L\frac{di}{dt}\text{ volts, when } L \text{ is constant.}$$

The unit of inductance is the henry, and a circuit is defined as having unit inductance when a current of 1 ampere flowing through it produces 10^8 linkages. Thus, in the above expression, $L=T_c\Phi/i.10^8$=magnetic linkages due to 1 ampere $\times10^{-8}$ represents the self-inductance of the circuit in henries.

The reactance X of the coil for a sinusoidal current is then calculated from the inductance as follows :—

$$e_x=-L\frac{di}{dt}=-L\frac{d}{dt}(\bar{i}\sin\omega t),\text{ when } i=\bar{i}\sin\omega t,$$

$$=-\omega L\bar{i}\cos\omega t.$$

Hence, the maximum value, $\bar{e_x}=\omega L\bar{i}$, and the virtual value, $E_x=\omega LI=XI$, where $X=\omega L$=reactance of circuit in ohms.

In the case of a machine where a coil has one part in air and another in iron, to calculate the inductance the linkages must be summed up over the whole coil, or,

$$L=\frac{\Sigma(T_x\Phi_x')}{i}10^{-8}=\frac{T_c}{i}10^{-8}\Sigma\Phi_x,$$

where the actual flux Φ_x' is replaced by an imaginary equivalent flux Φ_x associated with all T_c turns. It has already been pointed out in section I. that part of the leakage flux is fictitious, but the effect on the terminal pressure is the same as if the flux were actually present, so that no account of this need be taken in calculating the inductance.

The flux is defined as the quotient of the M.M.F. divided by the reluctance, so that

$$\Phi_x=\frac{0{\cdot}4\pi i\,.\,T_c}{\frac{l_x}{a_x\mu_x}}=0{\cdot}4\pi i\,.\,T_c\frac{a_x}{l_x},$$

when $\mu_x=1$, that is, when the reluctance of the iron part of the leakage path is negligible compared with that of the air part.

Now, a_x/l_x is the magnetic permeance of the part x, and we can write $\frac{a_x}{l_x}=L_x\lambda_x$, where λ_x is the specific permeance or the permeance per centimetre length of the path extending over the length L_x. Thus, we have for the leakage flux of a coil

$$\Sigma\Phi_x=0{\cdot}4\pi i\,.\,T_c\Sigma(L_x\lambda_x),$$

and for the inductance of a coil

$$L=\frac{T_c}{i}10^{-8}\Sigma\Phi_x=0{\cdot}4\pi T_c^2\Sigma(L_x\lambda_x)10^{-8}.$$

The former expression is used when the leakage flux is required, the latter when it is desired to calculate the reactance pressure.

To calculate $\Sigma(L_x\lambda_x)$ it is practicable to divide the summation into two parts, corresponding with the slot leakage flux Φ_s and the overhang leakage flux Φ_0. Thus, for a whole coil, consisting of two coil-sides,

$$\Sigma(L_x\lambda_x)=2L_s\lambda_s+2L_0\lambda_0,$$

where $2L_s$=length of coil embedded in iron, and $2L_0$=length of coil in air.

Leakage Flux of Stator Winding.—The application of the above expression for the leakage flux is very simple. The leakage flux is usually expressed as a percentage of the main flux per pole, and since this latter value is associated with the maximum value of the induced E.M.F. per phase, we must take the maximum value of current when calculating the leakage flux. We have then for a sinusoidal current the leakage flux associated with one coil :—

$$\Sigma\Phi_x=0{\cdot}4\pi\sqrt{2}IT_c\Sigma(L_x\lambda_x),$$

$$=0{\cdot}4\pi\sqrt{2}IT_c2(L_s\lambda_s+L_0\lambda_0),$$

$$=3{\cdot}55IT_c(L_s\lambda_s+L_0\lambda_0). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

With q slots per pole and phase, the leakage flux $\Phi_a=\Phi_s+\Phi_0$ of a phase will be due to the current flowing in q coils. Thus, the number of turns producing Φ_a are now qT_c, but at the same time the reluctance of the leakage path has increased q times, for the leakage flux has now to cross q slots, or go round q coils. Taking, then, the same specific permeances λ_s and λ_0 as for a single coil, we have then

$$\Phi_a=\Phi_s+\Phi_0=3{\cdot}55IqT_c\left(L_s\frac{\lambda_s}{q}+L_0\frac{\lambda_0}{q}\right), \quad . \quad . \quad . \quad . \quad (8A)$$

and the percentage leakage flux is $100\Phi_a/\Phi$, where Φ is the main flux needed to produce normal pressure on no-load.

Separating now the slot from the overhang leakage, we have for the *slot leakage flux*

$$\Phi_s=3{\cdot}55IqT_cL_s\frac{\lambda_s}{q}=3{\cdot}55IT_cL_s\lambda_s, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

where λ_s is the specific slot permeance calculated for a *single* coil. In this expression the number of turns per coil T_c is

Digitized by Google

equal to the number of conductors per slot u, so that $I \cdot T_c = AC$ per slot, whilst L_s is equal to the core-length minus the ducts.

Calculation of the Specific Permeance λ_s.—In Fig. 10 is shown the section of a slot and conductors, and it is seen that all the leakage flux above the coil-side—*i.e.*, beyond r_2—interlinks all the turns T_c; whilst the flux passing through the coil-side—*i.e.*, between O and r_2—only links part of the turns. For the former path, the permeance is simply the area divided by the length, but for the latter the equivalent permeance—*i.e.*, the permeance corresponding with an imaginary flux linking all T_c turns—must be found. Since the induced E.M.F. depends on the inductance of the coil, and the latter on T^2 (*see* above expression for L) the equivalent linkages will be proportional to $(T_x/T_c)^2$, and not to the actual linkages, which would be proportional to T_x/T_c.

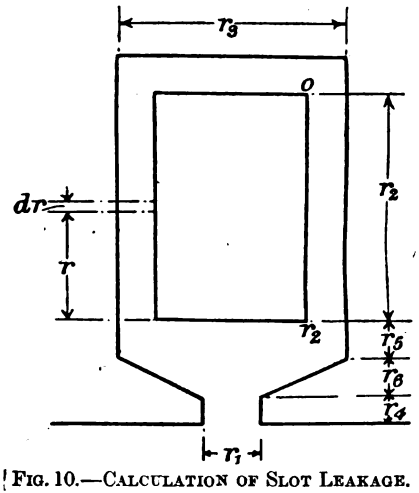


Fig. 10.—Calculation of Slot Leakage.

There are various ways of calculating the gap permeance, according to the way the problem is regarded, but as leakage is of much less consequence in alternators than in induction motors, there is no need to go into such great refinements as in the latter case. For alternators, it is sufficient if we take the specific gap permeance as equal to the gap-length l_g divided by the slot-pitch y_s. Thus, for the specific permeance λ_s for the slots and gap we have

$$\lambda_s = \int_0^{r_2} \left(\frac{r}{r_2}\right)^2 \frac{dr}{r_3} + \frac{r_5}{r_3} + \frac{r_6}{\frac{r_3+r_1}{2}} + \frac{r_4}{r_1} + \frac{l_g}{y_s},$$

$$= \frac{r_2}{3r_3} + \frac{r_5}{r_3} + \frac{2r_6}{r_3+r_1} + \frac{r_4}{r_1} + \frac{l_g}{y_s}.$$

For the *overhang leakage flux* we have

$$\Phi_0 = 3{\cdot}55 I q T_c L_0 \frac{\lambda_0}{q} = 3{\cdot}55 \lambda_0' I q T_c L_0, \quad . \quad . \quad . \quad (10)$$

where $\lambda_0' = \lambda_0/q$. There are different formulæ for calculating λ_0', an exact knowledge of which is important in some machines, such as turbo-alternators, owing to its effect on sudden short-circuit. Unfortunately, the formulæ that have been developed are seldom able to take into account the complicated arrangement of the overhang of a turbo-stator, because of the large masses of iron, &c., surrounding it, in consequence of which many designers fall back on values obtained empirically. The author has found the values given by Miles Walker agree fairly well with those obtained from short-circuit tests. These are as follows (though not given in this form by Walker in his book):—

$3{\cdot}55\lambda_0' = 2{\cdot}8$ for a three-phase winding with a two or three-plane overhang.

$= 1{\cdot}8$ for a three-phase winding with a two-layer overhang.

In turbo-alternators, the overhang leakage is usually much larger than the slot leakage flux, but in slow-speed machines the two leakages are often of the same order.

From the ratios Φ_s/Φ and Φ_0/Φ, it is now possible to obtain E_s and E_0 as a percentage of E straightaway, and so draw the vector diagram in Fig. 2.

Reactance of Stator Winding.—Some designers prefer to work with the reactance pressure instead of the leakage flux, and for this purpose we develop the expression for the inductance of a coil, and so obtain E_x straightaway.

In general, it may be said that the accurate calculation of the inductance is not nearly so important in alternators as in induction motors, especially since automatic pressure regulators have become so widely used with alternating-current generators. Whilst regulation has become less important, however, short-circuit effects have become more important, making high leakage desirable to limit the rush of current at the instant of short-circuit.

(To be continued.)

CONVERSION OF LIGHT INTO ELECTRICAL ENERGY.

BY THEODORE W. CASE.

Summary.—The announcement in the daily press that experiments are being carried out by Mr. T. W. Case in Florida on obtaining electric energy directly from sunlight gives added interest to a Paper which was read last year by Mr. Case before the New York Electrical Society. In this Paper the results obtained from a cell containing two copper plates, one being bright and the other oxidised, are described.

After some preliminary, more or less unsuccessful, experiments, a cell was made by winding a cork with two copper wires, opposed to each other, as electrodes, under tap water. When both copper wires were exposed to intermittent light, naturally no results were obtained; but, upon shielding one of the copper wires from the light a note was again heard in telephone receivers. The conclusion was reached that the copper wire, under the influence of the intermittent light, must be producing the current. But this arrangement would work at times, and not at others. It was then found that this was due to the fact that some parts of the Cu wire used were oxidised and other parts were not. One of the Cu wires was then cleaned with emery paper and the other Cu wire was highly oxidised in a Bunsen flame before being wound on the cork. With this construction the notes on the telephone were far louder than before.

As soon as it was found that the copper oxide electrode was the one that had been reacting a larger cell was constructed, consisting of two copper plates, instead of wires, both plates having been oxidised in a flame, immersed in tap water, and placed one behind the other, with light shining on the front plate. The back plate, or the one shielded from the light, acted as the zinc plate in an ordinary battery. NaCl was put into the water to reduce the internal resistance, and a much stronger current was produced. In bright sunlight, a deflection of 45 deg. to 50 deg. was noted. When the light was thrown on what was formerly the back plate, the formerly exposed front plate would, while in the dark, act as the zinc. In other words, the plate in the dark always acts as the zinc.

Next the action of polished copper plates, not oxidised, was tried in the NaCl solution, under the influence of light. The plate exposed to the light gradually, during 15 to 20 minutes, changed to a reddish colour; then quickly to a very dark purple, and, finally, to a greyish black. This cell was then tried with a galvanometer and found in its reaction similar to the above cells in which the front plates were oxidised in the flame, except that the reaction was very much weaker. The back plate acts as the zinc, and the cell is in every way, except in intensity of reaction, similar to the cells which have oxidised plates. The polished copper plates do not turn this dark purple except under the influence of light. However, polished copper immersed in NaCl solution will turn a reddish tint in the dark, which was taken to be Cu_2O; then, if exposed to light, will turn to dark purple, which is assumed to be a higher oxide. Only when this cell is short-circuited does the back plate undergo a marked change of appearance; it then grows darker in colour, although it always remains of a much lighter shade than the front plate which is being exposed to light.

To return to the cell in which the front plate is oxidised in a flame and the back plate is polished copper. Some of its peculiarities proved very interesting. If left short-circuited in the dark while not in use, the efficiency of the light reaction is greater upon exposure than when left open-circuited while not in use. Upon exposure of the front plate to light the reaction is practically instantaneous. However, after the rapid upward swing of the galvanometer needle, there is a continuous slow upward swing, lasting a few seconds, before the complete swing is reached. If the light be left on for a short time, fatigue is noticeable. This, at present, cannot be explained, but it may be due to the absorption of gases. In this fatigue, however, the galvanometer needle only drops a few degrees and then seems to remain there. If the cell be rested in the dark, recovery is then evident upon again exposing the cell to light.

Digitized by Google

If light be cut off from the cell, the needle drops quickly for a few degrees only. Assume the reading to be 40 deg. on the galvanometer when first exposed to the light; then the light be shut off, the needle will drop to 15 deg. almost instantly; but from 15 deg. to zero, it will drop slowly, due to some after effect. The needle will finally come to zero within two or three minutes; then, in most cells, will reverse three or four degrees; then come to zero and remain there. The reversibility in the dark, after exposure, seems to depend upon the strength of the NaCl solution, for zero is reached almost instantly in a very dense solution, but much more slowly, as above described, in weaker solutions.

The output of the cell depends upon the strength of the NaCl solution. The weaker the solution, up to a certain point, the better the results. For instance, 1·005 Beaumé sp.gr. of electrolyte gives the best result. A cell 3 in. by 4 in. gives 1/10 of a volt in sunlight and about 1/2,000 of an ampere. Upon increasing the strength of the NaCl solution the amperes increase, as would be expected in lessening the internal resistance of the cell; but the voltage drops quickly.

The effect of the spectrum on a small cell, which was made for this particular purpose, is of great interest. It was found that the red end of the spectrum was the most effective, especially the lower red end.

Better results are attained if the back of the exposed plate be heavily painted or enamelled, or insulated in some way, so that no local action will occur between the front of the exposed plate and its back.

When these cells are newly made, if they be left in the dark, say, over night before being used, the cells will act much better the next morning than when first made, and will continue to do so thereafter.

In experiments conducted in Florida during the last winter in strong sunlight, the following results were obtained: A cell was constructed with two polished plates of nearly pure copper about 6 in. square, immersed in the electrolyte of very dilute salt water. One electrode was supposed to have been entirely in the dark, since it was wrapped in several thicknesses of blotting papers, and since all of the jar except that which covered the front plate was painted black. The front plate, as above, had been oxidised in a Bunsen burner, and the back plate polished. At noon, on a clear day, the E.M.F. observed was a little over 1/10 of a volt. And from a larger cell the current obtained was over 2/10 of an ampere.

If salt water be used as the electrolyte and air be not excluded, the copper oxide is attacked by oxygen in the water and by the carbonic acid gas present, which forms basic carbonate of copper and perhaps a basic chloride. This will be noticed as a green flocculent substance in the cell, an objection which can be greatly reduced by putting oil on top of the electrolyte to exclude gases and prevent evaporation.

Two theories suggest themselves by which the action of this cell may be explained:—

1. The electron theory.

2. The chemical theory—namely, that the front plate, or contiguous liquid layer, undergoes chemical change, under the influence of light, which causes a flow of current. At present, the evidence seems to point rather to the electron theory as the conditioning agent, and the chemical theory as a secondary effect and not the primary.

The Cu plates when being heated in the flame become oxidised to Cu_2O, then to CuO. The Cu plates, whose outer black coating has been removed, thereby leaving the red coating, do not act nearly as efficiently as when the outer black coating is not removed.

CHEMICAL COMPOSITION VERSUS ELECTRICAL CONDUCTIVITY.*

BY C. G. FINK.

Summary.—The electrical conductivity of complex cold charges of an electric resistance furnace has been found to be dependent upon the average size of the coke particles in the charge. A theory is developed applying to the conductivity of metals and gels, flaming arc electrodes and compound brushes, porcelain and other insulators.

Some years ago the author carried out a number of experiments on the electrothermic production of ultramarine. Powdered mixtures of sodium sulphide, china clay and carbon were interposed between carbon electrodes in a closed crucible furnace. In order to keep the electrical resistance and the temperature of the charge fairly low so as to avoid decomposition of the ultramarine very finely divided carbon, such as lampblack, was necessary. With charges made up of coarse powdered coke no appreciable current would pass between the carbon electrodes up to potentials of 250 volts. It has been found repeatedly that the electrical conductivity of mixtures of finely divided substances is a function of the relative size of the components.

Experimental.—A series of tests was made in order to get values of a more quantitative nature. Two substances were selected, the physical properties of the one as divergent as possible from those of the other—a black metal powder, tungsten, and a white insulator powder, thoria. Both tungsten and thoria will stand very high temperatures and can therefore be made practically moisture-proof. (In all high-resistance tests adsorbed moisture is a very disturbing factor.) Other factors that decided the selection of tungsten and thoria were: (1) High state of purity; (2) availability of both in extremely fine powdered form (readily sifted through 250 mesh gauze); (3) constancy and stability under ordinary atmospheric conditions; (4) sharp distinction in colour; (5) high specific gravities (which reduced the tendency to dust).

All mixtures here recorded were made up of equal weights of tungsten and thoria. The mixtures would pass readily through silk, having 250 meshes to the inch. The holes in this silk are about 0·001 in. in diameter. All attempts to segregate particles of a well-defined size by such methods as suspending in water, organic liquids or air, were frustrated on account of the persistent tendency of the very fine particles to form agglomerates.

We finally resorted to the familiar "tap test." This gave us fairly good comparative values of the fineness of the various powders used. Ten grammes of the powder or powder mixture were filled into a 10 cubic cm. glass graduate and tapped to constant volume; usually, after seven minutes no further decrease in volume could be detected. It can easily be demonstrated that the values so obtained are a function of the density and mean particle size. In the ordinary preparation of metal or oxide powders in single small lots by far the greater majority of particles are approximately of the same size. This tendency to form a "standard" size is a universal phenomenon, the dimensions of any particular standard being dependent upon the physical conditions such as temperature, strength of solution, &c., under which the particular powder is prepared.

The thoria powders varied in relative fineness between 0·720 and 0·238 and the tungsten powders between 0·577 and 0·113 cubic cm. per gramme. The calculated values of mixtures agree fairly well with the experimental, and support the contention that the particles of any freshly prepared powder are of fairly uniform size.

If the relative volume for the white powder is high as compared with the value of the black powder, the appearance of the mixture is white; if the white poswer is coarser than the black powder, the appearance of the mixture is black.

Electrical Measurements.—The powders were pressed into rods 4 cm. long and 0·5 cm. square. They were then placed in a tungsten-hydrogen furnace, and fired at 1,600-1,650 deg. for three hours. This firing caused the rods to sinter together, and rendered them practically proof against moisture. The fired rods were kept in a P_2O_5 desiccator.

The rods were then mounted between brass clamps, and the resistance measured on a Wheatstone bridge with a sensitive galvanometer. Care was taken to make these measurements on days when the humidity of the air was low.

In view of the differences in "colour" of the various mixtures in the powdered form, it was not very surprising to find marked differences in the electrical resistances although the firing at 1,600 deg. resulted in an almost uniform shade for all of the mixtures. In Table I. below are recorded four of the characteristic resistance values found. In the last column are the calculated specific resistances values:—

Table I.

Powder.	Resistance.	Resistivity.
ThO_2 No. 2	Over 10^{12} ohms.	Over 10^{12} ohms.
Z	41·8	173·0
X	0·0271	0·108
W No. 1	0·0040	0·016

The powders, ThO_2 No. 2 and W No. 1, were pressed up into rods the same size as those for the mixtures; they were likewise fired at 1,600 deg. for three hours.

Since in all of our original powders a small percentage of grains was present whose size was considerably smaller than that of the majority of the grains, the results tend to show that under ideal conditions of mixture, relative grain size, uniform distribution, &c., the resistivity values for white mixtures such as Z would be even higher than here recorded. Similarly, the resistivity values for black mixtures such as X would be even lower than those found, approaching a limiting value equal to twice that of the 100 per cent. metal rod.

Conclusion.—In general we may conclude that the electrical con

* Abstract of an article in the "General Electric Review (U.S.A.)."

Digitized by Google

ductivity of a substance is primarily dependent upon the shape and the distribution of the fundamental grains or particles composing the substance, and, secondly, upon the presence or absence of thin films of secondary material enveloping these ultimate grains.

On the basis of this theory we can account for the comparatively high conductivity of gels that contain but a trace of conducting material. We can also account for the marked difference in resistance of, say, two samples of commercial copper, whose chemical composition is identical, depending upon whether the impurity, such as sulphur, is uniformly dissolved in the metal or whether it forms a film (" cement ") of copper sulphide around pure granules of copper. The latter case is to be regarded as an emulsification of copper in copper sulphide. The high resistance of these surface films composed of, say, sulphide or oxide or arsenide accounts for the high resistivity values of copper containing but a trace of one or more of these impurities.

INDUSTRIAL DEMOCRACY: WITH PARTICULAR REFERENCE TO THE RELATIONS BETWEEN CAPITAL AND LABOUR.*

BY GEORGE WESTON.

It is desirable in all branches of industry to substitute co-operation for strife, and for Capital and Labour (employer and employed) to work together for their common good, to co-ordinate their efforts into collective action in the pursuit of their mutual well being, and for each to understand and assume his full obligation to the public. This Paper, however, will be directed principally to public utility companies upon the basis of service to the public, and fairness and justice to all concerned.

The subject of improved relations between Capital and Labour has been discussed at great length, but usually from extreme partisan viewpoints, with Labour and Capital arrayed against each other.

Hostility between Capital and Labour is unjustifiable and wrong. It is founded upon the theory that the interests of one are antagonistic to the interests of the other, and therefore there can be nothing common between them; a theory erroneously fostered and encouraged and seemingly taken for granted by the rank and file. This is a false doctrine because their interests are similar; at least they are not antagonistic. Justice can be done to both Capital and Labour without warfare.

There are two sides to the question, Labour and Capital, and they both are entitled to fair treatment, but up to the present time frequent and serious disagreements have arisen resulting in riots, strikes, destruction of property, and the forcing of increased wages without considering its effect upon the income accounts of all parties affected, or " higher cost of living," or the general economics of the country, all of which are disastrous, and in the end the public pays the bill. The conditions attendant upon this situation are becoming grave and must be corrected to save our country from business and financial failure.

I am a champion of the rights of labour. It should receive its just reward and in full measure. I am opposed however, to a one-sided system of forcing a selfish principle upon others by threats, mob law or otherwise, without care as to its effect upon their neighbour, the public in general or the economic questions of the nation. The necessity for a public utility is the need of some class of service to the public, and this requires capital investment and the work of labour skilled in the different branches necessary to create the property and operate it, and both should receive a fair return for its service; but neither Capital nor Labour should be permitted to exploit the property for unreasonable gain or for the exercise of objectionable coercive union or political power.

Capital should not be permitted to pile up huge profits at the expense of underpaid labour. Capital and Labour should be partners in the business, each receiving its fair return from the net profits. When Labour understands that it will be placed upon a footing equal to that of Capital, that there will be no aristocracy of Capital growing unjustly rich from the fruits of their labour, but instead that there will be one great democracy of interests building up a great public utility to serve the people, and that each worker and each contributor of a dollar to Capital investment will be treated alike, and receive his just and fair portion of the earnings, then the present general feeling of jealousy, dissatisfaction and unrest will disappear, and harmony and general good feeling will be restored.

My connection with public utility matters for many years has caused me to give this subject thought and study, and at the time of the street and elevated railway strike in Chicago, June, 1915, I compiled the following fundamentals:—

1. Capital and Labour are dependent one upon the other.
2. Capital cannot be successfully employed without the help of Labour, and Labour cannot be profitably employed without the assistance of Capital.
3. From this fact it seems most fair and equitable that each should participate fairly in the results of their joint efforts.
4. This principle should be the fundamental economic basis upon which to consider the relations between Capital and Labour.
5. That the two chief elements necessary to create and operate a public utility have the same fundamental interest in properly performing the obligation to the public assumed in the franchise of the public utility.
6. This obligation should be inviolate in principle and good service to the public should be the first consideration in the operation of a public utility property.
7. The obligation to give good service to the public falls upon Labour as much as upon Capital. Consequently, all legitimate and fair operating expenses necessary to give good service must be considered, as well as all reserve funds necessary for the upkeep of the property or other franchise obligations, before any increased division should be made to Capital or Labour.
8. After having fulfilled all franchise obligations then any remaining earnings should be disposed of upon some fair basis to the benefit of both Labour and Capital.
9. It would be unfair to increase the share to capital beyond a reasonable return upon the investment and not increase the return to Labour, and it would be unfair to increase the return to Labour by reducing the return to Capital below a reasonably fair amount.
10. From the fact that service to the public should be the first consideration of any public utility it should be unlawful for the employés to conspire to " strike " or the employers to conspire to " lock out."
11. It would seem that either a National, State or city court or Board of Arbitration should be established by law, to which body should be referred all matters of dispute between employer and employés that cannot be settled between themselves, and this should be accompanied by a law making it a penal offence for employés to conspire to " strike " or for employers to conspire to " lock-out."

The above fundamentals are based upon a viewpoint of fairness and impartiality. The recent steam railroad crisis has again brought this subject to my mind, impressing me with its increasing importance. The hurried passage of legislation without thorough and careful consideration and analysis depicts the menace that accompanies present conditions. It is certainly a grave situation when the brotherhoods of steam railway employés have the power to call a strike and tie up every steam railroad line in the United States, with the consequent paralysis of business and great financial loss and injury to the general public and to have it possible for them to stampede the President and Congress into the passage of hasty and questionable legislation.

Such legislation does not cure the evil, but acts only as a temporary estoppel of the exercise of mob law and to falsely encourage the labour leaders into believing that their strike tactics are justifiable.

Our country is essentially one of industry, and industrial success requires the co-operation of capital and labour—a co-operation based upon fraternalism instead of strife and discord. We must extend scientific management to include at least the necessary wants of the workman and his family in the beginning of his period of labour and make it possible for him to increase his earnings in the future in accordance with his individual growth and advancement so he can provide more of the pleasures and advantages for them.

Industrial democracy includes many factors and its ramifications are far reaching. In addition to those specifically touched upon herein are the following that I will mention—and these are not all: High wages; high cost of living; assurance of the more capable man in the more responsible position; the top must be recruited from the bottom; unity of action for the common good: high wages should mean maximum output; high wages with minimum output means " high cost of living."

It often becomes necessary for persons or people to be protected against themselves, and I am herein recommending forced arbitration and legislation to prevent by law strikes or lockouts. Not upon the basis of attacking either Labour or Capital, but to prevent them from conducting warfare based upon erroneous principles that in the end only tend to tear down and disintegrate, and substitute for them principles of justice and fair dealing, which latter will endure for ever.

Much time and effort has been spent in the past to enact legislation to control Capital—" Combination in restraint of trade " " concentration of capital," " railroad pooling," &c. Is it fair

* Abstract of a Paper read before the Western Society of Engineers.

Digitized by Google

to the general public to exact legislation to control one element of rate making and tolerate unlimited organisation in another element, and to use its united power by threats and co rcion to accomplish its selfish ends, to create riot, and conditions akin to civil war ?

A division of net earnings between capital and labour (employer and employed) is commonly referred to as " profit sharing," and in the cases of smaller corporations and partnership businesses that have adopted the principle is variously apportioned ; in some instances a bonus based upon percentage of sales or a per cent. increase upon the annual wage or some other basis of division mutually satisfactory.

With large corporations and public utility companies where profit sharing has been adopted, various plans have been pursued from merely recognising the principle through the establishment of " old age pensions," Christmas gifts equal to a small percentage of the annual wage, to the apportioning of a certain per cent. of the gross income to regulate the total return to labour, as in the case of the Philadelphia Rapid Transit Company, which, several years ago, instituted the principle of " profit sharing," apportioning 22 per cent. of the gross to labour. Other corporations in addition to adopting direct profit sharing, encourage the purchase of stock in the company, so that the employés become part owners of the business. Where real profit sharing has been adopted its beneficial effects upon the relations between employer and employed have been marked. The workmen take a personal interest in developing efficiency measures that lead to economies and better service to the public.

" Profit sharing," as it has been practised in the past, differs from " industrial democracy " as advanced in this Paper in the sense that the initiation of " profit sharing " and its discontinuance has been optional with the employer, while industrial democracy applied to public utilities, as intended by this Paper, means that along lines to be fair and equitable to all parties, capital, labour and the general public, the continuity of service to the public shall be regulated by law, nationally to the extent applicable, and by state and city legislation to the extent necessary, and that the character of service, rates, and the distribution of gross earnings shall either be regulated by law or supervised by a board or boards of control established by law. It is the duty of the public officials created by law, particularly the law-makers, to command what is right and to prohibit what is wrong, and to take the " middle of the road " in dealing with the subject, and go straight through to the end without fear or favour.

With large public utility companies the following basis of " profit sharing " offers a simple method of adjusting income distribution so that capital and labour will each receive its just share. It must be conceded that the wages of labour at the present time in the United States are high by comparison with any previous time in its history, or with any other nation, and therefore present wages can be taken as the minimum return to labour and be used as a fair basis for future pay-rolls to be charged to operating account or be readjusted from time to time as the limitations of the gross income may require. The total amount thus paid will establish the per cent. of the gross receipts paid to labour.

It is also necessary to have determined what is a fair percentage of return for capital, including sufficient to care for extra hazards of the business and corporate organisation expense, &c. ; this, together with general operating expense, including taxes, renewals, any other necessary reserve funds, franchise obligations and the establishment of a cash working reserve, should be first deducted from gross income, and the residue, if any, divided between labour and capital in the proportion that the total per cent. of gross paid in wages to labour bears to the per cent. of " fair return to capital."

DISCUSSION.

In what follows we give a few extracts from the discussion :—

Mr. IRA DYE : A surprisingly large number of financially successful men think that it pays to hold down wages of the workmen in their factories, on their trains, &c., until these workmen actually refuse to go on at the old rate. This produces an absolutely appalling quantity of discontent, and, more tangibly, slowing down of production. Probably some managers know this. Every workman knows it, and nearly all do it. Why do these men deliberately waste all the time they can ? Simply because they know from experience that extra effort will not be rewarded, at least, not until they strike. There will be men who deny this. Let them take a hammer and chisel and go into the shop and chip castings for 60 days, and they will know it. I shall not say there is only one way to bring about industrial peace and boost the human efficiency of our mines, mills, railroads and factories. I may say, however, that there is one way to do this without shock or expense—it will pay for itself. Let every corporation in America beat its employés to the strike by giving the inevitable rise in wages in the form of stock in the corporation—fractional certificates, pehaps. Let every labour organisation counsel and urge its members to put their savings into the securities of the employing companies. Make it easy to do so by taking the stock out of the hands of jugglers of prices—a little at a time, as the employés take it up. Elect a labour man or two on the board of directors and put a few of the directors' sons in the shop or on the trains. The plan is not new, in the idea. It is new only in insisting that the policy must be as widespread as the corporation, as a business machine.

Mr. C. W. BALBRIDGE : The relations between labour and capital as usually discussed refer to the relations between labour organisations, or unions, and their employés, and many people do not differentiate between the rights of a labourer as an individual and the rights of labour as an organisation. This is particularly true of the members of the labour organisations themselves. They are very ready to claim the benefits derived from organisation, but very loath to accept the responsibilities which must go with the act of organisation. Any person who will consider the matter calmly and without bias must realise that no large organisation, whether of labour or capital, can be permitted to exercise powers which they do not possess as individuals, or individual ownership in the case of capital, and at the same time claim and exercise the rights and exemptions enjoyed by the individual. To the present time, through fear of the voting strength of the labour organisations, legislative bodies have failed to pass any laws for the proper guidance and control of the power and strength of the labour organisations. The recently threatened and still menacing railway strike is serving to arouse the public to the fact that organised labour is not the only part of the body politic which has rights, and while no one wishes to deny the labourers their rights, the public has a paramount right to insist that organised labour shall not enforce its rights to the great detriment and inconvenience of the much greater number. It is, therefore, incumbent upon the public to insist that laws be passed to prevent needless injury upon the many, and to provide a means whereby the labourers may secure their rights by orderly process and without needless injury to others. Instead of opposing the creation of an orderly process for the settlement of organised labour disputes, the members of unions should take a leaf from the experience of capital and endeavour to mould such legislation fairly, instead of opposing it, until the public becomes aroused and causes the passage of adverse legislation, as has happened in the case of the railways. No one wants to deny any individual the right to quit his job at such time as he sees fit, provided it is a bona fide action, but there is a very clear distinction between a bona fide quitting of a job and a strike or walk-out. Neither does any fair-minded person want to deny to any employer the right to discharge any individual employé when his services are unsatisfactory, or to lay off his forces when their continual employment means an actual and serious loss to him, but such an action is also clearly different from a lock-out. There is one other thought which I want to mention, and that is that in the minds of many people, labour organisations are right. We continually hear the expression that labour organisations are right and that they are doing wonderful things for their members. If this is true, why should we leave them to the necessity of fighting for everything they get ? Why make it necessary for them to lose time and pay and inflict punishment upon themselves and the public in order to inflict sufficient punishment upon their employers to enforce their demands ? Why not provide by law an orderly process for securing their rights, without inflicting the loss upon themselves and others which is necessary through the present process ?

Mr. F. H. BERNHARD : I believe that the commission should have the authority to fix not merely rates and pass on matters of stocks and bonds, but also to act as arbitrators when it comes to a question of differences of opinion between the public utility and its employés. It seems to me that this is only a perfectly natural and logical development of the public service regulation idea, and that it affords a very simple means of solving the frequently vexatious problem of the relationship between the public utility and its employés.

Mr. S. MONTGOMERY : In connection with the profit-sharing proposition, you have something that seems to me, upon analysis, to be entirely impracticable. As soon as you begin to weigh one manufacturer or one public utility corporation against another and allow for the amount of water that has been injected into one and the amount of milk that has been removed from another, you have a condition in which the return on capital would be something less than zero in one case and a very fair return in another case, assuming you have fixed wages. If you are going to divide the surplus above a legitimate return to capital, among the employés, that practically means an increased wage scale in certain sections. The same thing would apply in manufacturing corporations. One automobile manufacturer may, through a combination or circumstances and ability, succeed in paying enormous dividends when he is buying material at the same price, or buying labour at the same rates as other manufacturers, who fail. Now, if you are going to fix rates for labour in the automobile business by the available surplus for distribution to the employés of the most fortunate automobile manufacturer, you simply give him a monopoly of the automobile business, because no one else could manufacture automobiles at all. But, on the other hand, if you are going to fix wages for employés in the automobile trade in proportion to the capital and the returns on capital of some of the companies that failed, you will find that some of the employés would have to be paying a penalty for working for the automobile manufacturer. The whole proposition of profit-sharing is so utterly mixed up that it seems hopeless to do anything with it. The thing, however, that is of some importance for the time being in connection with the disputes between capital and labour is the element of restriction of output. The rank and file believe that if half the men in the world became twice as efficient, the other men would be out of employment, and that therefore it was the duty of every conscientious citizen to do just half as much work as he is able to do, so there would be just twice as many jobs.

Digitized by Google

The Electrician.

FRIDAY, AUGUST 17th, 1917.

Editorial and Publishing Offices:—

8, BOUVERIE STREET, LONDON, E.C. 4.

Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

SOME AMERICAN VIEWS OF CAPITAL AND LABOUR.

At the present day it is a very interesting study to follow what is happening in the United States under the stress of war. So far, of course, this stress is scarcely felt; it takes time to operate, and the weak points of national arrangements are only discovered after a time. Compared with Great Britain, the United States may be looked upon as a new country, not bound by precedent and long standing customs; and therefore we should expect the effect of war conditions to be somewhat different from what we have experienced, more particularly as in the United States they have had the advantage of lengthy warning, whereas with us the war came as a thief in the night. Many interesting speculations present themselves. Will there be difficulties with labour? Will there be inefficiency in high places? Will the right man be in the right place, or will there be many round pegs in square holes? Already there is evidence that some of the troubles through which this country has passed are being felt in the United States.

From the labour point of view, the opinions expressed in a discussion held by the Western Society of Engineers (of Chicago) are of some interest. In his Paper, Mr. GEORGE WESTON lays down certain doctrines, such, for example, as the view that capital and labour are not necessarily antagonistic; that a one-sided system of forcing a selfish principle upon others by threats, mob law or otherwise, should be opposed; that capital should not be permitted to pile up huge profits at the expense of underpaid labour; and that when labour understands that it will be placed upon a footing equal to that of capital, that each worker and each contributor of one dollar to capital investment will be treated alike, the present feeling of dissatisfaction and unrest will disappear.

These statements we may regard as ideals. Their realisation depends to a large extent upon the definition of equality between capital and labour. Is such equality possible? Or is it even desired on the part of labour? We do not think it is. The shareholder will risk going without his dividend, but the workman will not, and cannot, risk going without his wages.

Of the various methods proposed to relieve the tension between capital and labour that of profit sharing has figured largely. Apart from the difficulty of deciding what share should be allotted to labour, there is the further difficulty that a successful concern would be at a very great advantage compared with one that is unsuccessful, or even only moderately successful, in the terms that could be offered to the workers. Profit sharing, if it embraced a considerable proportion of the profit, might have the effect of raising the standard of wages to the detriment of less successful firms, and would tend towards monopoly on the part of those who are more successful. Thus it is questionable whether good wages are not preferable to any considerable participation of profits in the form of profit sharing. From this point of view there is much, we think, to be said in favour of co-partnership schemes, provided they are applied so as to free the worker from needless financial risk, and they have the great advantage that the worker has a permanent, and probably increasing, interest in the firm in which he is employed.

Unfortunately, there is much ignorant and foolish talk at the present day by persons who apparently only look on one side of the question, and such talk is capable of doing an infinite amount of harm. For example, we read in the "Herald" that "there is no cure for industrial unrest short of the destruction of capitalism," and similar phrases are common enough in a certain class of literature. We very much doubt if the writer of this sentence knows the meaning of it; but if he does know the meaning he should proceed to define it. Labour has never yet been able to do without capital, and certainly cannot do without capital any more than capital can do without labour. The mere shifting of capital from private hands into the hands of the Government, which is the dream of some Socialists does not eliminate capital, but inevitably leads to its more inefficient use. Supposing any such socialistic scheme came into being in this country, how should we compete commercially against Germany and other countries? Would our people be content to increase the cost of our own products and not to purchase imported products from cheaper markets? Whereas the older workers may realise such points as these, the younger men are often ready to be led away by entirely fallacious arguments. It should surely be part of our scheme of national education to teach some of the elements on which the wealth and industry of a nation depend. Perhaps it is not too much to hope that this aspect will not be lost to sight in overhauling our educational system. Progress for labour, or any other section, cannot thrive on fallacies.

Part of this feeling towards capital is due to the idea that large sums of money are paid to those who manage industrial concerns, and who, in the popular mind, sit in an arm chair and do nothing—or at least have a very easy time. In two interesting articles in the "Fortnightly Review" last year, Mr. W. H. MALLOCK pointed out that labour in these days is able to earn far more than was possible some centuries ago. This is not due to the worker's capacity being any greater. It is due to the fact that every operation is partly mental and partly manual. In the modern factory the mental part is isolated from the manual, and one man of practical genius is enabled to do the thinking for a thousand, or it may be for thousands, of average men. The average man is thus able to do more than would be otherwise possible, the average performance is raised and the average product increased. Although the thinking man at the top may, in the eyes of some people, be the embodiment of capital, that is no reason why both he and capital should not have their reward. On the other hand, there is no reason to ignore the just claims of labour.

Much of the talk and unrest at the present day is due to ignorance, to restricted outlook, and to the false idea that wages may be increased indefinitely without increasing the cost of living. If labour is to obtain some of the legitimate objects at which it is aiming in the near future, it must be prepared not to adopt any uncompromising attitude; it must rather be prepared to realise also the claims of other sections of the community, and to look at matters in the light of knowledge instead of ignorance. Otherwise we may emulate the unfortunate spectacle presented by Russia at the present time—a condition brought about by high ideals based upon ignorance of the extent to which such ideals are practicable.

Digitized by Google

THE PRODUCTION AND DISTRIBUTION OF POWER AND ITS INFLUENCE ON THE DEVELOPMENT OF IRISH INDUSTRY.*

BY J. F. CROWLEY, D.SC., B.A.

At the congress held in Killarney in 1914 I had the honour of delivering a lecture † before this association on "Technical Education in connection with the Irish Woollen Trade." During the course of my remarks on that occasion I pointed out:—

That if cheap electrical power developed in central stations were distributed in the industrial areas, the capital required for the starting of factories would be considerably reduced. In England and Scotland it is possible to start manufacturing with small capital outlay, because of the advantages offered by "room and power" schemes. These schemes have been developed to such an extent in the cotton trade that buildings are erected and driving plant installed by syndicates with the express object of the whole being let to intending manufacturers at a yearly rental. Textile machinery is also hired out in many cases, and the advantages offered by such a system are obviously very great. The nearest approach we can hope to make to it in this country (Ireland) is in the provision and distribution of power, and from the point of view of industrial development generally this question is of the greatest importance and might well form the subject of inquiry by a Royal Commission.

Since these words were written many developments have taken place, the most important, perhaps, being that the President of the Board of Trade has this year appointed an Electric Power Supply Committee. I think you will understand, therefore, that when you again extended to me an invitation to address you, I felt that I could not do better than enlarge on the earlier remarks I had made on this subject.

INTRODUCTION.

The Sun our Prime Source of Energy.—The prime source of all our energy, no matter in what form it may present itself to us, is the sun, and it may be valuable at the outset to have some quantitative ideas regarding the energy we are continually receiving from that body.

The most recent determination of the solar constant‡—viz., the amount of radiant heat which reaches our atmosphere from the sun in unit time—is 1·93 calories per square centimetre per minute. This heat, which passes without appreciable loss through the enormous distance separating us from the sun, suffers a loss of some 30 per cent. in passing normally through our atmosphere, and we receive on an acre of the earth's surface at noon on a clear day the heat equivalent of approximately 5,000 H.P. From experiments § carried out in Egypt in 1913 it would appear that the heat received on the surface of the earth, measured, of course, normally to the incident radiation, falls off towards evening and morning to 75 per cent. of the noonday maximum due "to the greater thickness of the atmosphere through which the radiation has to pass," while the absorption of solar energy by the atmosphere is about 20 per cent. greater in summer than in winter, possibly due "to there being a larger total quantity of water vapour in the atmosphere in summer than in winter." Of this vast quantity of energy a very small part is retained and stored through the agency of the chemical and physical changes it produces.

Available Stores of Energy.—The available sources of energy we owe to the sun may be conveniently divided into three classes:—

1. Those accumulated during long periods of time and stored for corresponding long periods, as brown coal, peat, lignite, coal, petroleum and natural gas.

2. Those accumulated during shorter periods and stored also for shorter periods, as wood and other vegetable products.

3. Those for which there is practically no natural storage, as water, the winds, the tides and the sun's radiant heat, which is now being used in the tropical belts of Africa for the production of power.

Having noted the various sources of energy on which we can draw, we may usefully consider those that are of greatest commercial utility to us. In the following table ‖ is given a statement of the total horse-power used for industrial purposes in the United Kingdom in 1915, excepting only that used for transport purposes on our railways, tramways, canals and ships, or employed in connection with agriculture:—

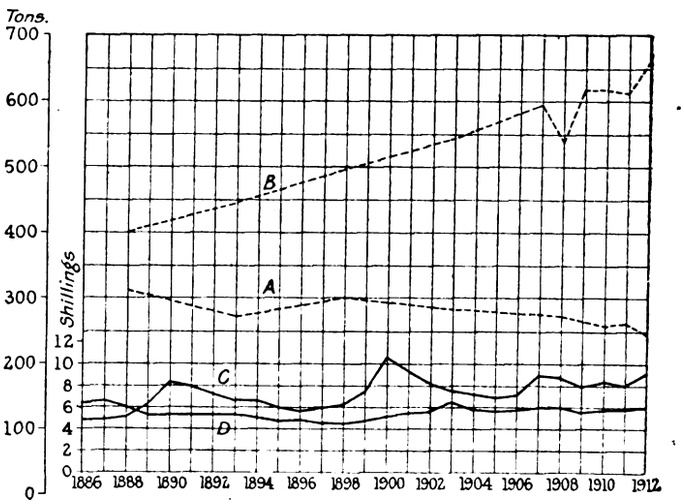
Steam engines.			Gas & oil engines, &c.	Water power.	Other power.	Total.
Recip.	Turbine.	Total.				
H.P.	H.P.	H.P.	H.P.	H.P.	H.P.	H.P.
9,294,742	531,202	9,825,944	680.227	178,157	70,681	10.755,009

The total horse-power for Ireland for the same year is given as 259,407 H.P.

Coal.—It will be noted that notwithstanding the many sources of power apparently open to us, over 90 per cent. of the power used in industry in the United Kingdom comes from reciprocating steam engines or steam turbines using coal as a prime source, and less than 10 per cent. is derived from all other sources. Coal, therefore, is our principal source of power, and it is important to inquire how we stand with regard to our supplies of it.

In 1905 it was estimated* that "the available quantity of coal in the proved coalfields of the United Kingdom was 100,914,668,167 tons, and in the unproved coalfields 39,483,000,000 tons at depths of less than 4,000 ft. in both cases while the total figures for available coal in Ireland † are given as 174,458,000 tons. The amount of coal raised in the United Kingdom in 1903 was 230,334,469 tons. The average yearly output for Ireland between the years 1880 and 1902 was 115,500 tons, and for the past 12 years only 86,000 tons, with average yearly imports during the same period of 4,574,234 tons. Of the total coal raised annually in the United Kingdom, 63,805,000 tons are exported in one form or another, the remainder being consumed at home. Apparently, then, if we ignore the needs of future generations we can continue to use coal at our present rate for a very considerable time without any fear of exhausting our supplies.

There is another side to this matter, however. According to the Coal Commissioners' (1905) Report, we may look forward to a time not far distant when the rate of increase of output will be slower, to be followed by a period of stationary output, and then a gradual decline.



CURVES OF OUTPUT AND VALUE OF COAL.

A = Tons of Coal produced per Annum per Person Employed, United Kingdom.
B = " " " " " " United States.
C = Average Value of Coal per Ton at Pits Mouth, United Kingdom.
D = " " " " " " United States.

We can view this matter also from another point of view. In the above diagram *A* shows the output of coal per operative per annum for the United Kingdom from 1886 to 1912, while *B* gives similar figures for the United States. The steady yearly increase in output in the United States and a rapid yearly decrease in the United Kingdom are clearly marked. Curves *C* and *D* show the corresponding alterations in the price of coal at the pit mouth in both countries for the same period, and indicate the maintenance of a steady average price in the States, as against a steady advance in price here. We see, then, that while our supplies of coal are very great, we cannot go on increasing our yearly output indefinitely, and the price of coal at the pit mouth is steadily advancing, while, on the other hand, our need of this important commodity is steadily growing. We must, therefore, seek some methods of economising in the use of coal employed for power purposes, and may consider the following possible methods:—

(*a*) A reduction in the amount of power used for industrial purposes.

(*b*) The development of alternative sources of power.

(*c*) Economy in the methods of producing, transmitting, distributing and applying power.

I propose taking these possible methods of economy in order.

* A Paper read before the Irish Technical Instruction Congress. Slightly abbreviated.

† "Technical Education in Connection with the Irish Woollen Trade," J. F. Crowley, "Journal of the Department of Agriculture and Technical Instruction," Vol. XIV., No. 4.

‡ C. G. Abbott, Smithsonian Institution, 1913.

§ A. S. E. Ackermann, "Journal of the Royal Society of Arts," Vol. LXIII., No. 3,258.

‖ "Census of Production (1907) (Cd. 6.320)."

* "Royal Commission on Coal Supplies (1905) (Cd. 2.353)."

† "Royal Commission on Coal Supplies (1905)," Prof. Hull's Report on Available Coal Resources of District G (Ireland).

Digitized by Google

REDUCTION IN THE AMOUNT OF POWER USED IN INDUSTRY.

In considering whether it is practicable to reduce the amount of power used in industry, the following table compiled from figures given in the Census of Production (1907) Report* should be of interest :—

—	1. Excess of value of work done over cost of materials used.	2. No. of operatives.	3. Engines owned. Total H.P.	4. Net output per operative.	5. H.P. per operative.
England & Wales	602,994,000	5,808,269	9,097,869	104	1·56
Scotland ..	86,364,000	885,403	1,397,733	98	1·57
Ireland ...	22,777,000	291,304	259,407	78	0·88

Column 1 gives the value of the total output of all the industries of the United Kingdom covered by the Census of Production, less the value of the raw materials purchased and the amount paid to other firms for work given out. This value is called the "net output," and is a figure of considerable value, as it gives without duplication the value added to the raw materials during manufacture.

Net Output per Operative per Annum.—Column 4 gives the "net output" per operative per annum, and *judiciously employed* is a figure of the greatest importance for comparing the efficiencies of various industries or groups of industries.

In a Paper read in Manchester † in 1912 I expressed the relation between the various quantities above referred to algebraically, as under :—

If M = the value in pounds of one year's raw material,
S = the value in pounds of one year's output,
N = the number of operatives, and
K_1 = a constant for a particular industry or group of industries.

Then $$M+K_1N=S. \quad \ldots\ldots\ldots \quad (1)$$

For the industries of the United Kingdom, taken as a whole, the constant K_1 has a value of 102.

Still following the method of treatment developed in the Paper referred to, and since the "net output" has to provide all wages, standing charges, and profits, we have :—

If P = profits in pounds per operative per annum,
C = cost of power per operative per annum,
R = rent, rates and taxes, maintenance interest and depreciation in pounds per operative per annum,
W = the wages in pounds per operative per annum,

$$P+C+R+W=K_1. \quad \ldots\ldots\ldots \quad (2)$$

From the Board of Trade Reports on Earnings and Hours of Labour, we obtain the average wages of all operatives in a given industry, and we thus obtain the value of W, which enables us to re-write (2) thus :—

$$P+C+R=K_2. \quad \ldots\ldots\ldots \quad (3)$$

The following table, which gives the values of certain of the above figures for industries which are of special importance to Ireland, may be of interest :—

—	H.P. per operative.	K_1.	W.	K_2.
Lace	0·28	98	£54·5	£43·5
Cotton	2·16	79	48·0	31·0
Wool & worsted, carpet flock & shoddy	1·23	70	40·0	30·0
Elastic webbing	0·36	68	37·0	31·0
Hosiery	0·15	61	38·5	22·5
Silk	0·58	55	34·5	20·5
Linen, jute & hemp (spinning & weaving)	1·09	61	31·5	29·5
Bleaching, dyeing, finishing & printing of textile goods	1·83	101	54·5	46·5

Net Output and Industrial Efficiency.—As already pointed out, it is usual to take the values of K_1 for different industries as indicating to some extent their efficiency as competing entities, and much information can be obtained by comparing the values of K_1 for British trades with corresponding figures for other countries where such are available. It must not be overlooked, however, when using this method, to compare even different industries in the same country, that factors peculiar to the industries compared have to be taken into consideration. It has, for instance, been pointed out * that low wages and a large proportion of female labour are usually associated with a low net output per operative per annum, while a high net output is found where an industry is heavily capitalised, or "where the output consists chiefly of patented or proprietary articles."

I would suggest also that K_2, a figure that is available for all countries for which K_1 can be obtained, forms a better basis for comparing industries as trading bodies abroad, since high wages, while they increase the value of K_1, have an adverse effect on ability to compete.

The only really practical test, however—and this is a point that must not be lost sight of—of the relative efficiencies of similar industries in different countries, considered from the point of view of successful trading, is the price at which they can place competitive articles on a suitably chosen neutral market.

Net Output and Power.—By a work * first published in 1916 public attention was focussed on the fact that, in comparing two similar trades in different countries, a high value of K_1 is almost invariably associated with a high horse-power per operative. The horse-power per operative for England, Scotland and Ireland, at the time of the last Census of Production, as given in a previous table, was 1·56, 1·57 and 0·88 respectively, the corresponding figures for K_1 being 104, 98 and 78. If we turn to America we find figures for K_1 varying over a wide range of industries between one and a half and three times as great as those for the United Kingdom, with a horse-power per operative between one and a half and six times as great. It should be noted that the various figures given for horse-power per operative in industry are based on the horse-power of the engines used, as returned, but since in the worst case this would make a difference of only 2 per cent., and in the average case much less, this is not a serious matter.

It should be clear, then, that if wages are to improve and capitalists to receive an increased return on their investments, both essential to the advancement of industry, an increased amount of power must be introduced into industry, and, instead of being able to effect coal economies in this direction, we must be prepared to meet fresh demands on our resources.

(*To be concluded*)

* "Census of Production, 1907 (Cd. 6320)."

† "The Individual Electric Drive in Weaving Sheds," J. F. Crowley, "Journal of the Association of Managers of Textile Works," Manchester, March, 1912.

* "Eclipse or Empire," H. B. Gray and Samuel Turner. (Nisbet & Co., Ltd.)

HALIFAX CORPORATION ELECTRICITY DEPARTMENT.

To cope with the rapidly extending demand for current in the Halifax area, the Corporation recently installed a new turbo-generating plant of 6,000 kw. capacity.

Five years ago it was decided to adopt for power supply purposes a three-phase sustem at 50 cycles 6,600 volts, and to instal a 1,500 kw. turbo-generator, the British Thomson-Houston Co. being given the contract for this together with the necessary switchgear; the Worthington Pump Co. were given the contract for the surface condensing plant. At the same time it was also decided to instal two 750 kw. rotary converters in order to convert the alternating current to continuous current for supplying the ordinary continuous current network for lighting and power purposes and the overhead lines for tramway purposes. The contracts for these rotary converters were also given to the British Thomson-Houston Co. The demand increased very rapidly, and a further turbo-generator with a capacity of 3,500 kw., together with surface condensing plant, was installed at the end of the year 1913, this plant being also divided between the British Thomson-Houston Co. and the Worthington Pump Co., while another 1,000 kw. rotary converter made by the British Thomson-Houston Co. was installed just as the war commenced in 1914. Owing to the rapid increase in demand for power purposes due to the war this plant soon became loaded up, and it was therefore decided to instal the 6,000 kw. turbo-generator referred to above. This plant was officially started up by Lady Rhondda, wife of the Food Controller, on July 19, 1917.

In the meantime the demand had been such that the existing 1,500 kw. and 3,500 kw. turbo-generators had been running practically on full-load for over 18 months without any spare, and it speaks well for the reliability of turbo plant that only one small breakdown occurred during the whole of that time, this being due to a very slight mishap on the governor gear of the small auxiliary turbine driving the condensing plant of the 3,500 kw. set, a repair being effected within three hours of the mishap occurring.

During the time when the above extensions were being made to the generating plant substantial additions had been made to the steam raising plant in the shape of four Babcock & Wilcox water-tube boilers, two capable of generating 21,000 lb. of steam per hour,

Digitized by Google

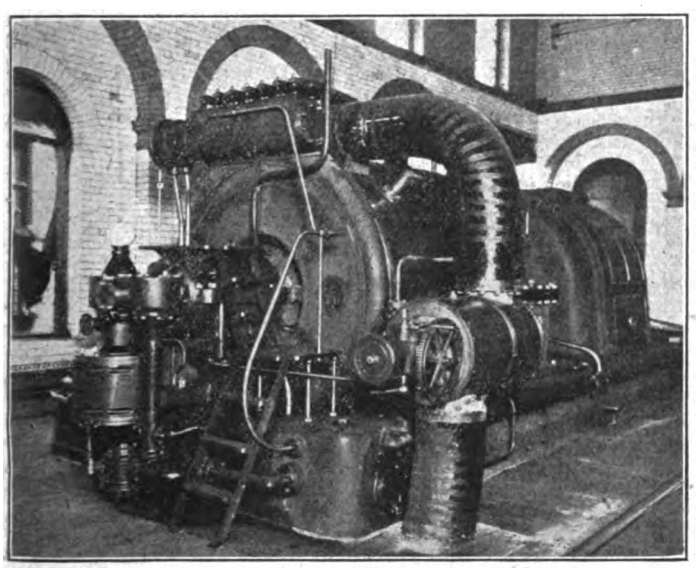
one of 30,000 lb. per hour, and the remaining boiler 27,000 lb. per hour. The two former are fitted with chain-grate stokers of Messrs. Babcock & Wilcox make, while the two latter are fitted with the underfeed type of stoker, as made by the Underfeed Stoker Co., the forced draught for these being provided by fans made by Messrs. Musgrave & Co., of Belfast. At the present time the boiler house plant is barely sufficient to cope with the demand, but another water-tube boiler by Messrs. Babcock & Wilcox is on order to evaporate 30,000 lb. of steam per hour, together with economisers by Messrs. E. Green & Co., and an induced draught fan by Messrs. Musgrave & Co. This plant should have been ready for delivery before the winter load comes on, but it is doubtful whether the delivery date promised will be kept, owing to the difficulty in obtaining material.

The normal full-load of the new turbo-alternator is 6,000 kw. at 100 per cent. power factor and 7,500 k.v.a. at 80 per cent. power factor. The alternator is capable of 25 per cent. overload output for a period of two hours at 80 per cent. power factor. The guaranteed steam consumption per kilowatt-hour at 100 per cent. power factor and with 28 in. vacuum is as follows:—

1½	full load	14·0 lb. per kilowatt-hour
1	,,	14·1 lb. ,, ,,
¾	,,	14·4 lb. ,, ,,
½	,,	15·3 lb. ,, ,,

the above figures being guaranteed with a 2½ per cent. margin.

The plant supplied by the Worthington Pump Co. (Ltd.) consists of a circular surface condenser with a cooling surface of



NEW PLANT AT HALIFAX.

16,500 sq. ft. The circulating pump is a 16 in. twin high-speed type, dealing with 12,500 gallons of water per minute against a total head of 42 ft., lifting the water to the top of the existing cooling towers.

The air pump is of a somewhat novel type, consisting of a 10 in. rotary air pump, and one 8 in. low-lift operating pump. These pumps take this water from a tank and discharge the same under suitable pressure through a regulating valve into the nozzle of an ejector, the nozzle being of angular shape. When leaving the nozzle the water passes through a wheel by which the angular jet is divided up into a number of jets of approximately rectangular cross-section, leaving sufficient space between each other for the entry of air and vapours removed from the condenser, at the same time the wheel imparts to the jets a rapidly revolving motion, as a result of which the water jets rush through the ejector cone and diffuser in the form of a helix with a pitch and velocity diminishing as the compression of air and vapours go on. The air and vapours from the condenser entering round the rotary transforming wheel are caught and enclosed by the issuing water jets and compressed on the way down to the diffuser discharge. The water discharged by the ejector into the tank gives up the air entrained, and is circulated over again by the centrifugal pump, and in order to prevent an undesirable rise in temperature in the operating water by the process, cold water is constantly supplied to the tank. We understand that the results of this apparatus have been highly satisfactory; it is extremly simple, and can run practically without attention. The vacuum obtained is excellent, and the power required moderate. It has the advantage that if air leaks open up in the system, causing the vacuum to drop, it will accommodate itself to such condition, and maintain the best possible vacuum, and if the cause of the leak is removed will pull the vacuum to the original height. Even if the transforming wheel stopped or was taken out altogether the efficiency and vacuum are reduced, but the machine would continue its work just the same.

The cost of the whole plant, including foundations, piping, &c., has been approximately £23,000.

It is interesting to note that the above set has displaced a 300 kw. Pollit engine and alternator and two 200 kw. Parsons direct-current turbo-generator, which plant was installed some 18 years ago.

In the year 1916-17 the kilowatts demanded were 6,784 and the units sold amounted to 16,703,101.

CORRESPONDENCE.

PHASE LAG IN CURRENT TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am greatly obliged to the author for the explanations in his letter of the 23rd inst., which confirm what I had suspected, that I was regarding the matter from a point of view different from his. It is only necessary to reduce our statements to a common basis in order to arrive at agreement. Thus, in the case of two current transformers of nominal ratio t, connected back to back, whose actual ratios are $t+m$ (fed in on primary), and $l/(t-m)$ (fed in on secondary), I prefer to say that the errors in the ratios are different, since they differ in sign; while the author would state this fact by employing the same coefficient λ in each case to express the drops in voltage on the sides delivering current, which drops, of course, have similar signs.

This disposes, however, of the *reductio ad absurdum* put forward by the author, because I certainly did not make any statement which could be paraphrased into one saying that the primary and secondary voltages of such a combination would be strictly unity on all loads, ... &c. Instead, I stated an obvious truth that, assuming equal errors in the ratios (equal as regards magnitude and sign in the sense implied in the interpretation above) the overall ratio must clearly be 1.

Further, the author agrees with me that an assumption is made as regards the absolute values of the transformation ratios, and that the method as applied to the case of two transformers back to back is suitable only for determining the average characteristics of a type rather than the absolute errors of individual instruments.

It is hardly necessary to repeat that this objection does not apply to the case of a single transformer tested by this method.—I am, &c.,

Paris, July 31. E. W. HILL.

Small Electric Refrigerating Apparatus.—We notice that a small type of electric refrigerating apparatus is being produced in Germany by the Elektrofrigor Kältemaschinen Gesellschaft. A three-phase motor is employed to suck into a cylinder and evaporate methyl chloride, which is subsequently condensed and returned to the chamber for re-evaporation. Through the low temperature produced in this cycle of operations any amount of ice can be produced and the apparatus is claimed to be very convenient and simple for restaurant and domestic use. Another device with the same object has been produced by the National Self-Cooling Machine Co., of Ohio, U.S.A. In this case also the operation depends on the evaporation of a special fluid (the character of which is not stated), which is sucked into a coil by a pump, while a fan blows air away from the coil and over the compressor. A pressure regulator breaks up the fluid into fine gas as it enters the expansion chamber and a thermostat regulates the temperature of the refrigerator. An ice-making attachment is included. The fluid is stated to be non-inflammable, and is not poisonous to inhale.

Digitized by Google

CHARACTERISTICS OF SMALL DRY CELLS.*

BY C. F. BURGESS.

The production of dry cells is a branch of the electrochemical industry which is exhibiting a remarkable growth. If fifty million represents the annual output of standard, or so called No. 6 dry cells, in the U.S.A., this figure may be multiplied several times to represent the number of small dry cells used for flash light and miscellaneous other purposes.

In spite of the financial importance and the wide-spread utility of small dry cells, little has been published on efficiencies, outputs, and other characteristics. This Paper is presented as an approximate record of the performance of flash light cells, such as have been found on the market during the past year. It embodies the summary on tests of about 4,000 cells. As an adjunct to manufacturing operations we have maintained an experimental and testing department. In this department about 3,000 lots of experimental batteries, or over 30,000 cells have been made and tested during the past few years to determine the influence of impurities, of modification of construction and new ideas relative to improvement.

The two most important characteristics by which the value of flash light batteries may be determined are ability to furnish light over a period of time, or its capacity, and its ability to withstand deterioration when not in use, or its shelf life.

The standard method of capacity test which has been used by our laboratories and by several other manufacturers is to adopt a fixed standard resistance through which the individual cell is discharged, and noting the length of time on discharge required for the cell to drop to a certain voltage. Since the average resistances of flash lamps per cell of battery is about 4 ohms, this value for the testing resistance has been adopted. As to the end point, a voltage of 0·5 across the cell terminals when delivering current to the 4 ohms resistance is taken as indicating when the current has fallen so low as to give a non-useful light. With the pressure at one-half volt per cell the light is dull, but enough to read a clock dial; it is not enough for general flash light service.

Capacity or Time of Burning.—Our standard method of capacity test then consists in connecting an individual cell to a resistance coil of 4 ohms, and discharging continuously until this voltage drops to 0·5 volt. The readings which are taken are the initial open circuit pressure, the short circuit flash through an ammeter, the voltage at the instant of connecting to the 4-ohm coil, and readings of voltage every hour, or half hour during the discharge. Our testing period is eight hours per day. Most of the flash light cells will drop to 0·5 volt during the eight-hour period, though the larger cells will run beyond this, therefore, giving some chance to recuperate before the beginning of the following test period.

Durability or Shelf Test.—Of importance equal to the capacity test is the test showing the ability of the battery to stand idle without losing its capability of service. This is usually designated the "shelf-life test."

If we may judge from labels on batteries, and the wording of the guarantees of the makers, it appears to be a general practice of manufacturers to judge deterioration by the falling off in open-circuit voltage. We have found from long experience and a great many tests that a far better method of determining the deterioration going on within the cell is by measuring the short circuit flash which the cell gives when connected momentarily to the ammeter. Thus a cell which gives an initial flash of 8 amperes when new may drop to 4 amperes after six months, and this indicates roughly a depreciation in capacity of 50 per cent. While the decrease in flash is not strictly proportional to the decrease in ampere-hour capacity, it is nevertheless a far better indication than is the dropping in open-circuit voltage. For want of a better test, therefore, we have adopted this as our standard.

The method of procedure is to place the cell on the shelf after taking an initial reading of voltage and short-circuit current. At the end of each month period the tests are reported and results recorded. For the larger sizes of flash light cells the test period covers a year, and for the smallest sizes from six to eight months. At the end of such periods the cells are taken from the test shelves, usually in a run-down condition, and numerical rating is given by determining the percentage decrease in flash during such period, and dividing by the number of months to give the average monthly percentage of deterioration.

Voltage.—Dry cells vary in initial voltage far less than they do in other characteristics. Thus, cells on the market will be found to have a voltage of from 1·45 to 1·55 or even 1·6.

Recuperation.—The ability of a battery to "recuperate" or to come back to its ability to give a good light after resting for a period is an important quality in the opinion of some authorities and of less importance in the opinion of others. This property can be given to a cell by certain variations in methods of manufacture. Thus, a coarser grade of manganese will show a higher recuperative ability than will a very fine-powdered, more active grade. In general, it may be considered that high recuperative ability is inconsistent with ability to deliver current constantly without serious dropping in voltage.

Uniformity.—If a manufacturer could discover some method of construction so that each cell would be exactly like the best which he can produce, it would be a great achievement in the improvement of quality. Some of the reasons for variation are known and others are mysterious. There is no doubt that care in selection and purification of materials, and more especially care in assembling them, are important factors. A product which has a comparatively high rate of deterioration will show greater non-uniformity in the hands of the users than will a product which has a low rate, this being due to the variation in the period from manufacture to use.

Size of Cells.—Small cells are found on the market in a great variety of sizes and forms of battery. The most common form is the two-cell and three-cell tubulars, for use in metal or fibre cases. Of almost equal importance is the two-cell or three-cell battery of smaller dimensions, the cells being placed side by side for use in flat cases and commonly designated as the "case" type.

From our laboratory test records a compilation has been made from tests on about four thousand cells made during the period from February 1, 1915, to April 1, 1916, and showing the relative performance and characteristics of cells of various brands found on the American market. In presenting the results the various brands are indicated by the letters A to J respectively.

Table I.—*Capacity or Hours of Burning.*

Brand.	Size of cells. Inches.					
	$2\frac{1}{4} \times 1\frac{1}{4}$	$1\frac{13}{16} \times \frac{15}{16}$	$2\frac{1}{8} \times \frac{3}{4}$	$1\frac{7}{8} \times \frac{5}{8}$	$1\frac{9}{16} \times \frac{9}{16}$	$1\frac{7}{8} \times \frac{9}{16}$
A	13·25	3·5	3·75	1·9	56 min.	70 min.
B	...	3·6	4·2	1·7	...	...
C	10·5	2·0	...	0·85	13 min.	...
D	13·25	5·0	4·2	2·0	63 min.	66 min.
E	13·75	4·1	...	1·4	40 min.	...
F	9·25	3·1	2·5	1·25	34 min.	45 min.
G	8·75	3·2	2·0	1·1	...	...
H	13·25	4·3	4·0	1·9	40 min.	75 min.
I	9.00	...	...	1·0	...	...
J	...	...	...	1·1	...	...

Table II.—*Durability or Shelf Wear. Expressed in Monthly Percentage Reduction in Flash.*

Brand.	Size of cells. Inches.					
	$2\frac{1}{4} \times 1\frac{1}{4}$	$1\frac{13}{16} \times \frac{15}{16}$	$2\frac{1}{8} \times \frac{3}{4}$	$1\frac{7}{8} \times \frac{5}{8}$	$1\frac{9}{16} \times \frac{9}{16}$	$1\frac{7}{8} \times \frac{9}{16}$
A	3·66%	8·3	9·2	9·0	12·0	9·3
B	1·55	6·45	9·1	10·0	...	...
C	1·87	3·83	...	5·0	25·0	...
D	2·40	5·7	5·0	8·1	6·6	10·5
E	5·10	7·5	...	9·6	14·0	15·3
F	14·3	11·2	14·1	25·0	...	14·0
G	10·8	12·0	10·0	22·0	25·0	...
H	10·0	12·5	9·1	15·0	27·0	13·3
I	2·64	...	...	6·2	...	...
J	...	...	...	...	...	...

From the capacity tests it is to be noted that the best cells have a capacity about 100 per cent. above the poorest, and from the durability tests the differences are much greater. The brand showing the smallest deteriorations shows also the smallest capacity, and emphasises the fact that the factors which contribute to long life are not those which develop large ampere-hour capacity. In practice it is necessary to choose standard values of capacity and durability and combine them in a product to give greatest usefulness.

For guidance in our testing and manufacturing a set of standard curves has been prepared showing what cell performance may be expected. These are given in the original Paper.

The desirable and attainable qualities are summarised in Table III.

* Abstract of a Paper read before the American Electrochemical Society.

Digitized by Google

Table III.—*Performance that Should be Expected from Good Quality of Cell.*

Cell dimension.	Capacity, minutes.	Per cent. monthly deterioration.
2·25×1·25 in. (57·2×38·8 mm.)	960	Under 4%
1·8125×0·9375 in. (46·1×23·8 mm.)	300	„ 6 „
2·125×0·75 in. (54×19·1 mm.)	250	„ 8 „
1·875×0·625 in. (47·7×15·9 mm.) ...	120	„ 10 „
1·5625×0·5625 in. (39·7×14·3 mm.)	65	„ 12 „
1·875×0·5625 in. (47·7×14·3 mm.)...	70	„ 12 „

In the discussion which followed the reading of the Paper, Mr. C. A. Gillingham pointed out that the discharge through 4 ohms does not give the same actual life as does a discharge through a standard miniature lamp of 0·35 ampere drain. The resistance of these lamps at the rated voltage approximates 4 ohms per cell, as shown by Mr. Burgess in his Table I., but as the voltage across the lamp is reduced the resistance decreases to a very marked degree, as shown by the following figures which are representative :—

Volts per cell across lamp.	Resistance of lamp in ohms per cell.
1·5	4·06
1·27 (rated voltage).....	3·72
1·0	3·32
0·5	2·40

As the voltage of the cell on capacity test during the greatest part of the test is well below 1·0 volt, it is evident that 4 ohms is too high a resistance to use as representative of lamp service. We find 2·75 ohms about correct giving the same life as an actual discharge through a 0·35 ampere lamp.

It will be found that a 4-ohm test may show a different relation between two brands of cell than does a 2·75-ohm test. As the latter is closer to actual lamp service, the 2·75-ohm figure is the more reliable for comparative purposes :—

	Capacity through 4 ohms.		Capacity through 2·75 ohms.
Cells 2½×½ Brand A	894 min	.....	514 min.
Brand B	589 „	.....	381 „
Ratio A : B	1·52	.....	1·35

Carrying out a capacity test in eight-hour periods is liable to lead to unfair conclusions. Consider the case of two cells which, if run continuously, would give 7½ and 8½ hours respectively. Now, in the case of the 8½-hour cell the interruption of the test after eight hours will allow it sufficient recuperation to give an additional three hours' service the following day, bringing its total to 11 hours. The 7½-hour cell is not allowed this advantage and, therefore, suffers an unfair comparison.

The "end point" to be used in determining the life of the cell is an important item, as the shape of the curve varies considerably in different brands of cell. One cell may hold well at the beginning and drop off more rapidly toward the close of the test, while another may drop off rapidly at the beginning and hang on for the rest of the test just above the end-point voltage. The first cell will unquestionably give a much better light during its life than will the second, and this point is as important as the actual length of service. By using the results to a higher end point, say, 0·75 volt, as well as those to the 0·50 volt cut-off, we get an idea of the quality as well as the length of the service. The following figures will show the lack of relation between the results to these two end points. :—

Brand.	Capacity test run to 0·75 volt.		Capacity test run to 0·50 volt.
A	306 min.	.....	950 min.
B	452 „	.....	894 „
Ratio A : B	0·68	.....	1·06

Hence, the 0·50 volt results should not be considered alone, but in relation to the general shape of the discharge curve.

While these points may serve to make possible a more accurate rapid comparison of capacity, yet it is quite impossible by any continuous or nearly continuous test of short duration to gain an estimate of the relative value to the actual user of two different brands of cells. No consumer uses his flash light continuously. The great majority of flashlight batteries are burned less than five minutes a day or give service over a period of months or at least weeks. A test much more closely representing this actual service consists of discharging the cell five minutes daily. A resistance of 4 ohms and an end point of 0·5 volt are employed. In this intermittent test the shape of the curve is very different from the continuous curve holding up almost horizontal till nearly the end, where it falls off quite rapidly. This brings the 0·75 and 0·50 volt end points quite close together, so that the matter of which to consider is of little importance. Also, in this type of test 4 ohms more nearly represents lamp service than would 2·75 ohms, because the curve is practically all in the higher voltages where the lamp resistance approximates 4 ohms.

This test, covering as it does a period of several months in the case of the larger size flashlight cells, includes in itself the practical effects of capacity, recuperation and shelf life deterioration under service influence. It is certainly more representative of true value than any rapid continuous test, and its results may be entirely contrary to continuous test indications. The following table showing the discrepancies between the two methods of testing applied to a number of makes of 2·25×1·25 in. cells :—

Brand of cell.	Continuous capacity test. 2·75 ohms to 0·50 volt end point.	Intermittent capacity test. 5 minutes daily. 4 ohms to 0·50 volt end point.
A	542 min.	450 min.
B	463 „	81 „
C	381 „	660 „
D	515 „	577 „
E	509 „	473 „

For instance, brand A, which has the best continuous capacity, has to yield precedence to brands C, D and E when judged by the more indicative intermittent test. And brand C, which stands highest by the intermittent is comparatively poor in continuous capacity. Similar instances may be found among smaller size cells.

REGISTRATION OF DIRECTORS.

The Companies (Particulars as to Directors) Act, which received the Royal Assent on the 2nd inst., is an adaptation of the Business Names Act of 1916 to public and private companies. While the latter Act was being considered by the Houses of Parliament many trading and business undertakings were converted into limited companies, in order to avoid the publication of the names of partners, &c., required by that Act. The object of the present Act is, therefore, to close up this avenue of escape to alien enemies and persons under their control. A brief digest of the effects of the Act should be of interest to our readers.

By the new Act every annual return made up to any date subsequent to Aug. 2 last must be prepared on the new form prescribed by the Board of Trade, and contain the required particulars.

If any director has at any time changed either his Christian name or his surname the former name must be disclosed, except where in the case of a natural born British subject the Christian name or surname was changed or disused or an additional name was taken before he attained the age of 18.

The nationality of every director, whether British or not, must be set out. Foreigners who have been naturalised in this or any other country must disclose their original nationality. In the case of a woman who has acquired British nationality by marriage it will be necessary to state her original nationality ; and similarly where an English woman has married a foreigner (not naturalised) the fact that she was originally of British nationality must be disclosed. The business address must not be given, except where a director resides on the premises. If a director carries on a separate business (either alone or in association with others) or is a director of any other company his " other business occupation " must be disclosed. It will be necessary to enter in the register of directors the additional particulars mentioned above, and whenever any change occurs in such particulars it must be recorded and a copy of the register filed. Therefore, the filing of a copy of the register will be necessitated by a change of residence or occupation of any director or by a change of name or adoption of another nationality by naturalisation or otherwise.

Companies registered since Nov. 22 last and all companies registered in future, as well as all foreign companies which had a place of business in this country before Aug. 2 last, are subject to an additional obligation. Companies registered between Nov. 22 and Aug. 2 must furnish (within a month) to the Registrar of Companies the particulars required by the Business Names Act in the companies' annual returns ; but companies registered before Nov. 22 last will not be required to furnish the particulars until their next annual return.

Within three months of the passing of the Act every company registered since Nov. 22 last and foreign companies with a place of business within the United Kingdom shall " in all trade catalogues, trade circulars, show cards and business letters in which the name of the company appears," have printed in legible characters the Christian name, or the initials thereof, and present surname, any former Christian name or surname, the nationality (if not British), and if the nationality is not the nationality of origin the nationality of origin of every director of the company.

Digitized by Google

PARLIAMENTARY INTELLIGENCE.

EDUCATION REFORM.

In the House of Commons on Friday last the President of the Board of Education (Dr. Herbert Fisher) introduced a bill to make further provision with respect to education in England and Wales. In the course of his remarks, Dr. Fisher said the bill might be divided under six heads. They desired, in the first place, to improve the administrative organisation of education; secondly, they were anxious to secure for every boy and girl in the country an elementary school life up to the age of 14 years, which should be unimpeded by the competing claims of industry; thirdly, they desired to establish part-time day continuation schools, which every young person should be compelled to attend, unless he or she was undergoing some suitable form of alternative instruction; fourthly, they submitted a series of proposals for the development of the higher forms of elementary education and for the improvement of the physical education of the children and young persons under instruction; in the fifth place, they desired to consolidate the elementary school grants; and, lastly, they desired to make an effective survey of the whole of the education provision after the war, and to bring private educational institutions into closer and more convenient relations to the national system. The bill imposes a duty upon the Council of every county and county borough to provide for the progressive development and the comprehensive organisation of education in their respective areas and to submit schemes to the Board. In order that this function may be adequately discharged it is proposed to remove the 2d. limit on the amount to be raised for higher education. The bill abolishes all exemptions from school attendance between the ages of five and 14, and consequently abolishes what is known as the "half-time" system. No child under 12 is to be employed in shops, and no child under 14 is to be employed on any day on which he or she is required to attend school before the close of the school hours or after 8 p.m. on that day, or on other days before 6 a.m. or after 8 p.m. Every young person no longer under obligation to attend a public elementary school shall attend such continuation school as the local education authority may require for a period of 320 hours in the year, or the equivalent of eight hours a week for 40 weeks. The attendance at such schools will not be required in the case of a young person who has received to the satisfaction of the Board suitable full time instruction up to the age of 16 years, or passed the matriculation examination of a university of the United Kingdom or an examination recognised as equivalent to that. In other words, provision is made for every young person in the kingdom who has not received a full-time education up to 16 to receive a part-time education up to the age of 18, either in schools provided by the local education authority or in schools under their direction, such as the schools established by manufacturers in their works, or in schools providing satisfactory alternative instruction.

WORKMEN'S COMPENSATION.

In the House of Commons on Monday the Workmen's Compensation (War Addition) Bill was read a second time. Mr. Brace, who moved the second reading, explained that it was proposed to give a 25 per cent. increase of compensation to all totally incapacitated cases of injury in all industries, which was made imperative by the rise in the cost of living.

Armorduct Mfg. Co.—In reply to a question in the House of Commons on Monday, Mr. Roberts stated that tenders for the business of this company were recently obtained by the controller appointed to wind up the business, but they were not considered satisfactory, and had been rejected. The controller would take further steps to dispose of the assets. None of the assets had been sold or transferred to William Small or to anyone acting on his behalf.

LEGAL INTELLIGENCE.

Liability for Damage by Electric Heater.

In the City of London Court last week a lady claimed 30s. from Messrs. Wm. Lund & Son for damage caused to a seal coat through defendants' electric heater not being sufficiently guarded. Plaintiff said that she went to defendants' shop to buy a tortoise-shell bag frame and was asked to look at one in the window. While she was doing that her coat was burned by the electric heater, which was on the floor underneath the window. The burned piece of fur had been replaced at an expense of 30s.

Defendants admitted that plaintiff's statement was accurate. She must have tiptoed to look into the window. Before they could say, "Don't go too near the radiator," she had burned her coat. Of course, they were sorry, but they could not accept responsibility for her action. The radiator was wired in a proper manner.

The Judge held that, as defendants invited people to go into their shop to buy goods, they must keep the place in a safe condition; if electric heaters were put into business premises the owners did so at their own peril. Judgment was, therefore, entered for plaintiff.

Instructions for the Use of Transformers.—A pamphlet on this subject has been issued by Ferranti (Ltd.). Notes are given on drying out, filling with oil and the maintenance of transformers. Vector diagrams are included showing the electrical relations for the various methods of connecting up commonly adopted; and directions are given for identifying the polarity of terminals. While primarily concerned with Ferranti transformers, the pamphlet will be found of considerable interest and utility to any user of this type of plant.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

16,203 CHALIER. Tubular electric incandescent lamp floats or foot lights. (15/7/13.)

1916 SPECIFICATIONS.

3,029 HAMILTON, J. E. Electric battery lamp. (25/7/16.) 107,773.

5,445 MARKS, E. C. R. (Goldberg, H.) Electric current regulators, more particularly for use with arc lamps. (13/4/16.) 107,777.

Comprises an electrical controlling apparatus having a solenoid in series with the circuit being controlled, a second solenoid in shunt with said circuit, a third solenoid in parallel with said second solenoid and therefore also in shunt with said circuit, an armature responsive to said first and second solenoids and controlling the flow of current through the second and third solenoids.

6,079 DAVIES & WOOLISCROFT. Electric switches. (28/4/16.) 107,397.

6,392 SIEMENS BROS. & CO., BRISTOW & IRELAND. Electric ignition or sparking arrangements. (24/5/16.) 107,399.

6,407 KETTERING & CHRYST. Electric engine starter and electricity generating systems. (11/10/15.) 101,784.

6,965 BAESE, C. Method of and apparatus for the localisation of foreign objects in and the radiotherapic treatment of the human body by the X-rays. (17/5/15.) 100,491.

7,995 HEURTLEY, E. S. Telegraphy. (6/6/16.) (Cognate application, 11,465/16.) 107,783.

8,320 SWITCHGEAR & COWANS & RODWAY, E.D. Electrical regulators or rheostats. (13/6/16.) 107,788.

9,165 MARCONI'S WIRELESS TELEGRAPH CO. & WRIGHT. Means for controlling speed of an electric motor. (29/6/16.) 107,425.

9,246 MARCONI'S WIRELESS TELEGRAPH CO. & EWEN. Measuring instruments, relays and the like. (30/6/16.) 107,622.

9,370 ST. HELEN'S CABLE & RUBBER CO. & WHITE. Electric lamp and the like guards. (4/7/16.) 107,633.

9,539 MARCONI'S WIRELESS TELEGRAPH CO. & SHOENBERG. Measuring the frequency of electrical currents. (6/7/16.) 107,647.

The oscillating circuit, the frequency of which is to be measured, is coupled to a measuring circuit comprising a self-inductance or a condenser or both, a volt meter and a saturation device connected in series, and a voltage is applied across the limiting device in excess of that required for saturation.

9,541 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Electric rotary converters. (6/7/15.) 100,847.

Comprises the combination with a source of alternating current of a rotary converter connected thereto, and means for producing auxiliary current waves in the armature winding of said rotary converter having three times the frequency of the alternating-current source of supply, said auxiliary waves having such a phase relation to the main current waves as to equalise the net current and heating in all the tap coils.

9,776 JANE. Electrical heating apparatus. (11/7/16.) 107,655.

9,825 DRAKE & D.P. BATTERY CO. Electric accumulator containers. (12/7/16.) 107,656.

9,926 STEINMAN. (Picard.) Electric pocket lamps. (14/7/16.) 107,658.

9,833 INDO-EUROPEAN TELEGRAPH CO., MORSE, A. H. & MORSE, H. R. RIVERS-. Electric oscillating or wireless systems and apparatus. (12/7/16.) 107,815.

9,942 DAWE, P. H. Electrical resistance apparatus. (14/7/16.) 107,822.

10,036 STERLING TELEPHONE & ELECTRIC CO. & BELL, F. G. Electrically-driven vibratory apparatus and the like especially for use in the treatment of ear troubles. (17/7/16.) 107,825.

10,072 NEWITT. Electric fuses or cut-outs. (18/7/16.) 107,664.

10,096 GIRARDEAU & BETHENOD. Spark-gaps for use in wireless telegraphy. (21/7/15.) 100,957.

A multiple spark-gap formed by a plurality of discs, supported on rings of insulating material, the said rings being mounted on a plain cylindrical metallic tube, both rings and discs being insulated from each other so as to ensure exact parallelism of the electrodes.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Orders for the Week by
Officer Commanding, Lieut. Colonel C. B. CLAY, V.D.

Officer for the Week.—2nd Lieut. A. Ullmann.

Next for Duty.—Platoon Commander C. Campbell.

Monday, Aug. 20.—Technical Instruction (searchlight) for No. 3 Company, Right Half Company, at Regency street. Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' Drill, 6.30.

Tuesday, Aug. 21.—Lecture, 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, Aug. 22.—Drill and Elementary Bridge Construction for No. 1 Company, Left Half Company.

Thursday, Aug. 23.—Drill and Elementary Bridge Construction for No. 2 Company, Left Half Company. Ambulance Class.

Friday, Aug. 24.—Technical Instruction (searchlight) for No. 3 Company, Left Half Company, at Regency street. Drill, No. 3 Company, Right Half Company. Signalling Class. Recruits' Drill, 6.30.

Saturday, August 25.—Commandant's Parade for Route March and Drill. Parade Putney Bridge Station, 2.45 p.m., Uniform.

Special Order.—The Commandant desires to express to all ranks his appreciation of the excellent way in which the duties in camp have been performed. He is especially pleased that ALL duties, including cooking, &c., have been carried out by members of the Corps. He regrets that it was impossible to give longer notice of the Camp arrangements or, doubtless, a larger attendance would have been secured. He also congratulates the Corps upon the fact that its duties have now been defined by the authorities.

Musketry.—All N.C.O.s and men who have signed the "A" and "B" agreements are required to attend during this month to re-classify, in order to enable the corps to obtain the capitation grant. Preference will be given to these men in firing.

Armlets.—The new issue armlets can now be obtained at headquarters, and every enrolled man must obtain one without delay, and all old (red) armlets must be returned to the orderly room.

Note.—Unless otherwise indicated, all drills will take place at headquarters (Balderton street, Oxford street).

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

Brass Scrap.

Mr. L. W. Llewelyn, Director of Materials of the Ministry of Munitions, has notified firms desirous of obtaining brass scrap arising from the manufacture of munitions that in future they will only be able to obtain their supplies from the Ministry. All inquiries, with requisition form, &c., should be sent to 8, Northumberland avenue, London, W.C. 2.

* * * *

Imperial Preference.

In the House of Commons on Tuesday the Colonial Secretary (Mr. W. H. Long), after reviewing the important part taken by the Dominions and the Colonies in the War, said that the Imperial War Conference had met and passed resolutions in favour of encouraging the development of Imperial resources, and suggesting that each part of the Empire should give specially favourable treatment and facilities to the produce and the manufactures of other parts of the Empire.

The question had (said Mr. Long) been discussed before the war, but it had not since been made less difficult by the necessity of having a policy so framed as to meet the views of our Allies. The Prime Minister had appointed a committee consisting of Ministers representing all the departments concerned, and had asked him to preside over the committee. It was their duty to report on the best methods and machinery for giving effect to the resolution of the Conference.

The Committee, under the chairmanship of Mr. Long, which will consider how to carry into effect the decision of the Imperial War Council in reference to preferential trade within the Empire, will consist of representatives appointed by the following Departments: The Foreign Office, the Colonial Office, the India Office, the Board of Agriculture, the Board of Trade, the Treasury, the Ministry of Labour, the Ministry of Reconstruction and the office of the Shipping Controller.

* * * *

Electrical Power and Coal Conservation.

In the House of Commons on Wednesday the President of the Board of Trade was asked whether he would make available to local authorities the report of the Electrical Trades Committee of the Board of Trade and the interim report of the Coal Conservation Sub-committee of the Reconstruction Committee, in view of the fact that it was not possible for witnesses who were to give evidence on behalf of local authorities before the Board of Trade Committee on Electrical Power Supplies to make such evidence full and complete without a perusal and consideration of the reports.

In reply, Mr. Roberts said the War Cabinet had decided that the reports of committees appointed to consider questions affecting trade after the War should not be made public at present, and in the circumstances he feared that it would not be possible to adopt the suggestion made.

* * * *

Relations of Capital and Labour.

At the recent meeting of Messrs. Dorman, Long & Co. (Ltd.) the chairman, Mr. A. J. Dorman, made some interesting references to the relations of capital and labour. He said the employer did not ask for increased hours and harder work; improved machinery would do the hard work.

What he (the employer) asked and was prepared to pay for was the willing work of the workman. Under such conditions it was possible to pay higher wages and yet produce at a lower cost. He believed if they were allowed to manage their own affairs, employers and employed in conference together would arrive at a happy conclusion. To his mind the problem to be solved was: At what price would the workmen give their best labour, free from all restrictions? It must be evident to all thinking men that no higher wages could be paid, except in return for efficiency and increased output. Given that, a settlement would be an easy matter. They could assemble their material at less cost than most nations and had shipping facilities second to none. Their manufacturers had received little or no encouragement to embark in large commercial undertakings, and their machinery had been allowed to become somewhat antiquated. But a new life was springing up within them, and, if only a fair understanding could be come to between capital and labour, he had no doubt that the new industries that had been brought into being by the far-sighted policy of the Ministry would prove to be a source of great prosperity to the country and enable us to hold our own in the markets of the world.

American Electrical Exports.

During the month of April last electrical merchandise, valued at $4,740,995, was exported from the United States of America, compared with $2,630,169 in April, 1916. The value of the electrical exports for the first four months of 1917 was $18,379,351.

The "Electrical World" reports that a new record was set during the month for the export of metal filament lamps, which amounted to $215,739, or 1,056,464 lamps. A new record was also established for the export of motors, the value of which was $673,719.

During the 10 months ended April last the exports of electrical merchandise amounted to $41,733,199, compared with $23,666,267 for the 10 months ended April, 1916, and $15,922,467 for the 10 months ended April, 1915. The following figures were compiled by the Bureau of Foreign and Domestic Commerce.

Articles.	April.		Ten months ended April.	
	1916.	1917.	1916.	1917.
Batteries	$168,142	$212,154	$1,252,563	$2,362,304
Dynamos	151,727	164,337	1,189,462	2,041,161
Fans	45,528	63,820	298,370	336,588
Insulated wire cables	386,239	653,352	2,575,002	5,930,558
Int. wiring supplies, &c.	44,805	122,230	743,757	899,005
Arc lamps	639	1,240	15,998	13,048
Carbon filament lamps	5,410	11,653	130,851	121,108
Metal filament lamps	128,734	215,739	1,007,707	1,440,490
Meters & meas. instr'm'ts	52,255	89,297	624,200	780,783
Motors	272,261	643,719	3,468,843	4,818,684
Telegraph instruments (inc. wireless apparatus)	7,965	90,047	123,785	417,534
Telephones	52,064	206,588	786,706	1,513,435
Transformers	68,889	94,720	763,358	951,513
All other	1,245,511	2,172,099	10,685,665	20,016,988
Total	$2,630,169	$4,740,995	$23,666,267	£41,733,199

* * * *

An Empire Trade Mark.

The Patents, Trade Marks and Designs Committee of the Birmingham Chamber of Commerce reported recently upon the circular letter issued by the British Empire League regarding the proposal to register an origin mark for goods manufactured in the British Empire.

In response to a letter addressed to the League, asking in what respects the proposed origin mark would differ from the "British Empire Trade Mark," the registration of which was attempted some time before the outbreak of war and refused, the secretary of the Chamber had been furnished with a copy of a letter addressed by Lord Sydenham, chairman of the Executive Committee of the League, to the President of the Board of Trade. In this letter it was contended that the war had so materially altered the circumstances that any investigation made under pre-war conditions had no effective bearing on the question as it presented itself at present. The Committee of the Chamber reported that, as at present advised, it did not feel persuaded the contention that the war had materially altered the circumstances was justified, having regard to the cardinal objection to the British Empire trade mark, but before coming to a definite conclusion on the matter they had instructed the secretary to make full investigations with reference to the mark said to have been established in France, and the extent to which such mark was being supported by French traders.

The report was agreed to by the members.

* * * *

Bonus Scheme for Fuel Economy.

Some supply undertakings in this country have adopted schemes by which the generating station staff receive a bonus for fuel economies effected. The bonus principle is pretty general in the United States, where its beneficial effects are well-known. An Ohio public utility adopted the following bonus scheme in September last.

BONUS SCHEME.

Coal Consumption per unit.	Monthly Bonus per Man.
2·85 lb. to 2·95 lb.	$1·00
2·75 lb. to 2·85 lb.	3·00
2·65 lb. to 2·75 lb.	9·00
2·55 lb. to 2·65 lb.	15·00

Coal Consumed per Unit.

Before Adoption:	lb.	After Adoption:	lb.
June, 1916	3·10	October, 1916	2·87
July, 1916	3·38	November, 1916	2·76
August, 1916	3·11	December, 1916	2·88
September, 1916	2·98	January, 1917	2·84
		February, 1917	2·83

As the system has not been in force for a year, it is, however, not known how the improvements which have been experienced have been affected by weather conditions, changes in personnel of the plant or increase in load.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

By-product Steam Boiler Plant.—Application is to be made to the Local Government Board by Harrogate Corporation for sanction to borrow £4,710 for the installation of a by-product steam boiler plant, in accordance with the designs and specification of the borough electrical engineer, Mr. Geo. Wilkinson, M.I.E.E.

The scheme has been approved by the Ministry of Munitions, which has granted permission to expend an extra £1,710 required to meet the proposed capital outlay to be incurred. The additional outlay is in consequence of the increased cost of materials and labour since the scheme was first introduced.

Eccles.—The Electricity Committee proposes to purchase land at Rocky-lane for a transformer and meter house required in connection with the bulk supply scheme.

Sheffield.—The Electricity Supply Committee recommends the Corporation to accept an offer of the Ministry of Munitions with regard to the transference to Sheffield of plant of 28,000 kw. capacity; to give instructions for the contracts to be placed for the necessary machinery, boilers, &c., at a total cost of £560,000; and to approve expenditure of £448,000 of sum named during current financial year.

GENERAL.

Bath.—The City Council are of opinion that restrictions on private lighting are unnecessary and are appealing for their removal.

Belfast.—The Council has decided to increase the wages of all the workmen employed at the electricity works by 3s. per week.

Board of Trade Electric Power Committee.—In the House of Commons last week Sir J. Harmood-Banner asked the President of the Board of Trade whether, in view of the fact that out of 16 members of the Board of Trade Committee on Electric Power Supply, there were no members distinctively representing the lighting companies working under Provisional orders, and that the interests of the industry were often widely divergent from those of power companies or municipalities, he would nominate members to represent these companies.

In reply Mr. Roberts said there were two members who were directors of lighting companies working under provisional orders. The President was of opinion that the Committee as at present constituted was sufficiently representative of all bodies owning electricity undertakings, and he was not prepared to make any further additions to it.

Carlton (Notts.).—The Urban Council will not oppose the application of Nottingham Corporation for a provisional order.

Deal and Walmer.—The period limited for carrying out the provisions of the Deal and Walmer Gas and Electricity Act has been extended by one year.

Exeter.—The Corporation has passed a resolution unanimously recording "its satisfaction with the services of the city electrical engineer (Mr. H. D. Munro), its confidence in his management, and that the recent refusal to increase his salary is no reflection upon his management or professional ability."

Ald. Stocker said the recommendation for an increase was on the Electricity Committee's own initiative, and not on the electrical engineer's application.

Gillingham.—The Electric Light Committee, which is considering the question of adapting the existing Diesel plant to use tar oil, has appointed a deputation to inspect the tar oil plant at Hindhead.

Greasborough.—The Urban Council has decided to apply for a provisional electric lighting order.

Greenock.—The Electricity Committee recommend the Corporation to increase the salary of the burgh electrical engineer (Mr. Frank H. Whysall) from £600 to £700 per annum.

Increased Charges for Electrical Energy.—The charges for current are being increased at the following places:—

Gillingham Council is increasing its charges from 25 per cent. to 40 per cent. over pre-war rates.

Hove Corporation is increasing its charges for current for power to 2d. per unit by flat rate and 10 per cent. by indicator rate, as from Sept. 30.

Wrexham Council is increasing its rates, as from Oct. 1, for lighting and heating by 15 per cent. (25 per cent. over pre-war charges), and for power by 6⅔ per cent. (16⅔ per cent. over pre-war charges).

Loughborough.—The borough electrical engineer (Mr. R. B. Leach) recently reported that, in accordance with instructions, he had engaged a girl at a wage of 22s. a week, plus war bonus, to replace T. Dolby, a Class A man, who had been called up for Army serivce.

He had been informed by the Army authorities that Dolby's calling-up papers had been cancelled for the time being owing to the fact that he is a member of the Amalgamated Tool Makers' Society. Mr. Leach, therefore, asked for instructions and the Electricity Committee decided as arrangements had been made for carrying out duties hitherto performed by Dolby, he be given a fortnight's notice to terminate his engagement.

Richmond.—The Richmond (Surrey) Electricity Supply Act, which has recently received the Royal Assent, authorises the local supply company "until the quarter day next following the expiration and the duration of the present war," to make an increased charge not exceeding 15 per cent. for current for lighting. At present the price is 4½d. a unit. Current for heating and power is not to be increased beyond present prices, and after the war all charges are to come down to the pre-war level fixed by the agreement of 1913.

Rotherham.—Ald. Aizlewood, chairman of the Parliamentary Committee, reported to the Council last week on the result of their opposition to the Sheffield Bill, &c.

Ald. AIZLEWOOD referred to the scheme for the supply of electrical energy in bulk to the Mexborough & Swinton Tramways Co., which had necessitated an application to the Board of Trade until they could obtain statutory powers. There was also the application for "fringe" orders to supply electricity to new works which had been, or were being, built in the Blackburn valley. The result of the Board of Trade inquiry was not yet known.

In regard to the Sheffield Bill, there had been an exchange of rateable value. Terms were agreed upon whereby Rotherham should surrender to Sheffield the vacant piece of land required for the electric light station. Other concessions were also made. The total area they got was about 30 acres, and the area surrendered to Sheffield about 50 acres. As to the rateable value, Sheffield got £1,443, and Rotherham secured £10,300.

Southport.—The Electricity Committee has increased the wages of the stokers and drivers at the electricity supply works from 4s. 8d. to 5s. 6d. per shift.

LIGHTING AND INDUSTRIAL POWER.

Burton.—In a booklet issued for the purpose of demonstrating the advantages of the town as a manufacturing district it is stated that:

Electric lighting in factories is charged for at the power rate and electric motors are let out on hire at nominal rentals, and gas engines can also be obtained on the hire purchase system.

Electric Announcers at Dutch Auctions.—The United States Commercial Attaché at The Hague reports that at the regular trade auctions in the Netherlands, instead of having an auctioneer call for bids, there is a large dial provided with an index hand.

The face of the dial is marked with prices increasing in clockwise fashion. The hand is set at a price above that which the goods offered will probably bring, then is slowly moved to lower and lower figures until some trader indicates his willingness to buy. Electric push buttons are connected with the dial, which the traders press when a price satisfactory to them is shown by the dial. As the trader presses his button his number appears on the face of the dial, and the lot of goods is sold to him at the price indicated by the index hand. There is no noise or confusion, and the auctions are finished in a remarkably short space of time.

Grain Elevator Facilities in the U.S.A.—The electors of the City of Portland (Ore.) recently approved the issue of $3,000,000 bonds (about £616,000) for providing elevator and other port facilities for handling wheat in bulk and other goods.

It is proposed to provide for additional berthing space for six vessels, each 500 ft. long, and a new terminal, equipped with sheerlegs, gantry and locomotive cranes, in addition to electric trucks, winches and conveyors. The elevator will be completed in time for the 1918 wheat crop. In the meanwhile work on the new grain storage and handling plant at Astoria, at the mouth of the Columbia River, is progressing rapidly.

Scarborough.—It is proposed to adopt electric lighting on the Marine Drive and Promenade.

ELECTRIC TRACTION.

Bexley.—At a special meeting of the Council last week a report by the electrical engineer and tramways manager, Mr. H. P. Stokes, on the situation caused by the recent destruction by fire of the Dartford tramways depot was considered.

Mr. Stokes said he had been approached by the lessees of the Dartford tramways for assistance, and he put on a temporary service on the 8th inst. He had also attended a meeting in London in connection with the matter, and after meeting representatives of the lessees and Messrs. Vickers, and subject to Dartford Council's approval, he had arranged to take over the entire management of the Dartford tramways, and run the system in connection with their own.

The scheme was approved.

Burton-on-Trent.—The salary of the tramway manager (Mr. A. B. Slater) has been increased by £25 per annum.

Darlington.—The Council have decided to increase the tramway fares in order to meet the increased expenses due to higher wages and maintenance charges.

East Ham.—A report on the proposal to purchase electric dust-vans has been prepared by the Chief Sanitary Inspector, and the Health Committee has been authorised to obtain particulars of the results obtained from electric vehicles at Sheffield and other places.

Digitized by Google

Glasgow.—Under the new scheme for raising funds for comforts the sum of £ 40 was received from the sale of tickets on the Corporation tramways last week.

Leeds.—The threatened tramway strike, owing to the employment of female tramway inspectors, has been averted.

The Tramway Committee has given an assurance that in future appointments of ticket inspectors will be made from employés returning from active service if suitable for the work, but unfit for driving, or from any other suitable male employés. The present appointments to be a purely war measure.

Overhead Line Material Standardisation.—The Sheffield overhead line superintendent (Mr. S. W. A. Sturman) is to act on a committee of overhead line engineers (appointed by the Municipal Tramways Association), which is to consider the question of standardisation of overhead line materials.

Perth.—The salary of the tramways manager (Mr. W. G. Snell) has been increased by £25 per annum.

Southampton.—The result of the working of an electric tipping wagon is given in the annual report of the tramways department for the year ended March 31.

In July, 1916, the department purchased an Edison accumulator wagon, and in addition to carrying out all the carting work of the department the vehicle carried out the following work for other departments :—

For the electricity department, 427 tons ashes conveyed to tip ; for education department, 412 tons of coal, coke and wood carted from sidings to schools ; health department, 95 tons coal and coke carted from sidings to Isolation hospital ; Northam relief work, 51 tons coal and wood distributed throughout the flooded area.

The amount spent on maintenance is said to be quite negligible, and the only real expense, that of charging current, is inter-departmental. A full report of the working of the vehicle will be presented when it has been in use a year. The tower wagon of the same type continues to give satisfaction, the only drawback being the slow speed on gradients, which, it is hoped, will be overcome. The immediate effect of these two vehicles has been a speeding up in the work done, and a gratifying saving in horse food, stabling and attention. The charging plant necessary for the two electric vehicles has also enabled the committee to adopt electric welding, the same machine being designed for the double purpose, and successful repair work has been carried out on broken rail joints, worn car motors and other parts. Repairs by this means are carried out exceedingly quickly, and altogether a plant such as this is a great acquisition to an up-to-date tramways undertaking.

Tramway Workers' Wages.—The application of the operatives employed by the Birmingham and Midland Tramways Joint Committee and the motormen and conductors in the Black Country area for an increase of wages of 1d. per hour has been referred to arbitration.

IMPERIAL NOTES.

Australasia.—The question whether the use of electrically-driven coal-cutting machines at the Bulli colliery was, within the meaning of Sec. 28 of the Coal Mines Regulation Act, 1912, dangerous and threatening or tending to the bodily injury of any persons, was recently referred to arbitration.

Messrs. A. A. Atkinson and J. A. Neilson were arbitrators on behalf respectively of the Minister for Mines and the owners of the colliery and his Honour Judge Fitzhardinge was umpire. The umpire has now made his award and finds "that the practice of using electrical coal-cutters in the Bulli seam of the Bulli colliery is dangerous, and, in the interests of the miners and of the mine, should be at once discontinued." The Australian "Mining Standard's" Wollongong correspondent says the Bulli colliery is seriously affected by this decision. The Mines Department has taken up a hostile attitude to electricity in mines and in their last annual report expressed satisfaction at there having been no increase in the number of electrically-driven coal-cutters. The department notified the Bulli company to withdraw the electricity, as being a danger. The company claimed an inquiry and arbitration. The result has been the re-introduction of the pick in the colliery. Electricity is used in some way in most of the mines in this district, and no accident has been attributed to its use.

Canada.—At the recent annual convention of the Canadian Manufacturers' Association the president said that from a manufacturing standpoint the development of Canada's Western provinces had fully kept pace with their development in other directions. With characteristic enterprise their citizens had freely utilised the resources at hand to make themselves as independent as possible of outside sources of supply. In the heavier lines of manufacture her growth had been retarded by the high price of coal and power, but that difficulty had already been partially overcome by the development of hydro-electrical energy, with a good prospect that further, if indeed not complete, relief might shortly be had through the utilisation of the vast deposits of lignite with which the West abounded.

MISCELLANEOUS.

Engineers' Wages.—It is reported that great dissatisfaction is being expressed at the recent award of the Committee on Production regarding wages in the engineering and foundry trades, and members of the executive of the Amalgamated Society of Engineers consider that an advance of 3s. per week is totally inadequate.

Munitions Tribunal Case.—At Bristol recently Herbert J. Bridge, wireman in the sales branch of the electricity department, appealed against the refusal by the Corporation to grant a leaving certificate as they do not comply with the Fair Wages clauses.

In giving the decision the chairman (Mr. E. H. C. Wethered) said complainant was a member of the Amalgamated Society of Engineers. His contention was that the district rate for an electrical fitter was 50s. for a week of 50 hours. He was paid by respondents at the rate of 11d. per hour for 53 hours, which was equal to a wage rate of 45s. 10d. per week of 50 hours. In addition he received a 4s. war bonus. 50s. a week of 53 hours was the rate for an engineer's fitter in a "shore shop" in the Bristol district since the award made by the Committee of Production in March, 1917. Complainant's contention was that there was no distinction in the district between an electrical fitter and any other fitter, and that the rate for all fitters connected with the engineering industry was 50s. for a week of 53 hours. Complainant was formerly a member of the Electrical Trades Union, but he left that society about two years ago. For a time he belonged to no trades union, but he had recently joined the Amalgamated Society of Engineers.

Respondents contended that the engineers' rate above-mentioned was not applicable to their establishment. The electricity department employed two electrical fitters, two wiremen and three boys. They had a workshop, which contained no machinery driven by power ; they undertook repairs to electric motors. Such work as could be done by hand work was done in their own workshop ; any repairs which required machining were sent out. They also carried out a good deal of wiring work, and they contended that the work carried on in the department was a separate sub-trade of the engineering industry, similar to that carried on by a number of private businesses in the city who styled themselves "electrical contractors." They maintained that there was a special district rate for electrical fitters in the employment of establishments of that character, namely, 10d. an hour for a 50-hour week, and that, as they were paying the complainant 11d. per hour, they were paying more than the district rate, and were therefore complying with the Fair Wages clauses, quite apart from the war bonus of 4s. They contended also that the award of the Committee of Production of March 1, 1917, had no application to their establishment. A small number of tradesmen in Bristol had formed a Masters' Association, known as the Bristol Electrical Contractors' Association. The major part of the work done in establishments of members of the association consisted of electric wiring. They also did a small amount of repair work, for which they employed fitters, who were known as "electrical fitters." Work done by the electricity department of the Corporation was substantially the same as that done by private electrical contractors, but the Corporation were not members of the association. In 1913 the Electrical Trades Union agreed upon certain working rules with the Bristol Electrical Contractors' Association. By these rules a minimum standard rate of wages was agreed at 9d. per hour for a 50-hour week. The firms included in the association worked to those rules until October, 1915. In that month the union approached the association with proposals for a revision of the 1913 rules. An agreement was not arrived at, and the Board of Trade appointed His Honour Judge Stanger to act as arbitrator. By his award his Honour (inter alia) awarded on Nov. 2, 1915, that there should be an additional 1d. per hour to the rates of wages fixed by the 1913 rules, and that such addition should take effect on and from the first pay-day after the date of the award. The new rules scheduled to the award included (1) that 50 hours shall constitute a week's work (after which overtime rates shall be paid), and (2) that 10d. per hour be paid all wiremen, electrical fitters, cable jointers and armature winders.

The general manufacturung engineering shops in the district employed a considerable number of men engaged on various forms of electrical work. Several of them employed electrical fitters, and the practice of the manufacturing shops (both shore shops and marine shops) was to pay electrical fitters the same rates of wages as paid to ordinary fitters. Those rates were as follows, namely : Shore shops, 50s. a week of 53 hours on the two-break system, or 51 hours on the one-break system ; marine shops, 51s. a week on new work and 54s. a week on repair work, for a 53-hour week in each case. The engineering industry in the district fell into two broad divisions, namely, as practised in shore shops and as practised in marine shops. He thought the process of subdivision must be carried further in applying the Fair Wages clauses. For example, he was of opinion that an ordinary motor garage, the proprietor of which carried out repairs to motor cars, was a branch of the engineering industry, and was sufficiently differentiated from manufacturing engineering to be the proper subject of a separate agreement as to wages and hours of labour differing from those prevailing in manufacturing shops. Likewise, he was of opinion that the work carried out by electrical contractors, including the electricity department of the Corporation, was sufficiently differentiated from that of manufacturing shops as to be a fit subject for a special agreement, and that was what appeared to have taken place in that case. The Electrical Trades Union (which included electrical fitters among its members) had entered into a special agreement with the local association of employers in that subdivision and the working rules (as settled by Judge Stanger) seeme to him to constitute the rates of wages and hours of labour commonly

Digitized by Google

recognised by employers and trades societies in that branch of the trade in Bristol. As respondents were complying with those rules he was of opinion that they had not infringed the Fair Wages clauses, unless the award of the Committee of Production, which granted a general advance of 5s. to engineering journeymen as from April 1, 1917, applied to workmen employed in the electrical contractors' sub-division of the industry. He was of opinion that the award did not apply to the shops of electrical contractors. The award itself only directly bound the parties to it; it was an award in an arbitration between the engineering employers' federation and a number of trade unions, including the Electrical Trades Union. The award granted to the men concerned a 5s. advance as from April 1, 1917, and neither Bristol Corporation nor the Bristol Electrical Contractors' Association were parties to that award. They were therefore not bound by its conditions, save to the extent to which the award had affected the district rate of wages in the district. He was of opinion that it had raised the district rate by 5s., so far as the shops of manufacturing engineers were concerned, because it had increased the rate of wages commonly recognised by associations of employers and the trade unions concerned in the branches of the industry represented by the employers who were members of the local association of masters in the engineering industry, which was affiliated to the Engineering Employers' Federation. He thought that award had no effect upon the district rate arising from the special agreement between the Electrical Trades Union and the Association of Electrical Contractors in Bristol as varied by Judge Stanger's award, and that the electrical fitters and wiremen employed in the shops of those employers were not entitled to the 5s. advance granted by that award. That in no way affected the case of electrical fitters employed in the shops of manufacturing engineers, as the practice of the district clearly was to pay those men the same rate as was paid to ordinary fitters. So far as the Amalgamated Society of Engineers was concerned, their view was that an electrical fitter is a fitter, and so entitled to the fitters' rate, and the employers in the manufacturing engineering shops acquiesced in that view. He was therefore of opinion that respondents had not infringed the Fair Wages clauses, and he found that they had reasonable grounds for refusing a certificate to the complainant, and that the complaint must be dismissed.

Swedish Exports Prohibition.—The exportation of the undermentioned articles from Sweden has been prohibited, as from Aug. 2. In certain cases the export prohibitions are not entirely new, but are extensions of prohibitions previously in force:—

Electrical machines (and parts of machines), such as generators, motors, converters and transformers, stators, rotors, current collectors, magnet coils, brush holders and armature coils; also parts of all the foregoing—provided they are composed to any extent of non-precious metal other than iron, or are tinned to any extent: accumulators (unmounted cells), incandescent and arc lamps, searchlights, &c.; carbon and metal filaments and bases for electric lamps; carbon b ushes (weighing less than 3 kilogs. each), even if combined with other material; safety appliances mounted on porcelain insulators (not plates); starting, regulating and reduction resistances, controllers and electric regulators; also fitted boards for electric apparatus and instruments; switches and current interruptors, and incandescent lamp sockets with or without switches; telephone and telegraph apparatus, switches and telephone switchboards, &c.; special apparatus for electrical purposes, not specially mentioned, such as apparatus for signalling or conveying messages, Rontgen ray apparatus, apparatus for wireless telegraphy and telephony, &c.; and railway and tramway vehicles in combination with motors or steam engines.

EDUCATIONAL.

University of Manchester.—Full particulars of the lecture and laboratory courses in physics, preparing for both the ordinary and honours degrees, can be obtained on application from the registrar. Prof. Sir E. Rutherford will meet intending students on Thursday, Oct. 4.

University of Edinburgh.—The next session opens on Oct. 9. The preliminary or entrance examination is held in September. There are complete courses of instruction in civil, mechanical and electrical engineering, qualifying for the degree of S.Sc. in engineering, and extending over three years. Particulars of examinations, scholarships, &c., from the Matriculation Office, the University, Edinburgh.

The University Court have issued an ordinance instituting the degree of bachelor of commerce.

Armstrong College, Newcastle-on-Tyne.—The session 1917-18 will commence on Sept. 24. Full courses leading to the degree of B.Sc. in engineering are provided in mechanical, marine, civil and electrical engineering, naval architecture, mining and metallurgy, &c. Particulars can be obtained from the secretary, Mr. F. H. Pruen, M.A.

South-Western Polytechnic Institute.—Complete three years' day courses, leading to a diploma or university degree in electrical engineering, are provided at this institute. There is also a four years' evening course suitable for electrical engineering and electrical installation examinations of the City and Guilds' Institute, commencing with the next session on Sept. 24. Particulars may be obtained from the secretary, Manresa-road, Chelsea, S.W. 3.

Birkbeck College.—The Governors of this College have submitted a scheme for converting it into a constituent part of the University of London.

TENDERS INVITED AND ACCEPTED.

Tramway Stores.

Portsmouth Tramways Committee require tenders by Aug. 28 for six months' supply of Stores and Materials, including Tyres, Car Repair Stores, Insulating Materials, Lamps, Motor Windings, Overhead Line Materials, &c. Specification, &c., from the Engineer, Vivash-road, Fratton, Portsmouth.

Bell Wire.

The Commissioners of H.M. Works, &c., require tenders by 11 a.m. Aug. 20 for the supply of 400 miles of Bell Wire. Forms of tender, &c., from the Controller of Supplies, King Charles-street, London, S.W. 1.

Electric Lighting Fittings.

Keighley Guardians require tenders by Aug. 21 for the supply of Fittings, &c., for the main block of the infirmary. Forms of tender from the Clerk.

Rotary Converter.

Bermondsey (London) Borough Council invite tenders for a 500 kw. rotary converter. Specifications from the borough electrical engineer, and tenders by noon Sept. 7 to the town clerk, Town Hall, Bermondsey, S.E.

Coal Bunker.

Bootle Corporation invite designs and tenders for erection of an Overhead Coal Bunker at Marsh-lane generating station (for at least 400 tons of coal). Particulars from the Borough Engineer. Tenders to the Town Clerk by noon Sept. 12.

Glasgow.—The Corporation has placed an order with the Chloride Electrical Storage Co. for the renewal of sto age t at ery cells and o carrying out certain repairs to the storage battery at the Bellefield Sanatorium.

Sheffield.—The Corporation has accepted the tender of Dewhurst's Engineering Co. for the supply of 500 steel boiler tubes, and that of the Stirling Boiler Co. for a similar quantity of boiler tubes. Transformers of 2,500 k.v.a. and 5,000 k.v.a. capacity respectively are to be added to the schedule in the recent contract with the British Electric Transformer Co.

South Shields.—The Corporation has accepted the tender of the British Westinghouse Electric & Mfg. Co., at £140, for the supply of two transformers.

Government Contracts.—The following tenders were accepted by the undermentioned British Government Departments during the month of June:—

War Office.—F. R. Butt & Co., Cavendish Electrical Co., H. W. Cox & Co., A. E. Dear, Edison Swan Electric Co., Everett, Edgcumbe & Co., Medical Supply Association, Watson & Sons (Electro-Medical) (Ltd.) and White Electrical Instrument Co., X-ray apparatus and accessories; Cox-Walkers (Ltd.) and Peel-Conner Telephone Works, electric bells; Evershed & Vignoles, bridge meggers; Siemens Bros. & Co., elec. cells; T. De La Rue & Co. and Litholite (Ltd.), insulator cups; Edison Swan Electric Co., General Accessories Co., General Electric Co. and J. Sax & Co., electric light fittings and accessories; R. W. Paul, galvanometers; Callender's Cable & Construction Co., copper and electric wire; British Insulated & Helsby Cables, Connolly Bros., W. T. Glover & Co., Liverpool Electric Cable Co., London Electric Wire Co. & Smith's, Midland Electric Wire Co., St. Helens Cable & Rubber Co., and Ward & Goldstone, electric wire; Ellis & Ward, electric lighting.

Post Office.—Automatic Telephone Mfg. Co., India Rubber Gutta Percha & Telegraph Works Co., W. G. Pye & Co., R. Stafford and Tyer & Co., telegraph apparatus; British L. M. Ericsson Mfg. Co., General Electric Co., Peel-Conner Telephone Works and Western Electric Co., telephone apparatus; General Electric Co., Henley's Telegraph Works Co., Siemens Bros. & Co., Telegraph Construction & Maintenance Co. and Western Electric Co., telegraph cable; Siemens Bros. & Co., cells; British Thomson-Houston Co., Edison Swan Electric Co., General Electric Co. and Southall Lamp Works, glow lamps; British Insulated & Helsby Cables, cable plugs; Bullers (Ltd.), stay swivels and insulator spindles; T. & W. Lench, insulator spindles; E. & J. Richardson, cable suspenders; T. Bolton & Sons, British Insulated & Helsby Cables, Shropshire Iron Co. and F. Smith & Co. (inc. in London Electric Wire Co. & Smiths), bronze wire; T. Bolton & Sons, British Insulated & Helsby Cables, Elliott's Metal Co., R. Johnson & Nephew (Ltd.), F. Smith & Co. (inc. in London Electric Wire Co. & Smiths), Shropshire Iron Co., and J. Wilkes, Son & Mapplebeck, copper wire; Union Cable Co., v.i.r. wire; Sturtevant Engineering Co., elec. fans in Government buildings, Great George-street, Westminster.

APPOINTMENTS VACANT AND FILLED.

An assistant constructional engineer is required by the City of Birmingham Electric Supply Department. Forms of application, which may be obtained from the secretary of the department, 14, Dale-end, Birmingham, should be sent to the city electrical engineer (Mr. R. A. Chattock) by Aug. 25.

A lecturer in physics and mathematics is required for University College, Exeter. Particulars from the Registrar. Applications by Sept. 1.

Mr. Reginald Xenaky, lately of the Yorkshire Electric Power Co., has been appointed technical assistant to the station superintendent at the Salford Corporation Electricity Works. Mr. Fred. Valentine, of Salford, has been appointed secretary to the borough electrical engineer.

Mr. John D. Mackenzie has been appointed principal teacher of engineering at the Airdrie Academy Technical School.

Digitized by Google

BUSINESS ITEMS.

Until further notice communications for Mr. L. M. Waterhouse should be addressed to 113-117, Charing Cross-road, London, W.C. 2. Telephone: Gerrard 4327.

The Consolidated Pneumatic Tool Co. (Ltd.) has removed to 170, Piccadilly, W. 1.

Plant for Sale.—The Victoria Electric Plant Co., Spencer-street, Westminster, S.W. 1, have for sale a bi-polar motor-generator.

BANKRUPTCIES.

The discharge of Fredk. Brown, electrician (formerly partner in the firm of Hugh Bros. & Brown), 8, Stafford-street, Llanelly, Carmarthenshire, is suspended for two years ending July 6, 1919.

Claims against Geo. J. T. J. Parfitt, consulting electrical engineer, 11, Priory-road, Keynsham, near Bristol, are to be sent by Aug. 28 to Mr. C. H. King, 26, Baldwin-street, Bristol.

CATALOGUES, &c.

ELECTRIC LAMPS.—The Sun Electrical Co. (Ltd.), 118-120, Charing Cross-road, W.C. 2, has sent us the price list of metal and carbon filament lamps supplied by them.

ELECTRICAL SUPPLIES.—Messrs. Pass & Seymour, Syracuse, N.Y., send us a sheet giving particulars of their electrical fittings and fittings and a copy of the report of the National Physical Laboratory on the "Dim-a-Lite" (a small accessory for dimming a single electric light) manufactured by them.

WARNING SIGNALS.—In a leaflet issued by the Sun Electrical Co., 118-120, Charing Cross-road, W.C. 2, particulars and prices are given of Klaxon warning signals and Sun motor sirens, which can be used on a.c. or d.c. lighting circuits.

Exports to China.—The "London Gazette" of Aug. 10 contains a further list of firms and persons in China to whom goods may be consigned from the United Kingdom. The list includes the Gaston, Williams & Wigmore Electrical Engineering Corpn.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Carlisle.—The electricity department's accounts for the year ended March 31 show capital expenditure £131,731 (increase £7,093), of which £57,336 has been repaid.

Revenue was £27,287 (compared with £25,109 in previous year) and total costs were £17,384 (£15,384), leaving gross profit £9,903 (£9,725). Interest required £4,097 (£3,388) and repayment of principal £6,002 (£6,163), leaving a net deficit of £196 (against a profit of £174). Maximum load was 2,319 kw. (2,210 kw.) and load factor 23·4 (20·5) per cent. Average price obtained was 1·37d. (1·51d.) per unit. Coal cost 0·35d. (0·34d.) per unit sold and total costs were 1·39d. (1·5d.), including interest and sinking fund 0·47d. (0·55d.). Units generated were 6,040,538((5,200,843) and sold 4,750,591 (3,973,039). Total connections (exclusive of public lighting and traction) are equal to 235,718 (207,418) 32-watt lamps. Motors connected aggregate 4,842 H.P. (4,104 H.P.).

Norwich.—The electricity department's accounts for the year ended March 31 show gross capital expenditure £378,456 (increase £1,378), less £29,004 depreciation written off. In addition, £33,954 has been provided for capital purposes out of revenue. £39,041 of loans has been repaid, and sinking funds amount to £39,041.

Revenue was £66,760 (compared with £57,487 in previous year), leaving gross profit £27,467 (£24,876). Interest and sinking funds required £20,719 and to the remaining £7,011 is added £6,021 brought forward from previous year. Out of these amounts £271 has been paid for property in St. Stephen's Back-street, £2,283 placed to depreciation and £10,478 carried forward.

The report of the Electricity Committee states that units sold were 9,532,091 (compared with 7,973,755) and that the increase in the demand for heating was very marked. Average income per unit sold was 1·68d. (1·73d.). Price of coal increased 11·3 per cent., and cost per unit 7 per cent. Consumers are 6,817 (6,794), and total connections equal to 202,043 (198,573) 8 c.-p. lamps. Motors connected are 964 (889) = 6,333 H.P. (5,715 H.P.). Heating and cooking appliances are equal to 2,389 kw. (1,635 kw.).

Portsmouth.—The accounts of the tramways department for the year ended March 31 show gross capital expenditure £732,369 (increase £188), of which £364,019 has been redeemed or provided for redemption and £24,750 of the expenditure was met out of revenue.

Revenue was £136,870 (compared with £127,546 in previous year), working expenses were £67,604 (£59,300), grants to dependents and war bonus absorbed £5,561 (£2,777), and after adding £878 (£750) interest on credit balances, the balance on the year's working was £64,582 (£66,218). Interest required £21,667, sinking fund £18,060 and income tax £6,174, and the balance for disposal was £24,953, of which £14,000 has been contributed in aid of rates, £6,388 contributed to renewals fund, £1,381 to reserve and insurance fund and £4,000 to reserve for Cosham improvements. Total revenue was equal to 14·20d. (14·101d.) per car mile and working expenses were 7·017d. (6·556d.). Passengers carried were 31,798,562, car miles run 2,312,391 and units used 3,278,630 (=1·417 per car-mile).

Salford—The accounts of the electricity department for the year ended March 31 show total capital expenditure £826,843 (increase £49,649). The sinking fund amounts to £53,788 and the reserve to £18,834.

Revenue was £156,955 and working and general expenses were £86,031, leaving gross profit £70,924, to which is added interest £612. Interest on mortgage debt and on deposits required £17,783, instalment of principal £154, and sinking fund £32,245, leaving £21,353, of which £9,353 has been placed to reserve and £12,000 applied to reduction of rates. Units generated were 31,794,640 and purchased 3,172,050 and 29,572,331 were sold. Total maximum demand was 10,246 kw.

Stoke-on-Trent.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £345,398 (net increase £9,312), of which £13,181 has been met out of revenue and £213,566 is outstanding.

Revenue was £59,577 (compared with £60,970 in previous year), and after providing for working and special expenses, the gross profit was £22,243 (£25,410). The net deficit for the year was £1,199 (against a surplus of £1,182). Net receipts were equal to 1·881d. (1·864d.) per unit sold and total costs 1·175d. (1·067d.), or 1·919d. (1·827d.) including commercial costs.

Mr. C. H. Yeaman (borough electrical engineer) says in his report, units generated by coal were 10,362,505 (10,542,380), coal used per unit was 3·89 (3·90) lb., and coal cost 0·365d. (0·313d.). In addition to a reduction of £1,394 in revenue (due chiefly to a reduction of 425,118 in units sold for private lighting), there was an increase in generation, &c., costs of £1,848, owing to higher prices of materials, higher wages, war bonus, &c. but this was partially counter-balanced by a decrease of £215 in capital charges and £644 paid for items of a capital nature. Units sold were 7,574,764 (7,673,381). The sale of about 6,000,000 power units produced nearly the same revenue as 1,500,000 lighting units. Though the economy of the turbine plant has been a value in stabilising the financial position, Mr. Yeaman says no undertaking with the major portion of its revenue obtained from lighting could face such drastic changes in the habits of the community as have been brought about by the lighting restrictions, liquor control and early closing orders and the Summer Time Act, without suffering severely. The 20 per cent. increase in charges for current represented £8,495 of the gross income, a further 5 per cent. advance has been authorised, but Mr. Yeaman thinks it desirable that another 8½ per cent. should be charged from the September quarter meter readings.

West Ham.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £670,299 (increase £7,408), of which £347,873 is outstanding.

Revenue was £152,987 (compared with £139,101 in previous year) and gross profit was £18,008 (£23,921). Interest and special charges amounted to £27,879 (£25,241), including £4,613 (£4,216) allowances to men on active service. Sinking fund required £25,554 (£24,882), and the net deficit was £35,425 (£26,202). Average price obtained was 1·019d. (0·924d.) per unit, coal cost 0·603d. (0·458d.), total works costs were 0·918d. (0·770d.) and total charges, including capital charges, were 1·281d. (1·105d.). Units generated were 42,332,509 (43,569,200) and sold 35,298,301 (35,895,393). Total maximum demand was 1,1820 kw. (12,225 kw.).

Mr. J. W. Beauchamp (engineer and manager) says in his report the consumers are 4,316 (4,305) and the connections are equal to 23,897 kw. (23,702 kw.), including 1,978 (1,944) motors equal to 22,007 H.P. (21,877 H.P.). The smallness of the net increase of consumers was due to the difficulty of carrying out new mains work, and the total and power connections are net after deducting a large number of motors put out of use for a time by accident. Load factor was 34·09 (33·52) per cent. The price of fuel increased 26 per cent. over the previous year, and the inferior quality of some of the coal greatly increased the quantity consumed and expense of handling. The sales department shows a surplus of £2,270 (£70) net.

The tramway accounts show capital expenditure £557,311 (no increase) and sinking fund, including stock cancelled, amounting to £152,168. Revenue was £166,313 (£164,557) and working expenses were £149,989 (£164,557). Interest required £18,796 (£18,456), sinking fund, &c., £12,795 (£12,738) and special expenditure £9,258 (£5,580), the net result being a deficit of £21,671 (against a surplus of £2,855. Passengers carried were 47,326,816 (46,734,440), car-miles run 3,650,855 (3,645,165) and units used 5,496,231 (5,860,821) = 1·63 (1·61) per car mile. Average total traffic revenue per car mile was 10·99d. (10·94d.) and working expenses, including power, were 9·86d. (8·22d.).

The general manager (Mr. L. Slattery) says in his report difficulty has been experienced in maintaining the services owing to depletion of staff and difficulty of obtaining certain materials. 128 women conductors are employed. A universal penny fare has been adopted in the borough. Allowances to employees who have joined H.M. Forces have cost £16,670 for the year and £36,019 since the commencement of the war. Tyres cost 180 per cent. more than pre-war prices, pinions 136 per cent. more, axles 101 per cent., trolly wire 107 per cent., oil 135 per cent., and other material showed increases of from 58 to 106 per cent.

Digitized by Google

COMPANIES' MEETINGS AND REPORTS.

BROWN, BOVERI & CO—The net profit for the past year was £123,000 against £106,000 in 1915-16 and £92,000 for 1914-15. A dividend of 7 per cent. has been declared, compared with 6 per cent. last year. The capital is to be increased from £1,280,000 to £1,440,000. The report states that the electrical branch of the business has been well employed, and that there has been a good demand for hydro-electric plant. The war having shown the dependence of Switzerland upon foreign coal supplies, the military authorities have altered their opinion and are now in favour of the electrification of the lines. This will, it is stated, be impossible until after the termination of the war.

KALGOORLIE ELECTRIC TRAMWAYS (LTD.)—Mr. O. Wethered, who presided over the meeting last week, said that the period had been one of difficulty and anxiety, and one could not hope for improvement, at any rate until after the end of the war. The mines were passing through a very trying time, as not only had they been suffering from a shortage of labour, but the cost of everything had so largely increased that a great many of the mines were only continuing to work with great difficulty. The demands made for increased wages they could not agree to and the matter would go to arbitration. The Judge of the Federal Arbitration Court has stated that a company's falling revenue, or its financial position, would not be taken into consideration by him when arriving at what he considered a fair rate of wages to be paid to its employees. Unlike other businesses, it was not possible for them to call on the public to share part of the extra expenses put upon the company.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—Mr. G. C. Isaacs, who presided over the meeting last week in the absence of the chairman (Senator Marconi), explained the various items in the report which appeared in our issue of the 3rd inst. The freehold property at Chelmsford, together with plant, machinery and buildings and the Genoa works, had been added to during the year. Those items, as well as the long-distance wireless telegraph stations in England and Ireland, leasehold premises, &c., appeared in the balance-sheet at a lesser figure than in 1916. The shares in associated companies and patents (taken at cost) showed a small increase. Their par value was £2,487,450. The balance of contracts, sales and trading account was less than that of the preceding year, as was the net profit, but during 1915 they had some large contracts of an exceptional nature to carry out. Their relations with the Admiralty continued to be very good. Some of their associated companies had made considerable progress during the year. The Marconi International Marine Communication Co. had shown a very substantial development, and its progress was even greater than it was last year. Their Russian company had continued to do a very large business, and had paid a dividend for 1916 at the rate of 17 per cent. The French company (La Compagnie Francaise Maritime et Coloniale de Telegraphie sans Fil) had declared increased dividends on the ordinary and founders' shares. The Compagnie Universelle de Telegraphie et de Telephonie sans Fil (the shares of which were acquired by the Marconi company) was about to be transformed. The American company showed improvement in 1916, but continued to be handicapped very seriously in consequence of their Transatlantic stations being unable to work owing to the stations on this side being required for war purposes. Owing to the United States entering the war the Transatlantic stations and all the other American stations had passed temporarily into the hands of the American Government. They were advised that fair compensation would be paid. The same applied to the Transpacific service, which had been started and which was being successfully conducted. The telegraph service both with the Hawaiian Islands and with Japan was increasing. The company had been very much occupied for some time past in the conduct of legal proceedings against infringers of their patents, and he was glad to say that the results had been highly satisfactory. The most recent action was one in respect of the De Forest valve patents, and the court held them to be a complete infringement of the Fleming patent, which was the property of their company. Dr. De Forest claimed that they did not infringe, and that the American company infringed seven of their patents. The Court of Appeal had recently delivered its judgment, declaring that the judgment of the court below was upheld, that the De Forest valves were an infringement of the Fleming valve patent, which was a master patent, and that there was no infringement of six of the De Forest patents, and that the seventh De Forest patent was invalid. Their Canadian company had had to contend with abnormal conditions created by the war, but their account would show an improvement over the preceding year. The Compania Nacional de Telegrafia sin Hilos, of Madrid, in which the Spanish and General Wireless Trust Co. was so largely interested, was making much more satisfactory progress. The Belgian company's business continued to develop very satisfactorily, but inasmuch as they were unable to have any communication with their head office, it was impossible for them to close their accounts. After an explanation of the transactions connected with the American company and of the litigation with Messrs. Locker-Lampson and P. Wright and Mr. Hamilton, Mr. Isaacs said that the Transatlantic service had been closed down recently. That course had been adopted, not on account of any fault on the company's part, but solely because the exigencies of war had demanded it. The company would be entitled to full compensation from the Government. Since the issue of the report negotiations had been opened with a view to settling two important items under the four heads of claims upon the Government: (1) For remuneration and compensation in respect of the use of the company's high power stations since the beginning of the war, the staffing and management of those stations and other services in connection therewith; and (2) the claim in respect of the withdrawal of the Post Office from the contract for the Imperial chain of stations. The negotiations might take some little time.

The report and accounts were adopted, and a vote of confidence in the directors was also passed.

SUFFOLK ELECTRICITY SUPPLY CO. (LTD.)—At the meeting on the 8th inst. the chairman (Mr. P. C. Peddar) stated that, although there was no dividend to be declared, he was able to present a satisfactory report, for Stowmarket was not to be deprived of the blessings of electrical supply, either for power or lighting. The Minister of Munitions and the War Office had given a sympathetic hearing to the troubles in regard to the lighting of Stowmarket, and there was every probability that matters would be placed on a satisfactory basis in the near future; while the shareholders were not getting any dividend the company's business was stronger in view of the Government assistance given.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

HIGH-SPEED MACHINERY CO. (LTD.) (148,199).—Private company. Reg. Aug. 10, capital £2,500 in £1 shares. Mechanical, electrical, hydraulic, motor, telegraph and telephone engineers, machinists, &c. First directors are Joseph P. Annacker, Karl Johann Almfelt, Francis B. Spear, Balfour Strachan and Howard W. Whitworth.

J. H. NAYLOR (LTD.) (148,142).—Private company, reg. Aug. 2, capital £15,000 in £1 shares, to take over business carried on at Wigan as J. H. Naylor and to carry on the business of engineers, manufacturers of miners' safety lamps, &c. First directors are:—J. Naylor and C. N. Smith.

S. T. TAYLOR & SONS (LTD.) (148,146).—Private company, reg. Aug. 2, capital £15,000 in £1 shares, to acquire business carried on as S. T. Taylor & Sons and to carry on the business of manufacturers of and dealers in non-conducting cements and other coverings suitable for boilers, pipes, &c., mechanical, electrical, aircraft, heating and sanitary engineers, &c. First directors are:—E. Taylor and S. T. Taylor, each of whom may retain office while holding 1,000 shares. Reg. office: Tynos Works, Scotswood-on-Tyne.

MORTGAGES AND CHARGES.

ENTERPRISE MFG. CO. (LTD.)—Mortgage debenture dated Aug. 3, 1917, to secure £500, charged on company's undertaking and property, including uncalled capital. Holder: A. P. Grange, Latchford, Warrington.

MANDER & CO. (LTD.)—First mortgage debenture dated July 20, 1917, to secure £400 and interest charged on company's undertaking and property, present and future. Holder: Minnie Gertrude Mander, 38, Davey-road, Perry Barr, Birmingham.

WHITE, JACOBY & CO. (LTD.)—Particulars of £1,500 debenture created March 29, 1917, have been filed, amount of present issue being £630. Property charged, company's real and personal property, including uncalled capital.

CITY NOTES.

BLACKPOOL & FLEETWOOD TRAMROAD CO.—An interim dividend at the rate of 4 per cent. per annum (4s. per share) has been declared on the ordinary shares.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.).—An interim dividend for the half-year to June 30 at the rate of 8 per cent. per annum, less tax, has been declared on the ordinary shares.

COMPANIA DE ELECTRICIDAD DE LA PROVINCIA DE BUENOS AIRES.—Mr. H. Stuart has been elected a member of the London board of this company.

CHATHAM & DISTRICT LIGHT RAILWAYS CO.—An interim dividend at the rate of 6 per cent. per annum (6s. per share) has been declared on the ordinary shares for the past half-year.

FIFE TRAMWAY, LIGHT & POWER CO. (LTD.)—A dividend of 6 per cent. (less tax) has been declared on the preference shares.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The directors have declared an interim dividend on the preference shares at the rate of 4½ per cent. per annum (less tax) and on the ordinary shares at the rate of 10 per cent. per annum (less tax) for the half-year ended June 30.

LANARKSHIRE TRAMWAYS CO—An interim dividend at the rate of 6½ per cent. per annum (less tax) has been declared for the half-year ended June 30.

LANCASHIRE DYNAMO & MOTOR CO. (LTD.).—A dividend of 2½ per cent. (tax free), making 12½ per cent. for the past year, has been declared on the ordinary shares.

MANSFIELD AND DISTRICT TRAMWAYS CO.—An interim dividend of 3 per cent. has been declared on the ordinary shares.

PARA ELECTRIC RAILWAYS AND LIGHTING CO. (LTD.)—An interim dividend at the rate of 6 per cent. per annum (3s. per share), less tax, has been declared on the ordinary shares for the past half-year.

VICKERS (LTD.).—Mr. John Barr has been appointed a director of this company at Barrow, in succession to Mr. A. Miller, who has resigned

Digitized by Google

THE ROUND TABLE.

By "KVA."

The coal rationing season is about to commence. All good central station engineers are, of course, installing electric fires, even though their gardens back on to the works' coal pile!

* * * *

The latest addition to electrical expletives is the "air-blast rectifier." I wonder if any of the ancient and much blasted arc lighting rectifiers are still calling forth adjectives!

* * * *

Mr. Frank Pick has been appointed assistant to the Coal Controller, to deal with London coal distribution. This seems very appropriate, seeing that coal can not be got without the pick, the picking belt and the pick-quick electric coal cutter!

* * * *

An advertisement in a northern paper reads as follows:—

An experienced electrician wanted to take charge of light and power.

As a rule the experienced electrician is more accustomed to charges of "bitter and burton," which he regards as the fluid equivalent of the two items named!

* * * *

From "Blighty" Summer Number:—

Chaplain (to boy struggling with Army mule on the steamer gang plank): "You seem to be in difficulty, young man; can I help you?"

Boy: "Yessir—tell us 'ow Noah got *two* o' this blitherin' kind into the Ark!"

* * * *

The giant gooseberry is now *un fait accompli* of electro-culture, and the sea serpent has been successfully submarined, so there is a lack of holiday-season subjects. The "Johannesburg Star" is, however, not at a loss as the following, quoted in "Car Illustrated," shows:—

Petrol and steam have done much for modern transportation; and have yet a long way to go in usefulness. But many are convinced that the ultimate solution of the problem of locomotion is to be found neither in internal combustion nor steam engines, but in electricity. The problem that remains is one of chemistry; and there are many who are awaiting the advent of some bright young man from the research laboratory to tell us the ingredients of the primary battery of the future—a battery in which the electrodes are to be permanent, and the energy is to be derived from the chemical action of the electrolyte itself. He will have a device so simple that the chemist's shop will be our charging station; he may be able to patent it, but he won't be able to restrict its use—so we motorists will be glad to provide for his declining years. When he arrives, we will be able to buy the stuff by the barrel or by the ounce; or, if it is going to be a gas proposition, we will stop at the wayside station and buy not so many gallons of petrol, but so many atmospheres of oxygen or hydrogen, or whatever it is to be.

They tell us there is enough energy in a pinch of radium to reverse the hydraulic engines of Niagara. Electric energy is developed in the reaction of chemical salts upon each other; every compound, every element, in fact, contains the potential energy of a coiled spring. When the bright young man comes out of the laboratory with the secret of how to upset the ratchet of this spring, on that day we will cease to worry about geological survey reports on the available supply of coal and crude oils. Also on that day we will throw away all the super-structure of our cars except the springs and upholstery; and we will mount the remnant on a pair of axles, one of which—front or rear—will consist of the elongated halves of a self-differentiating electric motor. We will throw away radiators, magnetos, gear-shifting appliances that never grow up, smells, mean-effective pressures, clutches founded on the doctrine of coefficient-of-friction, the volumetric and thermal efficiency twins—all the ills, in fact, that a motorist carries around with him now, as sprung weight—except punctures, which we will always have with us so long as we ride on air.

Exeter has a way with its electricity department staff. During a discussion of the chief's salary the Council placed on record their satisfaction with the services of the Electrical Engineer, and their confidence in his management, and that their refusal to increase his salary was no reflection upon his management or his professional ability.

Very nice in its way, but how much sugar or coal does it buy?

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, August 14, 1880.]

THE HELIGOLAND CABLE.—We regret to hear that the traffic through this cable is pro tem. interrupted

NEWCASTLE.—The authorities at Newcastle have agreed to allow the representatives of the United Telephone Companies to lay underground wires for telephonic purposes.

BRADFORD.—The works at the new reservoir are being lighted by two of Mr. Crompton's lamps, so that the labour goes on continuously. It is said that the lamps are of 12,000 candle-power each.

DR. TANNER'S FAST.—While Dr. Tanner has been fasting, the Atlantic cables have been feeding. The companies have earned by the transmission of daily bulletins concerning the starving doctor's condition a sum probably not far short of the gate money pocketed.

SUCCESSFUL CABLE GRAPPLING IN 2,000 FATHOMS.—In our notice of this operation in last week's issue, part of the last sentence in the first paragraph was unfortunately misplaced. The words "late chief officer of the Telegraph Construction & Maintenance Co.'s steamship 'Scotia'" should be placed immediately after the name Captain Goodsall, to whom they refer. We take this opportunity of stating that the "Chiltern" is still engaged in the work on the cable referred to in our notice.

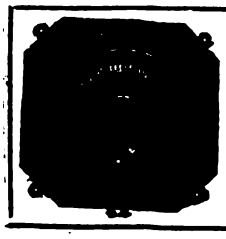
The Dehydration of Peat.—In a note in last week's issue of "Engineering," our contemporary refers to the late Count Botho Schwerin's experiment of about 15 years ago on the electro-osmotic dehydration of peat, dye-stuffs and other suspended matter.

It states that "we were under the impression that his somewhat successful experiments on peat treatment had been abandoned, because he could not get rid of more than about 40 per cent. of the water by burning one-eighth of his peat for generating electricity. From the obituary notices we see, however, that the treatment had lately been improved and resumed. The general principle of the process is that when water contains suspended matter, colloidal or not, in addition to small proportions of electrolytes, the different electric charges which the particles and the liquid assume between electrodes make these constituents travel in different directions—the water generally to the kathode, the particles to the anode. The electrodes were made of wire gauze, and the diaphragms of porous silica, &c., and so arranged that the water could trickle through them. Schwerin worked first in the dye works at Höchst, later he founded the Electro-Osmose Gesellschaft; his partial success in purifying dyes, clay, and colloids like glue and albuminoids and promoting dialysis probably diverted his attention from the problem of drying peat. There are, however, no particulars available about his improved peat process. The electrolytic decomposition accompanying his osmose seemed to be unimportant."

French Rolling Mills.—It is reported that inquiries from France have been made in the U.S.A. for 96 in. and 74 in. sheared plate mills and a 42 in. universal plate mill to be electrically driven. The specifications include three main mill motors, 100 small motors, shears, roll tables and from 9 to 15 heating furnaces. Lifting equipment, including 12 electric cranes, having capacities ranging from 10 to 50 tons, will probably be bought in Europe.

Natural Gas in Hungary.—Our contemporary "Engineering" reports that the town of Torda in Hungary, where the exploitation of natural gas has assumed large proportions, has installed a system of heating by natural gas for domestic and industrial purposes.

The price of gas for factories and industrial purposes is stated to be 1 heller per cubic metre. The Hungarian State Railways are illuminated with this gas, and, as the supply exceeds the local requirements, plans are under consideration for delivering it at Buda Pest (a distance of about 300 miles). A large electric generating station for the production of atmospheric nitrates, with a capacity of 20,000 H.P., and large aluminium works are projected, and in connection with both of these schemes test installations have been erected. A heller is about $\frac{1}{10}$d.



IGRANIC

FIELD REGULATORS

Over 300 Standard Ratings.

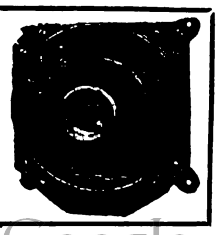
Amply rated resistance enclosed in insulating base. Convertible for front or back of board mounting. Large stocks for quick despatch.

No. 350-1.—Open plate type Field Regulator.

IGRANIC ELECTRIC Co LTD

147, QUEEN VICTORIA STREET, LONDON.

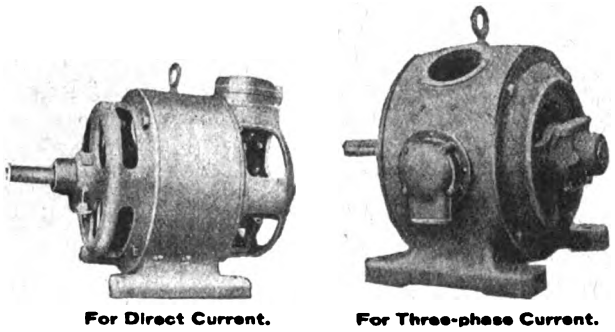
No. 350-2.—Protected plate type Field Regulator.



Digitized by Google

SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current. For Three-phase Current.

for

ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 16 & 18, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350 Telegrams: "SIEMOTOR, CENT., LONDON."

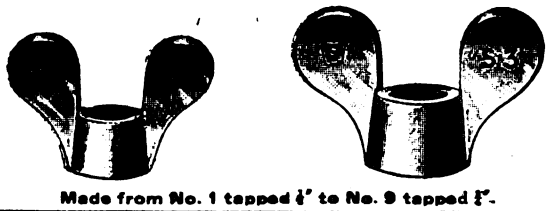
HOME BRANCH ADDRESSES:

BIRMINGHAM—Central Ho., New St.
BRISTOL—30, Bridge Street.
CARDIFF—89, St. Mary Street.
GLASGOW—66, Waterloo Street.
MANCHESTER—196, Deansgate.
NEWCASTLE—64-66, Collingwood Bldgs.
SHEFFIELD—22, High St.
SOUTHAMPTON—46, High Street.

Branches in Principal Towns Abroad.

E. SHOWELL & SONS, LTD.,
STIRCHLEY, BIRMINGHAM.

SOLID FORGED BRASS WING NUTS.
Tapped Standard Whitworth and B.A. Standard.



Made from No. 1 tapped ¼" to No. 9 tapped ⅜".

Sole Agent for the Electrical Trade:—
LIONEL ROBINSON, 3, STAPLE INN, LONDON, W.C.
TELEPHONE: *Holborn* 6823.

"FORMITE"
(Trade Mark)
For Moulded & Built Up Insulation
HEAT, ACID & SOLVENT RESISTING.

Apply—
PINCHIN JOHNSON & CO., Ltd.,
MINERVA HOUSE, BEVIS MARKS, LONDON, E.C.
Sole Selling Agents for
THE DAMARD LACQUER CO., Ltd.,
BIRMINGHAM.

ELECTRO-CULTURE.

Efforts have been made from time to time to apply electricity for the benefit of agriculture. Since the outbreak of hostilities and since the supply of home-grown food-stuffs has become so important, a more serious effort has been made to develop vacant land. gardens and allotments are to be seen in all districts, and the Government are making a serious effort to call for an increase of arable land in the season of 1918. Attempts are also being made to increase the yield of land under crops. Our readers are aware of the experiments as to the effect of an overhead electrical discharge upon crop production at Lincluden Mains Farm, Dumfries. These experiments are all the more worthy of notice because they are conducted by a lady, but the added interest and inquiry produced by the published details of these trials has proved an incentive to others. It is to be hoped, therefore, that definite information and exact data will shortly be forthcoming, in order that the farmer and the cultivator will be convinced of the merits of electrical treatment.

Sundry installations have been erected in different parts of the country within the past few months. These will be able to furnish valuable information at the end of the present growing season, when the harvest is stored and the results totalled. A very complete installation has recently been fixed in the extensive vegetable gardens attached to the residence of Sir Thomas E. Roberts, near Carnarvon. The whole of the installation was designed and erected by Messrs. E. M. Evans & Son, Ltd., Electrical Engineers, of Manchester. The equipment embodies careful experiment and long experience with high-tension apparatus together with more than ordinary insight and knowledge in general cultivation. At Carnarvon the apparatus is fixed permanently in a small shed, and is connected to the main cable which supplies electric light for the residence, the out-buildings and farm. The initial voltage is 220 volts continuous current, and passes through a controlling switchboard to the intensifying apparatus. The chief feature of the overhead wiring is the careful manner observed in insulating the wires, which are suspended over the respective garden plots—a uniform height of 7 ft. has been adopted in order to allow freedom for the garden staff to carry on the work of cultivation when the current is not in use. Abundant criticism has been levelled at the overhead discharge method of supplying electric current to crops, and the main argument used is usually the absence of detail appertaining to the purpose and direction of the treatment together with the lack of reliable data giving tangible results secured by this method of cultivation. It is, however, claimed by its advocates that there is every inducement to consider the system to be practical and that it can be easily applied for the benefit of crop production.

The engineers of the Carnarvon installation are convinced of several important features which have not been previously noted. They are emphatically of opinion that the ionisation of atmosphere is but of secondary importance, though attention is being particularly paid to the influence of prevailing winds to widen the area of influence. They maintain the main effect of the discharge is noticeable on the soil, and that soils heavily manured are more effectively benefited by reason of the latent humidity. The active result upon the soil is apparently due to the release and nitrification essential to the well-being of plant life. The dark green foliage and the building-up of new tissue is evident proof of the greater vigour and increased growth of the plant. Furthermore, confirmation is provided of the fact that sunlight is detrimental for the discharge to be in operation at the same time (more successful working is obtained at sunrise and sunset); a time-switch can be automatically arranged to switch the current on and off at these times. This fact also emphasises the approximate degree of humidity necessary for the success of the discharge, as the amount of dew or latent humidity prevalent at these periods are more or less helpful. Whereas, in heavy rain the discharge is inclined to run to waste, owing to insulation troubles. It must be borne in mind that the intensified voltage of 75,000 volts to 100,000 volts has to be dealt with in a very different manner to the ordinary electric light voltage, and the methods of control together with the periods of working are important factors in the welfare of the installation. The current expended at Carnarvon is economical in working. The current required at the primary terminals amounts to 450-460 watts per acre per hour (approximately only half a unit); the reason for the discrepancy is entirely atmospheric, the energy required being greater in proportion to the prevailing humidity to make up for the sundry current loss. This occurs on dull heavy days when mist or heavy dew prevails, whereas on prevailing dry periods the efficiency is uniform. Enough has been said to show that additional knowledge is gained day by day by the application, and the improvement in the quality of crops is ample justification for the further trial and increased research into the merits of electricity as a practical agent working for the benefit of the farmer and the nurseryman.

ELECTRIC STEEL IN U.S.A.

"Engineering" reports that the U.S.A. Government is expected to manufacture electric steel for both projectiles and steel castings at the earliest opportunity in various parts of the United States. Contracts will be placed for six 6-ton Heroult electric furnaces, and three of these will probably be installed at the new Government projectile plant at Charleston (W.Va.), while the other three will produce steel castings, one at the Washington Navy Yard, one at Puget Sound and one in the Boston area.

Digitized by Google

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite—Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1912 to 1917.

ATTWATER & SONS,

Telegrams: Attwaters, Preston. Telephone No. 1045 (2 lines).

Hopwood St. Mills, PRESTON.

Established 1868. Codes: 5th Edition A B C & Western Union.

J. P. DEVINE CO., BUFFALO.

MANUFACTURERS OF

Vacuum Drying and Impregnating Plant.

(PASSBURG SYSTEM.)

The Devine Co. are well known in the United States and Canada as the leading manufacturers and experts in Vacuum Drying and Impregnating Plant and have over 1,500 such plants in successful operation.

AIR PUMPS, COMPRESSORS,
VULCANISERS,
CONDENSING PLANT.

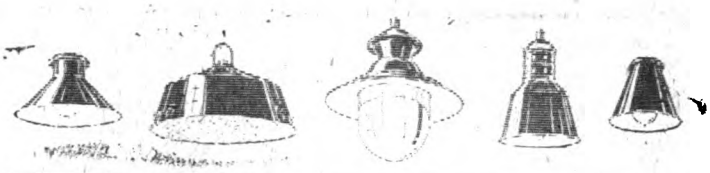
Solvent Recovery and Derisinating Plant a Speciality.

Sole Representative:

JAMES LIVINGSTON, LTD.,

IMPERIAL HOUSE, KINGSWAY, W.C.

Telegrams and Cables: "CINERARY, LONDON." *Telephone:* GERRARD 2300.



THERE IS A SEARCHLIGHT ON FACTORY EFFICIENCY

SOONER or later the Factory Acts will compel good lighting.

Why wait for compulsion, when money can be saved by dealing with the matter now?

The greatest waste of to-day is that of artificial light in our factories. Millions of tons of coal are burnt, and much human effort is spent, to produce electric light, of which a large proportion is wasted in glare, and in the creation of shadows, and thus the light which was intended to add to our national efficiency is made to militate against it.

With Simplex Steel Reflectors properly installed, every ray of light is diverted to useful work, there is no glare, and there is "Efficiency and Economy."

Simplex Conduits Limited

Works: Garrison Lane, BIRMINGHAM

113-17, Charing Cross Rd., London, W.C.
16, Corporation Street, Manchester.
72a, Waterloo Street, Glasgow.
61, High Bridge, Newcastle.
11, Denmark Street, Bristol.
96, Whitechapel, Liverpool.
6, White Horse St., Leeds.
14, Heathfield St., Swansea.
4, Westgate St., Cardiff.
1, Crimon Place, Aberdeen.
281-3, Attercliffe Common, Sheffield.

Digitized by Google

FOR
SLIDING RHEOSTATS
CONSULT
ISENTHAL & CO., LTD.
(DEPT. 4)
Denzil Works, Willesden,
London, N.W. 10.

GLUE POT HEATERS
SOLDERING IRON HEATERS
WAX MELTERS, METAL POTS
CORE DRYING OVENS
ENAMELLING OVENS
IMMERSION HEATERS
HOT PLATES, AIR WARMERS
and all kinds of special Electrical Apparatus for Munition Works, Shell Filling Factories and all manufacturing purposes.
BELLING & CO.
DERBY ROAD WORKS,
Montague Road,
EDMONTON, N. 18.

If you wish to dispose to best advantage of your ACCUMULATION of
OLD and NEW SCRAP
EBONITE & VULCANITE SOLID SHAVINGS
RUBBER GLOVES, CABLES, TYRES, VALVES, &c.
GUTTA PERCHA CABLES BUCKETS
When writing for Price List return this advt. for Special Quotations to
J. SCHNURMANN, Downham Mills TOTTENHAM
(Proprietors: J. J. SHERMAN and S. P. CASSY)
LONDON, N. 17.
Branch Works: 49/51, Broughton Lane, Manchester.

HYDRO-ELECTRIC UNDERTAKINGS IN SPAIN.

According to a Spanish authority, Senor Urrutia, the capacity of the hydro-electric works of Spain may be taken as 1,437,000 kw., though others put it at 2,000,000 kw., but by constructing barrages the figure could be increased to 3,000,000 kw.

When the country's resources are fully developed the annual production of power is estimated to be 10,000,000,000 units, or equivalent to from 30 to 40 million tons of coal per annum. Up to the present only about a tenth of the available resources has been utilised, representing an annual output of 750 million units.

M. Sallior gives some interesting particulars in "La Nature" of the principal undertakings in the province of Catalonia. The most important is the Sociedad Eléctrica de Cataluña, and was founded in 1911 under the joint auspices of the Cie. Générale d'Electricité and the Société Suisse d'Industrie Electrique. It has nearly 30,000 consumers and supplies annually about 120 million units of electrical energy. The water power is derived from the falls of Rio Flamisell, a tributary of the Noguera Pallaresa (the latter being a tributary of the Rio Segre, which flows into the river Ebro). The Flamisell basin comprises a series of 25 natural lakes at altitudes of from 2,000 to 2,600 metres and provides a reserve of 14 million cubic metres of water, capable of increase to 22 millions. The region in which these lakes are situated is subject to very low temperatures (the mean being 25°C. below zero) in winter. No difficulty, however, is experienced; a layer of ice about 1 metre thick forms at the surface, below which the water remains liquid at its temperature of maximum density. Tunnels or open channels are resorted to, being necessary, moreover, to protect the works from avalanches. The water from the lakes is conducted by tunnels to the Estangento lake, which itself constitutes the general reserve from which the supply is taken. These tunnels terminate in a supply basin, whence the pressure supply lines start. The pressure supply lines, 2 km. in length, distribute the water to the power station 835 metres downstream. A barrage raises the water-level in the Estangento lake, the supply line being arranged in the barrage itself. Reinforced concrete bridges are used for carrying the supply channels over the Rio Flamisell. These channels are coupled in pairs and distribute the water to two groups of 4 units each of 6,600 H.P., and to two further groups used for exciting the alternators. The station at Capdella has plant of 38,000 H.P., the effective horse-power being 30,000. Another station is being constructed at Molinos 7 km. below Capdella. Apart from the Capdella station the company has erected two others, one with steam generating plant at St. Adrian of 40,000 H.P. and the other at Ribas of 4,500 H.P. The St. Adrian station is fully loaded. The high-tension line, which is formed of six copper wires 10 mm. dia., is carried on steel towers. Chain type insulators are employed The company, which will shortly have available 94,500 H.P., possesses four distributing centres, transforming the energy from 80,000 volts to 22,000 and 11,000 volts, and nearly 400 secondary transformer stations.

Another important concern is known as the "Riegos y Fuerza" ("Irrigation and Power"), and is situate to the south-west of Barcelona. The Rio Noguera Pallaresa has been barraged at Trempo and utilises also the water of the Rio Segro, between Lerida and Seros. At Trempo (Talarno power station) a concrete barrage has been erected 82 m. in height, 290 m. in length, and with a breadth of 70 m. at the base and 4 m. at the top. This gives an immense reservoir of 200 million cubic metres, which is delivered at from 12 to 50 cubic metres per second. The generating station, situate 300 m. below the barrage, houses three turbines of 12,000 H.P. each driving an 8,000 kw. 6,000 volt three-phase alternator. On the Rio Segro, near Lerida, is another barrage 390 m. in length and 6 m. in height. The supply channel, 20 km. long, leads to the Seros generating station. The reserve of water is 20 million cubic metres. The station contains four turbines of 11,000 H.P. to 14,000 H.P., working under a head of 46-49 m., and each driving an 8,000 kw. alternator. Behind the turbine room is a transformer house containing four three-phase 13,333 kw. transformers, each formed of three monophase transformers of 4,444 kw. connected in delta. These raise the pressure from 6,000 to 110,000 volts. The energy is distributed by a 110,000-volt double six-wire conductor from Trempo to Camarasa, from Seros to Camarasa and from Camarasa to Sans. Each wire is formed by a hard-drawn copper conductor of 107 sq. mm. cross-section, and the total length of the 110,000-volt line is 220 km. (about 136½ miles). At Sans, an industrial suburb of Barcelona, there is a transformer station for reducing the pressure from 110,000 to 25,000 and 6,000 volts. The 25,000-volt pressure is used for aerial distribution in the neighbourhood, and for connecting up with the old steam generating station of the company, which is now used as an emergency station. The underground network of Barcelona is fed from the 6,000-volt lines.

Another undertaking, the Compañia Catalana de Gaz y Electricidad, which distributes energy to Barcelona, utilises a fall on the Rio Esera in the province of Huesca. The station, not yet complete, will comprise three groups. The capacity will be 7,000 kw. and energy will be distributed at 110,000 volts to Barcelona by a three-wire line 22 km. in length.

For Effective Impregnation
use "LACWATT"
Black or Golden Brown.
JENSON & NICHOLSON, Ltd.,
Insulating Varnish Department,
Goswell Works, Stratford, E.15.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

Patent No. 8722/17.

No! This is not a further example of frightfulness; but merely an illustration of how our new Self Aligning Contacts adapt themselves to extreme conditions.

In spite of the unusual aberration of the clips, conductivity is not impaired.

Much of the trouble experienced with fuse contacts is due to imperfect alignment, resulting in high resistance, and consequent heating, followed by permanent deterioration of the clips, all of which are obviated by our new device.

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED **SECOND HAND**

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.

Phone: Victoria 4026. Grams: Vicmaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh.

See our Illustrated Advt. Aug. 10.

Digitized by Google

HYDRO-ELECTRIC POWER IN NEW ENGLAND.

Extensions of the generating plant, transmission lines and sub-station equipment of the New England Power Co., estimated to cost about $7,000,000, are projected.

The "Electrical World" reports that the urgency of the coal situation and the rapidly increasing demands for power make the extensions necessary. The company owns hydro-electric and steam driven stations, supplying electrical energy to the extent of 70,000 kw. in five of the six New England States and also in New York State. Through reciprocal power contracts the company is also connected up with plants whose installed capacity totals 100,000 kw. For the year ended May 31 last the company's output was 271,000,000 units compared with 203,000,000 units in 1915-16. The recent peak load reached 67,000 kw. and at present the output is over 1,000,000 units a day. Within the last year the average price of coal in New England has risen from about $4 to $9 per ton. The demand for industrial power has increased and it is now proposed to raise the transmission pressure from 66,000 to 110,000 volts, to increase the capacity of three of the sub-stations and to build a new hydro-electric station of 22,000 kw. initial capacity in the Upper Deerfield Valley in Vernon. Two of the company's sub-stations will be of 12,000 kw. and 30,000 kw. capacity respectively. In order to improve the power factor of the system a 7,500 kw. G.E.C. synchronous condenser is being installed at Woonsocket sub-station; about $100,000 will be expended in increasing the capacity of the Greendale sub-station from 11,000 kw. to 24,000 kw. and about $225,000 will be expended on Rhode Island sub-station enlargements. A new sub-station is also to be built at North Adams (Mass.) at a cost of $75,000. The immediate generating facilities will add 150,000,000 units to the generating capacity and will mean a saving of 300,000 tons of coal annually.

The Massachusetts Waterways Board recently considered plans for the construction of an additional 66,000-volt line across the Connecticut River at Springfield for the supply of power to the Springfield Street Railway by the Turners Falls Power & Electric Co. It was reported that there were increasing difficulties by electric railways in securing capital to provide for power plant extensions. A sum of $1,500,000 would be required for the Springfield Co. in order to provide an adequate power supply of its own. That and other companies were, therefore, turning to the large hydro-electric systems for relief. Coal had greatly increased in cost and it was said that on account of delays in receiving coal the road came within 12 hours of complete shut-down several times last winter. About 35,000,000 units were generated yearly at the company's station, but it was hoped that by 1919 the road would be fully supplied by the Turners Falls Co.

ELECTRIC TAXICAB SALE AND RENTAL SCHEME.

The Fashion Automobile Station (Inc.), of Chicago, which is also an agency for electric automobiles, has developed a battery rental and exchange plan in connection with the sale of new cars.

The new "electric," minus the battery, is sold for $1,485. The battery for the car is then rented for $15 per month, plus $1 per battery change. The cars are equipped with a specially designed battery rack, so that the battery may be changed in 2½ minutes, or in less time than it takes to fill a petrol tank. Changes can be made at any of the five stations strategically located in Chicago and its suburbs. This plan supplies the user with unlimited mileage from a standard battery; it relieves him of investment in a battery; it assures him that his battery will always be under expert care, and, if he is out of the city, it permits him to eliminate battery costs and depreciation during periods longer than one month. The Electric Vehicle Section of the National Electric Light Association is advised that this method saves the customer about 20 per cent. on his original investment and relieves "electric" driving of all uncertainties, and that a similar plan with electric trucks has been used successfully in Hartford (Conn.) for over three years.

ELECTRIC WELDING OF BOILER DRUMS.

According to the "Iron Age," the welding of the joints of boiler drums is being advocated in America.

Drums are to be used up to 60 in. in diameter, and in order to bear a pressure of 300 lb. to 500 lb. the thickness of the plate will be very close to 2½ in. There are several methods of making this joint by spot welding, but the one favoured is the pencil form of electric welding. The temperature of the added metal in the gaseous and electric carbon type, wherein fluidity is a condition, approaches 2,800°F. to 3,000°F., while in the electric pencil method the temperature of the metal being added is not more than 1,500°F. Although the electric heat reaches an estimated temperature of 6,500°F. to 7,000°F., in this process the metal wire does not have time to reach this temperature before it is added to the plate or in the usual groove which is to be filled with the welding metal. Tests show that for pressures of 500 lb. per square inch, and with plates of 2½ in. or similar thicknesses, this method of welding makes a better joint than straps and rivets. To make sure that a joint so made will be stronger than the plate, it is only necessary to keep on adding new metal until the cross-section on both sides amounts to more than the plate itself.

Trade after the War.

If you contemplate erecting a

NEW WORKS *or* FACTORY

in an ideal position with the advantage of

CHEAP POWER
GOOD WATER SUPPLY
HEALTHY SURROUNDINGS

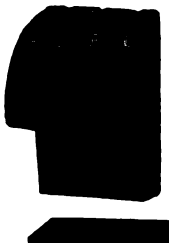
SIDING ACCOMMODATION
EFFICIENT TRANSPORT
FACILITIES

Write Great Central Railway Publicity Office, 216, Marylebone Road, London, N.W. 1, stating your requirements.

SAM FAY, *General Manager.*

H. Weidmann, Ltd., Rapperswil, Switzerland.

MAKERS OF PRESSPAN AND INSULATING MATERIAL.



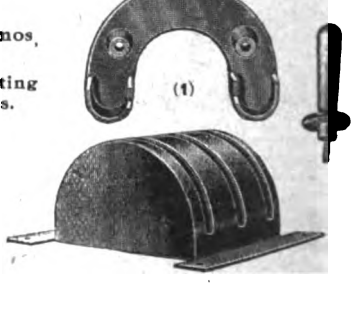
Pressboard (Presspan) in Sheets, Rolls and Tapes, Oiled Pressps Black Pressban, Pressban Tubes and Stampings.

Amianite (Vulcanised Asbestos) Coil Frames, Spools for Apparatus, Dynamos, Motors and Transformers. Insulating Blocks, Tubes, Plates, Boxes, &c.

Bakelite & Cornite (high tension material) Handles of Switchgear and Heating Apparatus, Controller Insulation, Moulded Pieces, Terminal Covers of all kinds.

Asbestos-Cement in Plates, Arc Shields for Controllers, &c.

Mica and Substitutes, Insulating Pearls, Transformer Spools.
Japanese Felt and Paper in rolls and tapes.
Oil-Varnished Linen, Diagonal Tapes, Oil-Varnished Silk & Paper.
Artificial Leather Discs for Friction Drive.
Insulators for Electric Furnaces, Tramways, &c.



Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,049. [Vol. LXXIX. No. 21] FRIDAY, AUGUST 24, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 805
Arrangements for the Week 807
The Electrification of the Riksgrans Railway. Illus.—*Concluded*.. 808
Notes on the Design of Electromagnetic Machines. By Stanley Parker Smith, D.Sc. Illustrated.—*Continued* 812
Report of the Committee for the Interconnection of the Lancashire and Cheshire Electricity Supply Systems 814
A New Method for the Determination of Magnetic Flux-Density and Permeability. By August Hund. Illustrated..... 817
Prevention of Trains Being Used with Insufficient Air Pressure.. 817
INTERLINKING IN LANCASHIRE AND CHESHIRE..... 818
The Production and Distribution of Power and its Influence on the Development of Irish Industry. By J. F. Crowley, D.Sc., B.A.—*Concluded* 821
Insulating Lacquers. By Prof. Max Bottler 822
CORRESPONDENCE 822
Industrial Reconstruction 824
Boiler House Elevators. Illustrated 825
PARLIAMENTARY INTELLIGENCE 825
LEGAL INTELLIGENCE..... 825
Patent Record 826
Volunteer Notices..... 826
COMMERCIAL AND INDUSTRIAL SECTION 829
Electricity Supply 830
Tenders Invited and Accepted 833
Financial Matters..... 834

NOTES.

Industrial Reconstruction.

WE are glad to note that the Ministry of Labour has requested the Federation of British Industries to consider the recommendations in the Whitley Report, and that the Federation has now submitted a memorandum on the subject. The tone of this memorandum is sympathetic, and there are but few points on which disagreement is expressed. It will be remembered that the Whitley Report recommended Works Committees, District Committees and National Councils. The present memorandum expresses the view that devolution of constructive work to District or Works Committees would be very dangerous—development should be only in the light of experience. The general principle is laid down that there should be centralisation of policy and decentralisation of administration. As a general statement this is likely to meet with approval. It is also suggested that there should be Councils of Industry, consisting of representatives of employers and employed in each group of trades forming an industry, and that there should be a National Industrial Council representative of all industries. It is not quite clear whether the latter already forms part of the scheme in the Whitley Report, but in any case it is desirable. The important suggestion is made that the Works Committees should be entirely composed of representatives of the employés, elected by secret ballot and quite voluntary; also that their duties should be confined to reporting breaches of agreement. We doubt whether this function is sufficiently wide. Such matters, however, are open to discussion. The important point, at the moment, is that the F.B.I. should proceed to play a part, which it is more qualified to play than any other employers' organisation, in arranging a mutually satisfactory basis for the co-operation of Capital and Labour.

Hiding Their Light Under a Bushel.

IT may be questioned whether innate modesty is the reason why many of our manufacturers keep the public in the dark as to what they are doing. From time to time we hear rumours that British firms lack commercial spirit, and that through lack of enterprise they allow foreign competitors to take the market. On the other hand, we are assured at intervals that there is little truth in such allegations. Occasionally, however, specific cases of lack of enterprise are brought to our notice, and in our correspondence columns this week some cases of this kind will be found. The letter carries a *nom de plume*, but we may say that it is written by a well-known engineer who is responsible for important works in India. His letter is called forth by a note in our issue of May 11th, in which attention was drawn to the prevalent idea in New Zealand that British manufacturers were not accustomed to making high-tension plant. Our correspondent gives several instances in which buyers, although anxious to support British firms, knew little or nothing of the British goods that were obtainable. American and German firms permit no such ignorance, sending out a dozen or more pamphlets to every one of British origin. The result is inevitable. Another point to which our correspondent calls attention is the great difference between American and English advertisements. In American journals the advertisements are frequently varied, and give a good deal of information as to what the advertiser can do and has done. In English journals, on the other hand, the advertisements, as often as not, are of the type that give little information beyond the name of the advertiser. The matter resolves itself into the question: Is it worth while to give information in the text and advertisement columns of technical journals? We agree with our correspondent that there is much to be gained by so doing. These things may seem matters of detail, but their neglect ultimately leads to the trade passing into foreign hands, more particularly where engineers in distant lands must depend upon advertisements and trade literature for much of their initial information.

Salaries of Technical Teachers.

WE are glad to note that Mr. Fisher, President of the Board of Education, has appointed a Departmental Committee to inquire into the principles which should determine the fixing of salaries for teachers in secondary and technical schools. This Committee is by no means before its time. The teaching profession has come to be associated, if not with penury, at least with extremely modest means. That this state of affairs should not continue is one of the objects of the Association of Teachers in Technical Institutions, and this Association has now issued a scale of salaries, which will be found in another column, and which it is felt should be a minimum. We think it will be agreed that the proposed scale is not excessive. The time has long since passed when even the village school teacher was "passing rich on £40 a year." And quite apart from the ordinary needs of body and soul, it should now be recognised that a good teacher is more than worth his salt. In the coming commercial competition between one nation and another the struggle will fall

Digitized by Google

largely on the shoulders of the rising generation. Good teaching gives the necessary preparation for the struggle; bad teaching may result in the formation of ideas that must be unlearnt at a later date at the cost of valuable time, thus proving a serious handicap. Apart from the important work which lies in the hands of the teacher, it should be remembered that the training of a teacher who is well qualified is laborious, lengthy and costly. Unless suitable salaries are paid it is useless to expect that the right men will be attracted.

Electrical Equipment for U.S.A. Fleet.—The "Electrical World" reports that the Emergency Fleet Corporation of the United States Shipping Board recently called for tenders for 375 10-kw. generator sets, 375 switchboards and 375 18 in. electric searchlights for the emergency fleet. The Corporation will shortly be in the market for the wiring equipment required for the smaller vessels. In the big Naval station to be equipped at Hampton Roads the "Electrical World" reports that "A great series of coast artillery batteries, electrically operated, will be constructed, as well as piers, storehouses, oil storage tanks, training stations, &c."

Operating Details of Gas Producers.—An interesting pamphlet on this subject by Mr. R. H. Fernald has been issued by the Bureau of Mines, Washington. The author deals first wth the present status of producer gas plants and the character of fuel used in gas producers. He then gives the replies received from numerous owners of producer gas plants in reply to letters sent out by the Bureau of Mines enquiring as to the character of fuel used, the reason for not using local fuels, and the necessity for low sulphur content. A number of other points are also dealt with, such as the quantity of water used, pre-ignitions, gas pressures, temperatures, &c.

The Human Side of Engineering.—"Metallurgical and Chemical Engineering" states that the International Committee of Young Men's Christian Associations has now enlisted in the United States 4,500 college men, who read each week to 100,000 working men and boys, teaching English to foreigners and giving instruction of various kinds. It is now suggested that there should be a college course on the human side of engineering, in which there would be 12 sections, including such subjects as the human factor in industry, industrial organisation, the ethics of engineering in business, the progress of typical companies, and the engineer's responsibility for service, &c.

A National Committee on Illumination in the United States.—It is announced that a National Committee on Lighting has been formed in the United States. The Illuminating Engineering Society (U.S.A.) has been given the opportunity to co-operate on this committee with the Council of National Defence. The committee will advise on all matters relating to this subject that come within the scope of the Committee on Labour, including the preservation of the health and welfare of workers. This work will deal primarily with the lighting of all factories, mills, industrial establishments and other work places, especially munition plants, Government shops, arsenals and all concerns directly under contract to the Government.

Temperature Measurements in Bessemer and Open Hearth Practice.—A bulletin by Mr. G. K. Burgess under the above title was recently issued by the Bureau of Standards, Washington. The author describes a number of experiments, and finds that the problem of temperature measurement and pyrometric control of furnace casting and ingot teeming temperatures present no serious difficulties. For this purpose optical pyrometers using monochromatic light are recommended, and the necessary corrections for emissivity of metal and oxides to give true temperatures are well known. Among other results it is shown that the temperature of the roof of an open-hearth furnace bears no necessary relation to that of the metal bath, the former varying from 1,550°C. to 1,750°C., the latter usually between 1,600°C. and 1,670°C.

Fuel Saving.—A circular issued by the University of Illinois Experiment Station (Urbana, Illinois, U.S.A.) discusses the chief factors involved in the installation of a satisfactory house heating system and the most economical methods of firing soft coal and operating heating plants. The properties of fuels and the processes attending their combustion are discussed in a fashion intended to help the ordinary householder. Tables giving the trade names, geological names and average heating value of the coals of the central western area are given and a chart is presented to show the relative worth of coals of different heating values. Coloured diagrams are employed to illustrate heat losses and means of overcoming them, and devices for regulating house heaters are shown by drawings, the value of proper chimney height, air-tight flues and various dampers and regulators being explained. Copies of the circular (price 10 cents) are obtainable on application to the Experiment Station.

Production of Sulphuric Acid.—In a Paper read before the Society of Chemical Industry by Mr. H. M. Ridge on the "Utilisation of the Sulphur Contents of Zinc Ore," it is pointed out that the cheapest source of sulphuric acid is zinc ore. In 1913 Germany made 540,000 tons of acid from this source; in 1915 the United States made 410,000 tons, but in the whole of the British Empire less than 25,000 tons was so produced in 1913, and up to 1916 the position had only slightly altered. In 1913 our consumption of spelter amounted to no less than 224,000 tons, of which 74 per cent. was imported. After allowing for the metal made by the refiners we imported about 166,000 tons of spelter and zinc in other forms. If this quantity were made from blende, the roasting fumes could be used to produce annually 400,000 tons of 140°Tw. acid.

Daylight Saving in the United States.—We notice that among other war measures being proposed in the United States a Bill has been introduced by Senator Calder on Daylight Saving. It is suggested that the period of the change should be from the last Sunday in April to the first Sunday in September and the Bill, if passed, would become legally operative next year. Apparently the enthusiasts for the Bill would like it brought into operation immediately, but in view of the lateness of the season this is of doubtful utility. The "Electrical World," in commenting on the matter, sees no objection to the change, which has been accepted as beneficial in Europe. But it expresses a warning against exaggerated estimates of the saving it is likely to accomplish. Experience in England suggests that the saving at any rate is not large, and there is no reason to expect otherwise in the States. The chief advantages of the measure are recognised to be social, and it is mainly by its effect on public convenience and health that its utility must be judged.

Electrical Resistivity of Iron Alloys.—In the "General Electric Review" (U.S.A.) T. S. Fuller gives some particulars of the electrical resistivity of iron-nickel, iron chromium, iron-cobalt, and other special alloys. The values are given for various percentages of the ingredients mentioned, and the results may be briefly summarised as follows:—

Alloy.	Range of elec. resistivity, microhms per cm.³.
Iron-nickel	11·8– 86·3
Iron-chromium	12·0– 60·0
Iron-cobalt	9·7– 20·0
Iron-nickel-chromium	11·8–113 0
Iron-nickel-manganese	11·8–103·0
Iron-nickel-chromium-manganese	11·8–111·0

The attainable resistivity is naturally governed by such factors as the amount of materials which will form a uniform alloy, the tendency to oxidation, capability of being worked, &c.

Investigations on High-Tension Cables.—In a thesis submitted to the Massachusetts Institute of Technology, Mr. T. Hada discusses some of the qualities of the stranded high-tension cable, the potential gradient at the surface of which is greater than that at the surface of a solid wire of the same cross-section. In a stranded cable the minimum potential gradient, or the maximum breakdown voltage, is practically at the position where $D/2h=e$, where D is the inside diameter of sheath, h the circumferential radius and $e=2{\cdot}718$. This is the same as in the case of the single-core concentric cable. In a multi-core cable, however, the maximum breakdown

Digitized by Google

voltage is nearer to the centre of the sheath than this position. The breakdown voltage can be calculated from the formula $V_1 - V_2 = Kd \log D/d$, where $V_1 - V_2$ is the P.D. between the wire and sheath, D the inside diameter of sheath, d the diameter of the wire (in cms.) $+ K$ is a constant for the material. The author gives various diagrams enabling this to be calculated in different cases.

"Hightensite."—A new moulding insulation under the name of "Hightensite" has been put on the market by the Park Royal Engineering Works, and has been developed to replace the German product "Stabalit." "Hightensite" is said to be an improvement upon "Stabalit" in certain respects. Its dielectric strength is over 20,000 volts per millimetre, and the material is non-hygroscopic and non-inflammable. Its limitations are that it cannot be used in connection with oil, and is not suitable for great heat, owing to the fact that rubber is an ingredient. It is a hard, close substance, and when used for distributors or other running contacts it does not wear away or carbonise. It is stated to be specially suitable for moulded articles, with or without metal fittings. Samples which have been submitted to us show that the material can be turned very satisfactorily, as easily as ebonite. Further, it is apparent that an excellent finish can be given to the surface, and metal inserts appear to present no difficulty in moulded parts.

An Electric Locomotive for Experimental Service.—The Pennsylvania Railroad Co. has recently built a 240-ton electric locomotive with a tractive effort at maximum speed of 87,200 lb. The locomotive will be used for experimental service on the company's electrified lines at Philadelphia, and possibly on the Norfolk & Western mountain electric section in anticipation of the electrification of the Allegheny Mountain branch of the railroad between Altoona and Johnstown.

The locomotive is designed to handle 3,350 tons at 1 per cent. grade. The "Engineering News Record" states that two of the engines, one pushing and one pulling, will be able to haul a 3,900-ton train at 20·6 miles per hour up the 12-mile 2 per cent. grade line from Altoona to Gallitzin, or a 6,300-ton train up the 25-mile 1 per cent. grade from Johnstown to Gallitzin. A feature of the new locomotive is the placing of the motors ahead of the drivers, adjacent to the pony trucks. There are four motors, each with a rating of 1,200 H.P. Two motors are mounted on each unit. The units are articulated, but there is only one car body for the two units. As in the Norfolk and Western electrification, energy is supplied on the overhead system at 11,000-volt single-phase 25 cycles. Only one normal operating speed (20·6 miles per hour) is arranged for, as this speed is the maximum that is considered safe for the heavy trains which the locomotive will be required to handle on the grades of the Altoona division. A speed of 10·5 miles per hour can be obtained by connecting the motors in cascade. The locomotive, which is 76 ft. 6½ in. over all, was built at the company's Altoona shops, and the Westinghouse Electric Co. furnished the electrical equipment.

Magnetic and Other Properties of Iron-Aluminium Alloys Melted in Vacuo.—A bulletin (No. 95) issued by the University of Illinois Engineering Experiment Station describes some experiments by T. D. Yensen and W. A. Gatward on iron and aluminium alloys melted in vacuo. It is claimed that the alloys so prepared are less contaminated by impurities than those hitherto obtained, and contain only 0·01-0·02 per cent. carbon. Aluminium is stated to be a more powerful deoxidiser than silicon, for it does not commence to combine with iron until all oxides present are reduced, and it readily forms a solid solution with iron. The tensile strength of the vacuum alloys increases in direct proportion to the aluminium content up to 6 per cent., the ultimate strength being 85,000 lb. per square inch in the unannealed state, and 70,000 when annealed. The corresponding figures for pure iron are 48,500 lb. and 35,000 lb. Aluminium in small quantity, like silicon, has a beneficial effect on magnetic properties. The best alloy, containing about 0·40 per cent. of aluminium, has a maximum permeability above 35,000. For higher aluminium contents the magnetic quality gradually decreases. The specific electrical resistance increases about 12 microhms for every 1 per cent. aluminium added, but above 3 per cent. the rate of increase falls off gradually.

Electricity on Canadian Farms.—In an article in "Engineering," some interesting data are given on the use of electric power for agricultural work in Canada. Mr. H. A. Robson, in a report on "A Projected Hydro-Electric System for the Province of Manitoba," remarks that the cost of generating and distributing power in Manitoba is at present calculated to be as high as 12·27 cents per kilowatt-hour, which is practically prohibitive. In Edmonton, on the other hand, the charge for power is 6 cents for the first 100 kw.-hours, falling to 2 cents when the number of hours exceeds 5,000, and in some parts of the Dominion a rate as low as 3 cents per kilowatt-hour is in force. On this basis the following table has been constructed:

Cost of Electric Ploughing at 3 cents per kilowatt-hour.

Depth of furrow (inches)	8¾	...	10¾
Acres per hour	2·25	...	1·92
Minutes per acre	27	...	31
Kilowatt-hours per acre	19·2	...	23·2
Cost of electricity per acre (cents)	57·6	...	69·6
Wages per acre of three men (cents)	20	...	24·9
Total cost of ploughing per acre (cents)	77·6	...	94·5

Against such figures, it is pointed out, other prime movers, such as engines driven by steam, gasoline, coal, oil or gas compete very unfavourably.

Magnetic Properties of Manganese and of Some Special Manganese Steels.—A Paper on this subject was read recently by Sir Robert Hadfield, F.R.S., and Messrs. Ch. Chéneveau and Ch. Géneau. The research has had for its object the investigation of the mass-susceptibility of manganese metal, and of certain of its alloys with iron and other metals. Manganese itself, when free from occluded gases, is para-magnetic, its value of χ being $+11{\cdot}0 \times 10^{-6} \pm 2$ per cent. This corresponds on Weiss's theory to a number of magnetons equal to 6. The removal of occluded gases is essential, as the ferro-magnetic properties of certain specimens of manganese is shown to be due to the presence of hydrogen. The manganese alloys investigated, with one exception, are all paramagnetic, χ varying from $17{\cdot}0 \times 10^{-6}$ to $259{\cdot}0 \times 10^{-6}$. An endeavour is also made to correlate the values of the mass-susceptibility with the composition of the alloys. In this connection it has been shown that the quantity of manganese within the limits investigated has very little influence upon the susceptibility, whilst increase of carbon tends to decrease it. In general it is concluded that in these special steels the susceptibility decreases as the carbon-manganese ratio increases. The carbon-manganese ratio being constant, addition of chromium, nickel or tungsten raises the susceptibility. The addition of copper to a manganese-nickel steel also raises the susceptibility, this notwithstanding the diamagnetism of copper.

Industrial Electric Heating in Canada.—At a meeting of the Canadian Electrical Association held last month a report of the Committee on commercial light and power was presented. This report besides covering the more usual and general uses of electricity dealt at some length with a number of important uses which directly or indirectly mean a substantial increase in the demand for power. Some of the uses and processes referred to are given below under several subheadings. In order to indicate the relative importance of the various processes to the electrical industry indication is given when possible as to the amounts of power involved in each and the energy consumtion per unit of product, and these data have, therefore, been included.

Arc Heating Processes.

Product.	Energy consumption in kilowatt-hours.
Calcium carbide	1·2 to 1·6 per lb.
Ferro silicon	3·0 „ 5·0 „
Ferro manganese	2·5 „ 4·0 „
Ferro titanium	2·4 „ 5·0 „
Ferro nickel	5·0 „ 7·0 „
Ferro molybdenum	3·0 „ 6·0 „
Ordinary steel	0·3 „ 0·6 „
Tool steels	0·5 „ 0·8 „
Tungsten	3·0 „ 5 0 „
Zinc	0·7 „ 1·2 „
Nitrogen fixation, 7·5 kw.-hours per lb. of conc. nitric acid by the arc or 2 kw.-hours per lb. of cyanamide.	

Resistance Heating Processes.

Calcining coal (carbon electrodes)	2·5 to 4 per lb.
Graphite	1·5 „
Carborundum	3·85 „
Bauxite melting (chrystolon, alundum, &c.)	1·0 „

Combined Electro Thermic and Electrolytic Processes.

Aluminium	10 to 20 per lb.
Magnesium	20 „ 40 „

Digitized by Google

THE ELECTRIFICATION OF THE RIKSGRANS RAILWAY.

(*Concluded from page* 771.)

Locomotives.

Freight Locomotives.—The design of the freight locomotives was based on the following conditions:—

Two locomotives shall be able to pull a train weight of 1,855 tons, and the speed on a 1 per cent. grade shall not be less than 30 km. per hour. The maximum speed is 50 km. per hour and the total running time on the Kiruna-Riksgräns Section is 3 hours and 20 minutes.

One locomotive shall be able to pull a train of empties of 455 tons car weight and one idle locomotive, and the speed on a 1 per cent. grade shall be 40 km. per hour and the total running time 2 hours and 56 minutes.

The locomotives shall, however, be so designed that a maximum speed of 60 km. per hour can be allowed.

Two locomotives together shall be able to haul two ore trains to Riksgränsen and return with two trains of empties to Kiruna each day. In similar train service the locomotives shall work six days in succession and each locomotive should be able to make a total of 90,000 km. per year.

The energy consumption shall not exceed 22·6 watt-hours per ton-km. for ore trains, and 23·9 watt-hours per ton-km. for empty trains.

The upkeep was guaranteed not to exceed 12·5 öre per locomotive-km.

The energy consumption per trip was estimated with 15 per cent. margin to average 1,360 k.v.a., and to amount to a maximum of 2,150 k.v.a., the stops at the stations being neglected in this estimate.

The locomotives are of the articulated type with six driving axles. In each half locomotive is installed a motor, which works on the drivers through cranks, jack-shaft and connecting rods. Both the locomotive halves are identical, each being divided into a driver's cabin with necessary control apparatus and a machinery compartment containing transformer, motor and switchgear. The general arrangement of the locomotives is apparent from Fig. 4.

The driving machinery is strongly designed and calculated for using the total adhesive weight at an adhesion coefficient of 0·27, corresponding to approximately three times the average drawbar pull in ordinary train service. Cranks and pins are forged in one piece and afterwards pressed on their respective shafts. Above the locomotive frame is erected a wooden body covered with sheet-steel. The body is furnished with carefully fitted windows and necessary ventilation system

The brake system is arranged for compressed air, automatic and direct acting brakes being furnished. A 10 H.P. compressor is installed in each half locomotive for furnishing the compressed air to the brake system and also for the whistle, for sanding and for the pneumatic control of electrical apparatus.

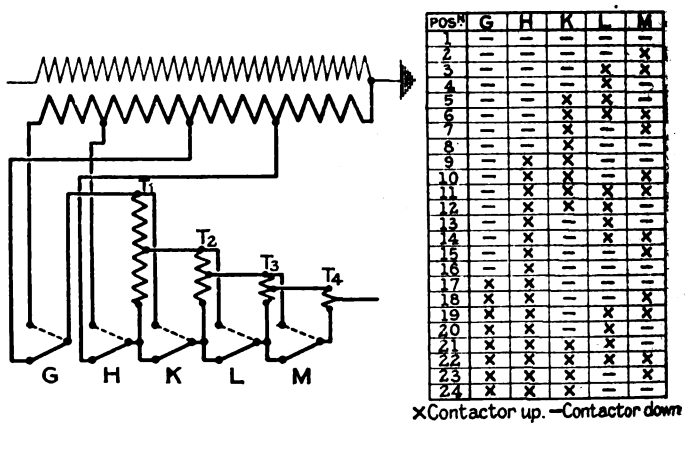
The general arrangement of the electrical equipment is apparent from the diagram in Fig. 5. From the pantagraph collector, the high tension current is led into the two halves of the locomotive, through the oil switches to the transformers. The two collectors are electrically connected through a conductor installed on the roof. The oil switches are pneumatically operated and furnished with overload release. They can also be closed by manual operation of the air cock for closing.

The main transformer is oil-cooled and arranged with 18 voltage taps on the low tension side and besides a few taps for current for various purposes such as auxiliary motors, heating elements, &c. In order greatly to increase the cooling surface the oil tank is furnished with double rows of cooling pipes welded to the tank. Current is furnished to the driving motor from the low tension side over a three-legged choke coil (see diagram). Ordinarily the three legs of the choke coil are connected to three adjacent taps on the transformer; the connections are changed on one leg at a time. In this way is secured the advantage, that the current in the motor is divided in three parallel paths, with only one-third of the main current in each path, which makes the design of the contactors much easier and cheaper. This system is a further development of the scheme using a two-legged choke coil which has been used many years for the same purpose.

The contactors are electrically operated. The control current is taken from the main transformer. Heavy rupturing contacts with magnetic blow-out are furnished. In order to prevent short circuits in case of faults in the control system, the contactors are electrically interlocked with each other. All the contactors together with control wires are firmly mounted in a frame which can easily be moved out of the locomotive.

Two controllers are installed in each of the driver's cabins for the control of the locomotives, and these are furnished with reversing switch and main operating cylinder. The many running points, which are necessary on account of the heavy train weights and the large voltage drop in the line (with maximum traffic up to 30 per cent.), makes a larger number of control circuits necessary. On these locomotives it has been necessary to use two coupler sockets in each end, besides the electrical coupling between the two locomotive halves.

The driving motors are compensated with commutating poles and designed to operate on an average voltage of 200 with a normal speed of 190 revs. per minute and a maximum speed of 300. The average current is about 3,000 amperes, but can reach 5,000 amperes on starting. The stator, rotor and commutator spiders as well as brush rocker are made of steel, and the clamping rings of brass. The motors have 24 poles with an air-gap diameter of about 200 cm. The rotor winding is connected in parallel. The commutating poles are fed in shunt from a special winding on the main transformer, and in this circuit is also connected the field winding and a small ohmic charging resistance (see diagram), all for the purpose of securing the proper phase displacement of the commutating field, which must compensate for both the reactance and the pulsation voltage. Special care has been taken with the windings and commutator. The efficiency of the motor is 90 per cent. at the guaranteed continuous load of 400 H.P.



Pos.N	G	H	K	L	M
1	–	–	–	–	–
2	–	–	–	–	×
3	–	–	–	×	×
4	–	–	–	×	–
5	–	–	×	×	–
6	–	–	×	×	×
7	–	–	×	–	×
8	–	–	×	–	–
9	–	×	×	–	–
10	–	×	×	–	×
11	–	×	×	×	×
12	–	×	×	×	–
13	–	×	–	×	–
14	–	×	–	×	×
15	–	×	–	–	×
16	–	×	–	–	–
17	×	×	–	–	–
18	×	×	–	–	×
19	×	×	–	×	×
20	×	×	–	×	–
21	×	×	×	×	–
22	×	×	×	×	×
23	×	×	×	–	×
24	×	×	×	–	–

×Contactor up. –Contactor down

Fig. 3.—Fundamental Diagram of Connections for Passenger Locomotive.

The motors are arranged for air-blast ventilation. The rear of the motor is located in an air-tight compartment and air is forced into this compartment by a 7 H.P. fan under approximately 70 mm. pressure. This air escapes through the ventilation ducts in the motor towards the commutator side and thence out into the open air again through screens in the locomotive body. Air ducts are arranged in the laminations at the back of the slots in both the stators and rotors. The main transformers are cooled by the air intake for the above fan, through which the air is drawn from under and around the transformer tank.

A pneumatically operated reversing switch is mounted on the motor. A number of smaller auxiliary apparatus and circuits are controlled from two instrument panels installed in the driver's cabins, within easy reach of the driver.

The following data are of interest:—

Total overall length over the buffers	18,600 mm.
Total weight of the locomotive	138 tons
Total weight on the drivers	105 ,,
Weight of mechanical parts	78 ,,
,, ,, electrical parts	60 ,,
,, ,, motor, excluding shaft and bearings	13 ,,
,, ,, transformer, including oil	10 ,,
Diameter of driving wheels	1,100 mm.
Diameter of guide wheels	750
Radius of crank	250 ,,

Digitized by Google

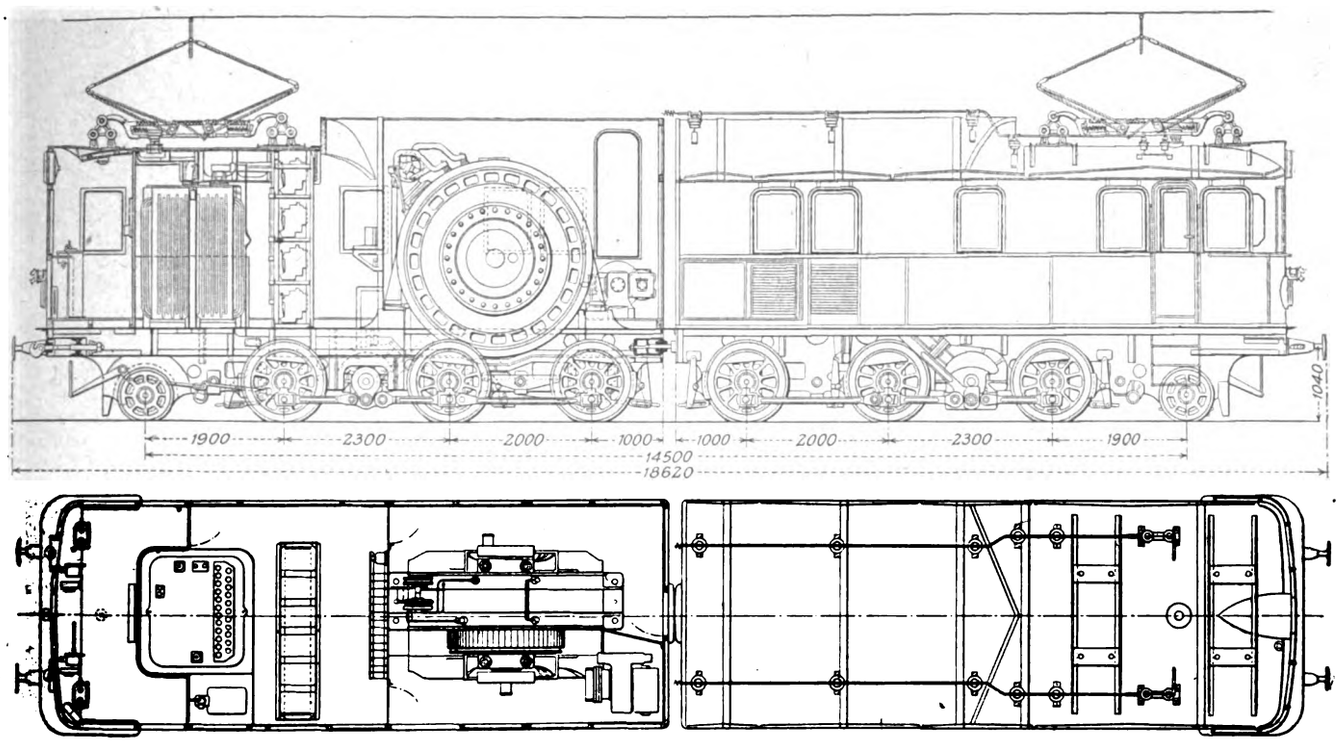
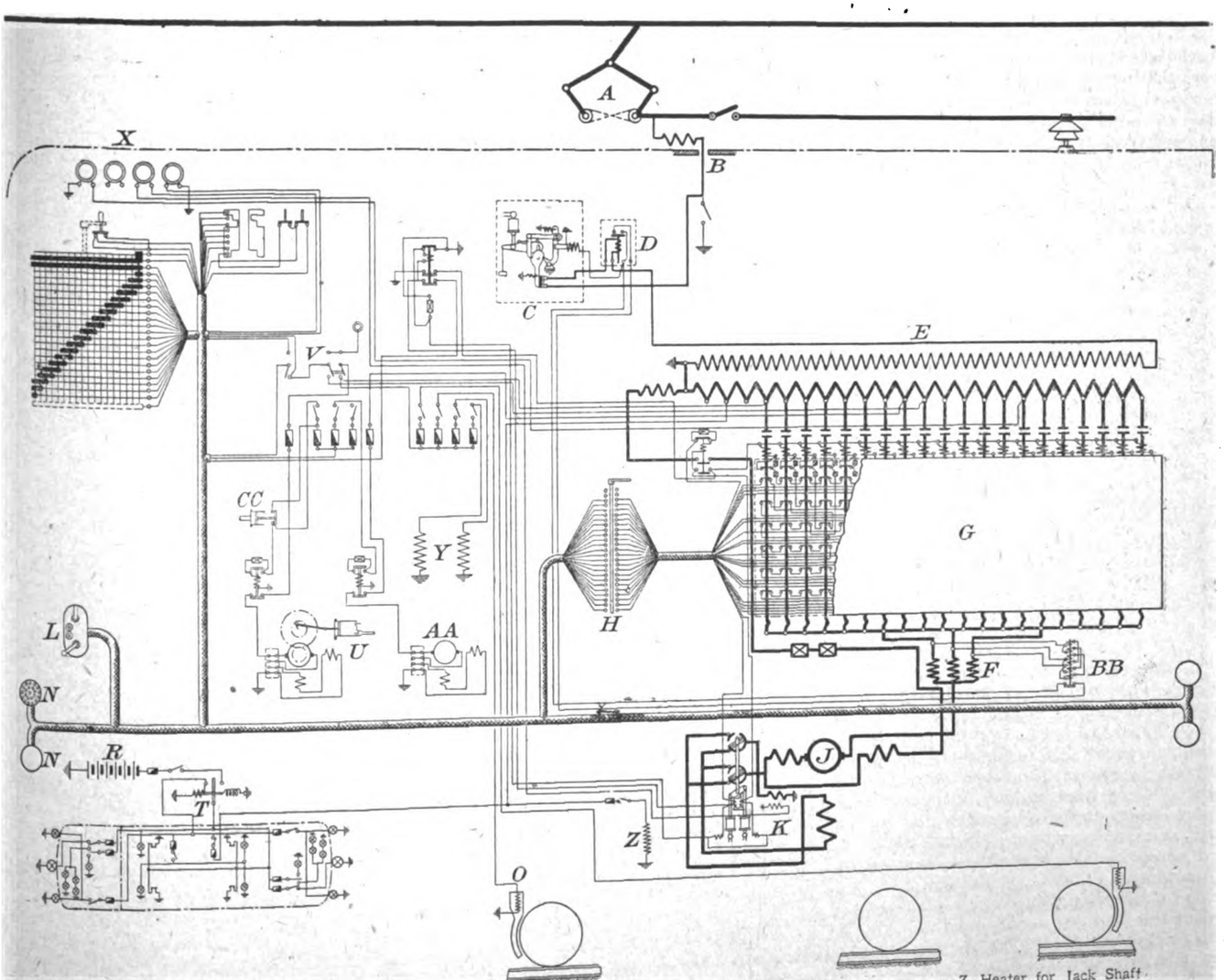


FIG. 4.—PLAN AND SECTION OF GOODS LOCOMOTIVE.



A Collector.
B High Tension Entrance Bushing.
C High Tension Circuit Breaker.
D High Tension Relay.
E Main Transformer.
F Choke Coil.
G Frame for Contactors.
H Control Circuit Commutating Switch.
J Motor.
K Reversing Switch.
L Controller.
N Coupling.
O Heater for Sand.
R Storage Battery.
T Double-throw Switch for Lights.
U Compressor.
V Double-throw Switch for Shop Inspection.
X Instruments.
Y Heater for Driver's Cabin.
Z Heater for Jack Shaft Bearings.
AA Ventilator Motor.
BB Safety Relay.
CC Compressor Circuit Breaker.

FIG. 5.—DIAGRAM OF CONNECTIONS FOR GOODS LOCOMOTIVE.

Digitized by Google

The energy consumption has been checked during the trial runs, and it has been found that it amounts to only about 70 per cent. of the guaranteed values. The efficiency guarantees for motors and transformers have also been met satisfactorily.

Passenger Locomotives.—The two passenger locomotives, which have been built by Allmänna Svenska Co. have been designed on a basis of the following conditions :—

One locomotive shall be able to pull a train of 200 tons car weight between Kiruna and Riksgränsen in either direction with a running time of 2 hours and 15 minutes The speed shall be up to 50 km. per hour on a 1 per cent. grade. Maximum speed allowed on horizontal road shall be 100 km. per hour.

The locomotives shall be able to go in such train service between Kiruna and Riksgränsen three round trips per day for six days in succession, and also make at least 100,000 km. per year.

The energy consumption shall not exceed 31·5 watt-hours per ton-km.

The upkeep shall not exceed 10 öre per locomotive km.

The hood over the jack-shaft for bracing the frame is made of cast steel. The forces on the driving machinery are smaller for the passenger than for the freight locomotives (the crank radius is 300 mm. against 250 mm.), but the higher speed requires special consideration for the design. The frame is in this case also designed for lifting the locomotive in the buffers.

Cranks and pins are designed in the same way as for the freight locomotives.

The brake system works with vacuum. Two motor driven vacuum pumps are installed of which one works at high speed for pumping out the train line when releasing the brakes, while the other runs continuously at lower speed for taking care of leakage. The first pump, which only operates intermittently, consumes about 8 H.P., the latter only 3 H.P. The vacuum maintained is 55 cm. The electrical equipment departs in some respects from that for the freight locomotives. The transformer and motor have higher capacities, and the control is arranged after an entirely different system.

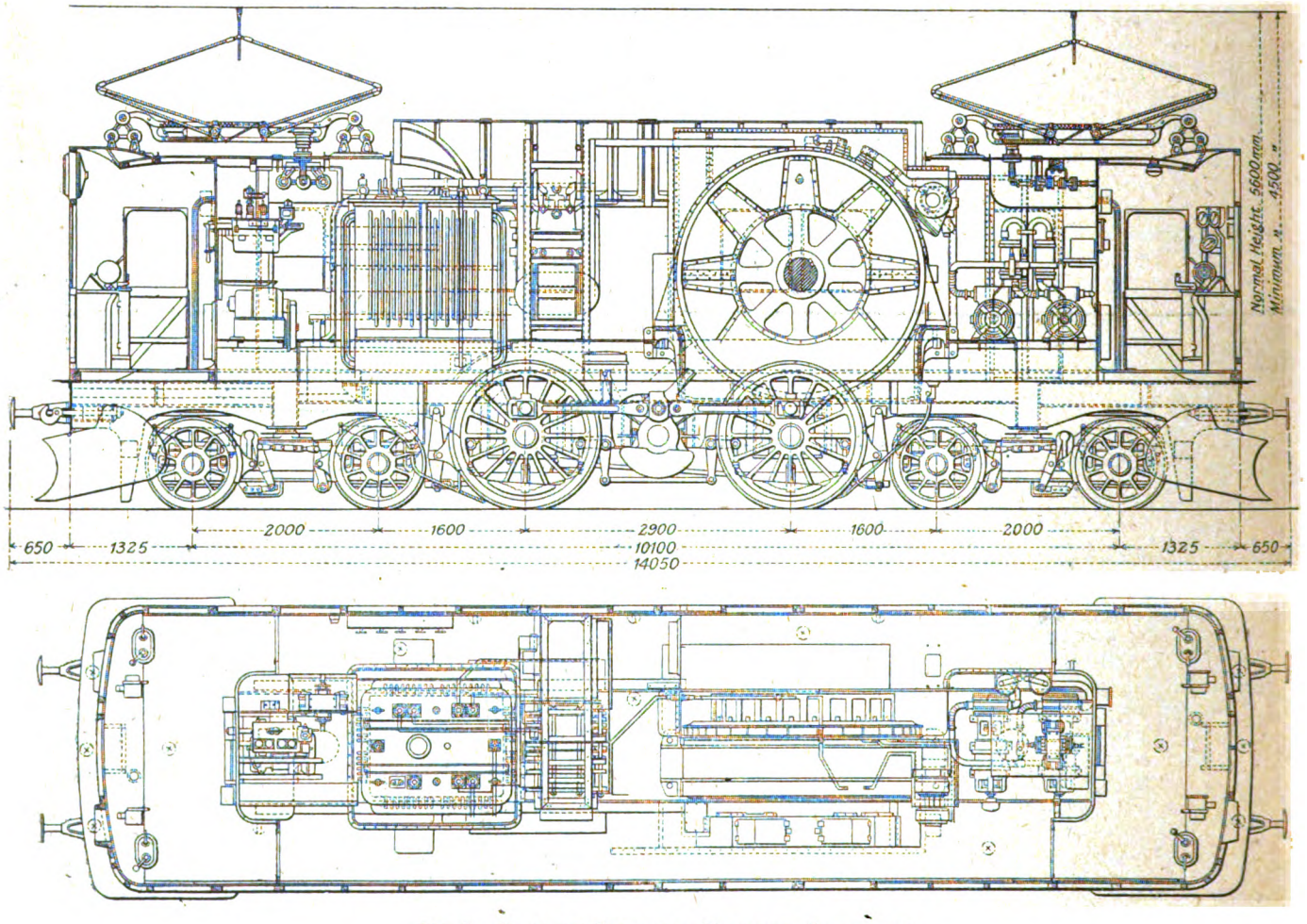


Fig. 6.—Plan and Section of Passenger Locomotive.

The energy consumpion per train was estimated with 15 per cent. margin to average 960 k.v.a. at an average speed of 61 km. per hour. The maximum consumption amounts to 1,400 k.v.a.

The locomotives are of type 2-B-2, two driving axles and guiding trucks in both ends. This type was developed with special consideration for making it suitable for high speeds. These locomotives, like the freight locomotives, have drivers cabins in both ends, and the machinery compartment in the centre, which in this case, however, contains only one transformer and one motor (see Fig. 6).

The mechanical parts of these locomotives are also built specially strong, and as the frame plates in this case are considerably longer than for the freight locomotives, it has been considered desirable to make the bracings even stronger. The foundation for the motor has been developed into rigid girders which connect the side frames from the upper to the lower edge. These girders form, together with the horizontal stay plate which runs between the side frames on these locomotives also, a box with whole bottom around the lower part of the motor, which is stable against all deformation.

The design of the main transformer is here much simplified, on account of the type of the control system, which is laid out in accordance with Mr. Ofverholm's invention. The system had been tried out earlier, amongst others also on an experimental locomotive built in 1910. The characteristic feature of the system is the use of choke coils with three terminals, which can be connected for boost or buck by double throw contactors connected in certain sequence, by means of which a large number of running points are secured. The principle of the control system for the passenger locomotives is shown by the diagram Fig. 3, together with table for the different coupling points. With only six contactors and four taps on the main transformer 24 running points are secured, which are more than plenty for passenger service. The four contactors nearest the motor would not need to be interlocked between themselves, as no short-circuit can result from faulty operation, but on the other hand it is necessary to interlock them with the outer contactor. This interlock is made both electrically and mechanically in order to be absolutely safe. Besides, the main circuit breaker is so interlocked

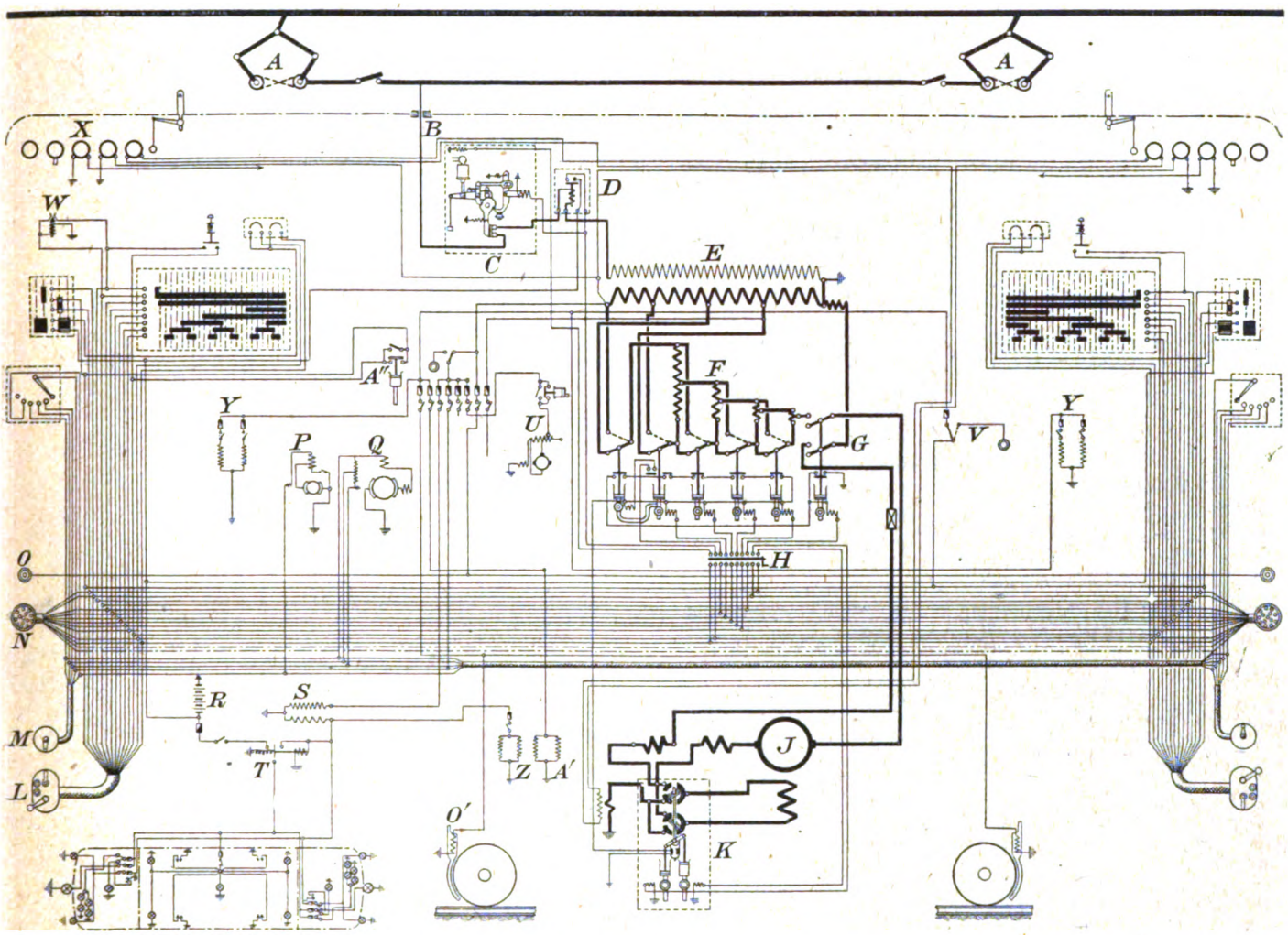
Digitized by Google

with the operating contactors that it can be closed only when these are in the starting position.

As these contactors are comparatively heavy, partly because they carry more current than those for the freight locomotives and partly because they are double-throw, it was considered desirable to operate them with compressed air. The control is so arranged that they are held in one extreme position by strong springs, and in the other by electrically controlled air pistons. These contactors also are furnished with strong sparking contacts but without magnetic blow-outs. All the contactors together with the choke coils belonging thereto are assembled in a frame similar to those for the freight locomotives. These choke coils are wound on one and the same iron core of shell type.

The system just described, as compared with the control system for the goods locomotives, offers the advantages of simplified control circuits and cheaper erection costs. The small coils for the air pistons require comparatively little current and all circuits can therefore be made lighter. Against the 30 multiple-unit wires for the goods locomotives, of which 20 are for voltage variation only, there are only 10 wires for the passenger locomotives of which six are for voltage variation, and this in spite of the fact that the number of running points for the former is only 18 against 24 for the latter. At the same time the entire system of interlocking of contactors is reduced to only a couple of wires.

The main transformer is of similar design to those for the goods locomotive. The oil tank is furnished with a large number of cooling pipes and besides so designed that it can be housed between the side frames. Around the transformer is left an open ventilation shaft, through which air is drawn in from below. The driving motor has 24 poles, like those for the goods locomotives, and is essentially of the same design. The efficiency of the motor at full load is 90 per cent.



A Collector.
B High Tension Entrance Bushings.
C High Tension Circuit Breaker.
D High Tension Relay.
E Main Transformer.
F Auxiliary Transformer.
G Main Circuit Breaker.
H Control Circuit Commutating Switch.
J Motor.
K Reversing Switch.
L Master Controller.
M Brake Controller.
N Multiple Unit Coupling.
O Train Lighting Coupling.
P Motor for Vacuum Leakage Pump.
Q Motor for Vacuum Exhaust Pump.
R Storage Battery for Emergency Lighting.
S Light Transformer.
T Automatic Transfer Switch for Lights.
U Motor for Compressor.
V Double-throw Switch for Shop Inspection.
W No-voltage Relay.
X Instruments.
Y Heater for Driver's Cabin.
Z Heater for Jack Shaft Bearings.
A′ Heater for Machinery Compartment.
A″ Automatic Transfer Switch for Control Circuits.
O′ Heater for Sand.

Fig. 7.—Diagram of Connections for Passenger Locomotive.

The following are the principal data for the passenger locomotives :—

Total overall length over the buffers	14,050 mm.
Total weight of the locomotive	90 tons
Weight of the mechanical parts	54 ,,
Weight of the electrical parts	36 ,,
Weight on the drivers	33·4 ,,
Weight on the guide wheels	56·6 ,,
Weight of motor, excluding shaft and bearings	14 ,,
Weight of transformer	12 ,,
Diameter of driving wheels	1,575 mm.
Diameter of guide wheels	970 ,,
Radius of crank	300 ,,

Recent Literature on Flotation of Ores.—The Bureau of Mines (U.S.A.) has issued a useful bibliography of recent literature on the flotation of ores, compiled by Messrs. D. A. Lyon, O. C. Ralston, F. B. Lavey and R. S. Lewis (Tech. Paper No. 135) covering the period January-June, 1916. Further bibliographies will be issued at regular intervals. The references are taken from 25 leading technical journals and Transaction of Institutions, a list of which is given.

Digitized by Google

NOTES ON THE DESIGN OF ELECTROMAGNETIC MACHINES.*

2. ALTERNATING-CURRENT GENERATORS.

BY STANLEY PARKER SMITH, D.SC.

(*Continued from page* 776.)

Summary.—In Part I. of the article the author deals with some of the main principles underlying the design of alternating-current generators. In Part II. these principles are applied to the design of a low-speed, three-phase alternator, giving 750 kw. at 2,200 volts when running at a speed of 250 revs. per min. In Part III a three-phase turbo-alternator is designed to give 2,000 kw. at 3,000 revs. per min. at a line pressure of 500 volts, and the mechanical stresses in the rotor are discussed.

6. CONVERSION OF ENERGY IN SYNCHRONOUS MACHINE.

In all electromagnetic machines, where power is converted from mechanical into electrical, or conversely, the product of the force set up by the interaction between the flux and the armature current and the velocity at which the force is moving is equal to the product of the pressure and the current. No matter whether these quantities are varying or steady, the mean mechanical power will always equal the mean electrical power, when all losses, &c., are properly accounted for.

In section 3 the effect of the coil-span and the phase-spread on the virtual value of the pressure was considered. It will now be shown that an identical relation holds for the resultant force acting on the conductors of a phase, the current being constant throughout the phase at any instant. Since the force produced by the interaction between the flux and current is what really exists, we are brought now to deal with fundamental relations, whereas the pressure may only be a conventional mode of expressing our ideas.

Consider a *single full-pitch coil* of T_c turns moving at a uniform peripheral speed of v cm. per second in a steady field distributed sinusoidally over the pole-pitch (*i.e.*, $B=B_{max.}\sin\theta$), and carrying a current $i=\bar{i}\sin(\theta-\varphi)$. Then, at any instant, the force F acting on the $2T_c$ conductors of length L cm. is

$$\begin{aligned} F &= BiL2T_c10^{-1} \text{ dynes,} \\ &= 2T_cLB_{max.}\sin\theta\times\bar{i}\sin(\theta-\varphi)10^{-1}, \quad \ldots \quad (11) \\ &= T_cLB_{max.}\bar{i}\{(\cos\varphi-\cos(2\theta-\varphi)\}10^{-1}. \end{aligned}$$

Thus, the force on the coil varies with twice the frequency of the current, and the mean force on the coil during a cycle will be

$$\begin{aligned} F_{mean} &= \frac{1}{2\pi}\int_0^{2\pi} F d\theta, \\ &= \frac{1}{2\pi}T_cLB_{max.}\bar{i}\left\{\cos\varphi\int_0^{2\pi}d\theta-\int_0^{2\pi}\cos(2\theta-\varphi)d\theta\right\}10^{-1}, \\ &= T_cLB_{max.}\bar{i}\cos\varphi10^{-1}, \\ &= \frac{\pi}{2}T_cLB_{mean}\bar{i}\cos\varphi10^{-1} \text{ dynes.} \quad \ldots \quad (12) \end{aligned}$$

The mean mechanical power due to the coil rotating at the peripheral speed $v=\pi Dn$ cm. per second is then :—

$$\begin{aligned} P_{mean} &= F_{mean}v=F_{mean}\pi Dn \text{ ergs per second,} \\ &= \frac{\pi}{2}T_cLB_{mean}\bar{i}\cos\varphi\times2pYn10^{-1}, \\ &= \pi T_cpnYLB_{mean}\bar{i}\cos\varphi10^{-8} \text{ watts,} \\ &= \pi T_cf\Phi10^{-8}\times\sqrt{2}I\cos\varphi, \\ &= E_pI\cos\varphi \text{ watts,} \quad \ldots \quad (13) \end{aligned}$$

where $f=pn$=frequency, $\Phi=YLB_{mean}$=flux per pole, $\pi D=2pY$, and E_p and I are virtual values (*see* eq. 4 for E_p).

Hence, the mechanical power $F_{mean}\,v$ is converted into the electrical power $E_pI\cos\varphi$. Since e is proportional to B, φ is the phase angle between E_p and I.

In a symmetrical or hemi-symmetrical system of N coils, quite independent and separately loaded, the mean power in each of the coils will be P_{mean}, and the N-phase system will give the total constant power $P=\sum_1^N p=NP_{mean}$.

If the coil-span is less than a pole-pitch, the force F must be multiplied by the coil-span factor.

Effect of Phase-spread.—Let there be m *full-pitch coils in series*, making up one phase of a winding. The phase current $i=\bar{i}_p\sin(\theta-\varphi)$ then flows in all the coils. θ is now the displacement of the mid-point of the group of m coil-sides—

i.e., $\theta=\theta_a+\frac{m-1}{2}\psi=\frac{\theta_a+\theta_m}{2}$, where ψ is the displacement in the field between successive coils.

Then, at any instant the force acting on the m coil-sides will be the sum of the forces exerted by B_a, B_b. . . B_m. Hence, equation 11 becomes

$$\begin{aligned} \sum_a^m F &= 2T_cLB_{max.}(\sin\theta_a+\sin\theta_b+\ldots\sin\theta_m)\bar{i}_p\sin(\theta-\varphi).10^{-1}\text{dynes.} \\ &= 2T_cLB_{max.}\bar{i}_p\{\sin\theta_a+\sin(\theta_a+\psi)+\ldots\sin(\theta_a+\overline{m-1}\psi)\} \\ &\qquad \sin(\theta-\varphi)10^{-1} \\ &= 2T_cLB_{max.}\bar{i}_p\frac{\sin\{\theta_a+\frac{1}{2}(m-1)\psi\}\sin m\psi/2}{\sin\psi/2}\sin(\theta-\varphi)10^{-1}, \\ &= 2mT_cLB_{max.}\bar{i}_p\sin\theta\,.\,\frac{\sin m\psi/2}{m\sin\psi/2}\,.\,\sin(\theta-\varphi)10^{-1}, \\ &= 2f_mTLB_{max.}\bar{i}_p\sin\theta\,.\,\sin(\theta-\varphi)10^{-1}\text{ dynes,} \quad \ldots \quad (11A) \end{aligned}$$

where $T=mT_c$=number of turns in a phase and $f_m=\dfrac{\sin m\psi/2}{m\sin\psi/2}$ is the distribution factor of the group of coils and is less than 1 (*see* section 3). Thus, $\sum_a^m F=mf_mF$, *i.e.*, *spreading a phase over an arc reduces the pull or force on the conductors by the same amount as the E.M.F. is reduced.*

For the mean force during a period, equation 12 then becomes

$$F_{mean}=\frac{\pi}{2}f_m\,TLB_{mean}\bar{i}_p\cos\varphi10^{-1}\text{dynes,} \quad \ldots \quad (12A)$$

and the mean power in the phase is (*see* eq. (4) and (13)) :—

$$\begin{aligned} P_{mean} &= \pi f\,f_mT\Phi10^{-8}\times\sqrt{2}I_p\cos\varphi \quad \ldots \quad (13A) \\ &= E_pI_p\cos\varphi \text{ watts.} \end{aligned}$$

If there are N such phases, forming an N-phase system, the total power will be constant, namely,

$$\begin{aligned} P &= \sum_1^N p = N.P_{mean}=\text{constant,} \\ &= NE_pI_p\cos\varphi, \end{aligned}$$

when a phase consists of a single coil, $f_m=1$.

The Output Coefficient.—When designing machines, a knowledge of the specific electric and magnetic loading ac and B_{mean} is important. To introduce these, it is only necessary to recast equation (13A) in a somewhat different form, as follows :—

Power in N-phase system—

$$\begin{aligned} P &= \sqrt{2}\pi ff_mTN\Phi10^{-8}I_p\cos\varphi \text{ watts,} \\ &= \frac{\sqrt{2}\pi}{2}pnf_m(2TNI_p)YLB_{mean}10^{-11}\times\cos\varphi \text{ kilowatts,} \\ &= 2{\cdot}22f_mpn\times\pi Dac\times\frac{\pi D}{2p}LB_{mean}10^{-11}\cos\varphi \text{ kilowatts.} \\ &= 1{\cdot}11f_m\pi^2D^2Ln10^{-5}B_{mean}ac\cos\varphi \text{ kilowatts,} \quad \ldots \quad (14) \end{aligned}$$

where $ac=(2TNI_p)/\pi D$=ampere-conductors per centimetre length of periphery=specific electric loading.

From this we get the output coefficient :—

$$\begin{aligned} \frac{P10^5}{D^2Ln\cos\varphi} &= \frac{KVA10^5}{D^2Ln}=C=1{\cdot}11f_m\pi^2B_{mean}ac10^{-6} \\ &= K\pi^2B_{mean}ac10^{-6}. \quad \ldots \quad (15) \end{aligned}$$

* The first article of this series dealt with Continuous-current Machines and the first part of the article appeared in THE ELECTRICIAN of June 2nd, 1916 (Vol. LXXVII., p. 280).

Digitized by Google

For $N=3$, $f_m=0{\cdot}955$ for a uniformly distributed winding with full-pitch coils, whence $K=1{\cdot}11$ $f_m=1{\cdot}06$ for a three-phase machine. Similarly $K=1{\cdot}0$ for a two-phase machine.

A shorter and simpler method of obtaining the above expression for C is to work backwards from $P=NE_pI_p$, but the above argument shows that it can be developed directly from the interaction between the current and the flux. It is also of interest to note that the coil-span and phase-spread have the same effect on the force acting on the conductors of a phase as on the E.M.F. induced in a phase.

7. Effect of the Number of Phases on the Output of an Armature Winding.

In section 2 it was shown that the limiting values of the phase-spread were $\sigma=\pi/N$ for the narrow phase-spread and $\sigma=2\pi/N$ for the wide phase-spread, these values being reached with uniformly distributed windings. The distribution factor for the fundamental of the phase pressure of a uniformly distributed winding is :—

$$f_m=\frac{\text{chord}}{\text{arc}}=\frac{\sin\sigma/2}{\sigma/2} \text{ where } m\psi=\text{phase-spread } \sigma,$$

$$=\frac{\sin \pi/2N}{\pi/2N} \text{ when } \sigma=\pi/N=\textit{narrow} \text{ phase spread,}$$

$$=\frac{\sin \pi/N}{\pi/N}, \text{ when } \sigma=2\pi/N=\textit{wide} \text{ phase-spread.}$$

This will be the value of the winding factor when the mean coil-span is equal to a pole-pitch.

When the mean coil-span is not equal to a pole-pitch, the effect of the deviation must be taken into account. This is very simple for the single-layer winding arranged for a symmetrical N-phase system. When N is *even*, as in Fig. 4B and 5 B, the mean coil-span is then equal to $(N-1)/N$ times the pole-pitch, and the phase-spread $\sigma=\pi/N$. The winding factor for the fundamental then becomes

$$f_n=f_c.f_m$$

$$=\cos \pi/2N\frac{\sin \pi/2N}{\pi/2N}=\frac{\sin \pi/N}{\pi/N},$$

since $f_c=\cos\varepsilon/2=\cos \pi/2N$.

When N is *odd*, the mean coil-span is equal to a pole-pitch.

Thus, the winding factor of a winding with a narrow phase-spread and a mean coil-span equal to $(N-1)/N$ times the pole-pitch is the same as the distribution (or winding) factor of a winding with a wide phase-spread and a mean coil-span equal to the pole-pitch. In double-layer windings, the deviation of the coil-span from the pole-pitch, if any, is usually made so small that the coil-span factor does not differ appreciably from unity, and, therefore, the output is not affected. Consequently, the only case of general importance of short-pitch coils is the single-layer winding when N is even, and for this we see reduction of the coil-span has the same effect as increasing the phase-spread.

By assuming constant magnetic and electric loadings with a given armature, we can then draw up Table IV., showing the effect of the number of phases on the output of the aramture winding, by calculating the winding factor.

Diametral Tappings.—A case of special importance is where the load is tapped off a closed winding by means of diametral tappings, as in a rotary converter. The number of tappings off a single polyphase system must be equal to twice the number of phases in the load, and the pair of diametral tappings monopolised by a load phase places in parallel two equal and opposite phases in the winding. The phase pressure is thus equal to the diametral pressure E_d, whatever the number of load phases N, whilst the phase-spread $\sigma=\pi$ radians.

From the $2N$ tappings for the N-phase diametral load we could get a $2N$-phase polygon load, and the relation between the phase pressure E_p with polygon loading and E_d with diametral loading is seen from Fig. 11—namely, $E_p=E_d\sin\pi/2N$.

To find the relation between the line current I_l and the resultant current I_c in a conductor, we must superpose the currents in the N-phases. Inside the winding, these N currents form a hemisymmetrical system, so that the internal currents of the several phases are displaced from one another by the angle π/N in time. Further, the line current divides into two equal parts in passing through the winding, since diametral tappings place equal and opposite phases in parallel. Taking instantaneous values, we thus get for the resultant current in a conductor :—

$$i_c=i_{p1}+i_{p11}+i_{p111}+\ldots i_{pN}.$$

$$=\tfrac{1}{2}(i_{l1}+i_{l11}+i_{l111}+\ldots i_{lN}),$$

$$=\frac{i_l}{2}\{\sin\omega t+\sin(\omega t-\pi/N)+\sin(\omega t-2\pi/N)+\ldots$$

$$\sin(\omega t-\overline{N-1}\pi/N)\},$$

$$=\frac{i_l}{2}\left\{\sin\left(\omega t-\frac{N-1}{2}\frac{\pi}{N}\right)\frac{\sin\frac{N}{2}\frac{\pi}{N}}{\sin\frac{1}{2}\frac{\pi}{N}}\right\}$$

$$=\frac{i_l}{2}\frac{\sin\left(\omega t-\frac{N-1}{2}\frac{\pi}{N}\right)}{\sin\frac{\pi}{2N}}.$$

Taking R.M.S. values, we get for the relation between the line current and the resultant current in a conductor

$$I_l=2I_c\sin\pi/2N. \quad \ldots\ldots\ldots \quad (16)$$

This enables us to find the output of a winding when loaded in this way. Thus, with an N-phase diametral load, the power is :—

$$P=N.E_d.I_l=N\frac{E_p}{\sin\pi/2N}2I_c\sin\pi/2N,$$

$$=2N\,.\,E_p\,.\,I_c.$$

Now, if we take a $2N$-phase polygon load off the winding, which we can do because there are $2N$ tappings, then for the same heating, we must have $I_p=I_c$, where I_p=the current per phase in the winding with polygon loading. Thus, the output $P=N\,E_dI_l$ with an N-phase diametral load is the same as the output $P=2N\;E_pI_p$, with a $2N$-phase polygon load. For the same armature, then, the output depends only on the number of tappings. Thus, the same output is obtained with a three-phase diametral load as with a six-phase polygon load ; the three-phase diametral load is the one commonly used on rotary converters. Now in Table IV. we have seen that from N-phases with $\sigma=\pi/N$ the same output is obtained as from $2N$-phases with $\sigma=2\pi/N$, so that with diametral tappings off a closed winding the same output is obtained as from an open winding with the same number of load-phases and a narrow phase-spread (*see* Table IV.).

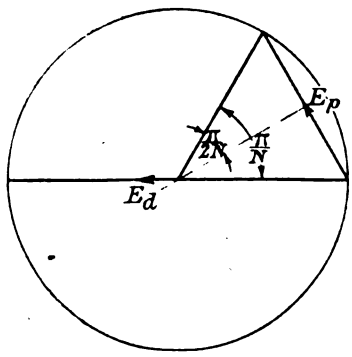


FIG. 11.—RATIO OF E.M.F. E_p WITH POLYGON TAPPINGS TO E.M.F. E_d WITH DIAMETRAL TAPPINGS OFF A CLOSED WINDING.

Table IV.—*Effect of the Number of Phases on the Output of an Armature Winding.*

No. of load phases N.	Mean coil-span = pole-pitch *and* (i.) open winding with narrow phase-spread, *or* (ii.) closed winding with diametral tappings.	(i.) Mean coil-span = $(N-1)$ × pole-pitch/N *and* narrow phase-spread. (ii.) Mean coil-span = pole-pitch *and* wide phase-spread.
1	0·637	0·000
2	0·900	0·637
3	0·955	0·827
4	0·973	0·900
5	0·984	0·936
6	0·989	0·955
8	0·990	0·973
12	0·993	0·989
∞	1·000	...

Digitized by Google

Though calculated for a sinusoidal flux distribution, the figures in Table IV. are practically true in general, though the actual output may be somewhat increased with a rectangular flux distribution.

The above table shows the advantage of decreasing the phase-spread. Thus, a three-phase winding with each phase spread over 60 deg. gives the same output as a six-phase winding with the phase spread over 60 deg.

Comparing the above outputs with the output of the winding when used for continuous currents, the current $I_c=I_p$ for the same heating whilst $E_c=\sqrt{2}E_d$, where $\sqrt{2}E_d$ is the amplitude of the diametral pressure. Thus, the continuous-current machine has an output equal to $\sqrt{2}$ times the output of a single-phase machine with the phase spread over an angle π; that is, the output of a continuous-current machine is proportional to $\sqrt{2}.2/\pi=0.900$.

It is further seen that the maximum output is obtained when S' coils are loaded independently as separate phases. On the other hand, little is gained by making N greater than 3 when the narrow phase-spread is used.,

Further, if a three-phase current is taken from a double-layer winding, by opening the winding at six points 60 deg. apart, the output is increased beyond that which would obtain by taking three points at 120 deg. in the ratio of 0·955 to 0·827—*i.e.*, an increase of 15 per cent.

We shall now use the results obtained in Part I. to assist us in the design of a slow-speed alternating-current generator (Part II.) and of a turbo-alternator (Part III.).

(To be continued.)

REPORT OF THE COMMITTEE FOR THE INTERCONNECTION OF THE LANCASHIRE AND CHESHIRE ELECTRICITY SUPPLY SYSTEMS.

The second report of this Committee has now been issued. An interim report was presented in September, 1916, and was dealt with in THE ELECTRICIAN of Oct. 13, 1916, Vol. LXXVIII. p. 53. In that report the area was divided up into four districts, and it was suggested that the Board of Trade should set up a Board with general powers to carry a scheme into effect. The present report goes very much further, outlining the constitution of the Joint Board and the basis for allocating charges.

CONSTITUTION AND POWERS OF THE PROPOSED JOINT BOARD.

The Committee proposes, with the assistance of legislation, to establish a Joint Board representative of the local authority and company interests. On this Board the local authorities would be represented according to the population which each authority serves, there being one representative when the population does not exceed 25,000 and eight representatives where the population exceeds 700,000. The basis of company representation would be capital outlay. The Committee proposes that the Joint Board should be divided into district boards corresponding to the groups A, B, C and D (see previous report).

The powers of the proposed Board are set out at length and include the co-ordination and prescribing of running hours of existing generating stations, the determination of the basis of charges, the acting in an advisory capacity in regard to future extensions and the making of working arrangements, the appointing of officials, compulsory powers to obtain wayleaves and lay mains, &c. In the event of any undertaking being adversely affected financially by the operation of these powers it will be incumbent upon the Joint Board to allocate the charges between the participating authorities so as to re-imburse the undertaking so affected.

It is proposed to delegate certain powers to the district boards, but not the power to incur any administrative expenditure without direct sanction of the Joint Board. Certain powers will also be delegated to a central executive elected by the several district boards.

Powers are not to be exercised within the area of an authority except with the consent of such authority, but if such consent is unreasonably withheld an appeal may be made to the proper Government Tribunal to dispense with such appeal.

The existing rights of all electrical undertakings as distributors are to be observed.

The Committee do not propose to invest the Joint Board with any financial powers to raise capital from time to time. In this respect their present proposals differ from those set forth in the Interim Report, which contemplated the raising of capital for purely interconnecting works, *e.g.*, linking-up mains and transformers, &c.

The Committee further recognise that the position of the companies under the proposals contained in this Report will require special consideration.

THE BASIS FOR DETERMINING THE CHARGES FOR ELECTRICITY SUPPLIES.

Bulk Supplies.—By a bulk supply is implied a supply afforded by one undertaking to another under an agreement for a defined period, and which is available at all times from the undertaking giving the said supply, and the undertaking receiving the same agrees to use regularly for supplying the usual requirements of consumers in his district.

The Committee recommend that—as a general rule—only those stations now employing or about to employ individual generating sets of not less than 5,000 kw. capacity should in the future be used for bulk supply purposes.

The items which should be included in the cost per unit at the busbars of the supply station are :—(*a*) Capital Charges on Generating Plant, (*b*) Working Expenses of Generating Plant, and (*c*) Coal.

(*a*) *Capital Charges on Generating Plant.*—The pre-war cost of installing a complete plant using modern sets of not less than 5,000 kw. will not be found to vary greatly as between one locality and another. The Committee propose that the figure should be taken out in each case and the total annual charges thereon, calculated at 10 per cent., should be expressed in £ per kilowatt of maximum demand (KW.D.).

(*b*) *Working Expenses (Generation only).*—Under this heading are included :—

Coal (Standby), Oil, Waste, Water and Stores, Wages and Salaries, Repairs and Maintenance, Management,	Expressed in £ per kilowatt of maximum demand per annum.

Although not strictly accurate, the method of treating the above working expenses as an annual charge per kilowatt demand greatly simplifies the calculation, and is sufficiently near theoretical accuracy for all practical purposes.

No allowance has been made in any of the above estimates for rates and taxes, as the Committee are of opinion that all plant at power stations used for electrical supplies delivered outside the area in which the power station giving the supplies is situated should be exempted from local taxation.

(*c*) *Coal (Running).*—The Committee recommend that the item of total fuel costs should be based on a consumption of 28,000 B.Th.U. per unit delivered to feeders at stations, with a 30 per cent. load factor, provision being made for a variation in the price of fuel. The allocation of the total fuel costs between "Running" and "Fixed" expenses being determined according to load factor.

For a 30 per cent. load factor the costs delivered to feeders at the station busbars work out at £2. 6s. per kilowatt demanded per annum plus 0·168d. per unit. The charge per kw. demanded is varied for load factors above and below 30 per cent. Alternatively this variation may take the form of a reduction in the running charge of 0·168d. per unit of from 1 per cent. to 7½ per cent. for load factors between 30 per cent. and over 50 per cent., and an increase in the said running charge of 0·168d. per unit of from 1 per cent. to 200 per cent. for load factors between 30 per cent. and 10 per cent.

The undertaking receiving the bulk supply shall declare its maximum demand in kilowatts, which may be exceeded to the extent of 15 per cent. only. In arriving at the fixed charges to be paid per annum to the supplying authority the actual recorded kw. demanded at the station supplying shall in every case be taken. There shall be a minimum fixed charge per annum payable in respect of all bulk supplies by the purchasing authorities, which minimum shall be based on 85 per cent. of the said declared maximum demand.

The bulk supply rates ascertainable in the manner put forward by the Committee shall only be applicable to authorities purchasing supplies involving a kw. demand of not less than 500.

Standby, Emergency and Reciprocal Supplies.—Standby supplies are classified into (A) those actually supplied during periods of breakdown, &c., and (B) those in which no energy may pass, the supply being merely an insurance against accidents. The rates for class A are to be determined on the actual kw. demand, and class B on a basis of 33⅓ per cent. of the capital charges for bulk supplies. No charges are formulated for emergency supply.

In the case of reciprocal supplies these may be divided into light load periods and heavy load periods. For light load periods capital charges are taken at 33⅓ per cent. and working expenses at 25 per cent. together with a running charge to cover cost of fuel. For heavy load periods the rates applicable are the same as for bulk supplies.

Digitized by Google

THE BASIS FOR ALLOCATING THE CAPITAL CHARGES ON INTERCONNECTING MAINS, TRANSFORMERS AND SWITCHGEAR AGAINST THE REVENUE ACCOUNTS OF THE PARTICIPATING AUTHORITIES.

As previously provided, each participating authority shall—where necessary—apply to the proper Government authority for borrowing powers for the interconnecting mains to be laid within its own statutory area. Each authority shall in like manner apply for the borrowing powers in respect of transforming plant and switchgear required for interconnecting purposes. If interconnecting mains have to be constructed in any area intervening between the statutory areas of two participating authorities, each of the participating authorities shall apply for borrowing powers for one-half of the cost of such mains.

The rates of charge set forth previously for bulk supplies, standby supplies and reciprocal supplies are given in terms of units delivered to feeders from the busbars of the supplying generating stations. As supplies given by interconnecting mains between various authorities may sometimes be metered at the boundaries of the respective areas of supply, and sometimes at the busbars of the receiving station, it is proposed to add a percentage to the overall costs (per kw. demanded) and per unit supplied as previously laid down to cover transmission and transformation losses. These losses are estimated to fall within the following limits :—

Transmission losses	1–2 per cent. per mile.
Transformation losses	2½–5 per cent.

The Committee is of opinion that all interconnecting mains and plant should be entirely exempted from assessment for rating purposes unless used for distributing supplies to consumers.

The Committee in setting forth the basis of charges for supplies have not made provision for any "direct" profit on sales thereon for the purpose of rate-aid, which must therefore—in the absence of any legislation—be left to be decided by each undertaking as at present, in accordance with the accepted local policy. The Committee cannot refrain, however, from giving expression to the opinion that the practice of making profits for the purpose of handing over substantial grants in aid of local rates is detrimental to the interests of an adequate and economical supply of electricity, particularly for industrial purposes. On the other hand, they would lay stress on the necessity of making adequate provision for depreciation and obsolescence of plant.

Whilst the Committee are of opinion that, broadly speaking, no direct profits should be made on the supplies enumerated in this Report, a possible exception may arise in the case of electricity supplies which are given to *new industries* established in an area other than that of the authority containing the source of the supply.

In this instance the establishment of the new works brings increased rateable value to the district in which they are established, and if, as may very well prove to be the case, the inducement to establish such new industries in the selected area was a supply of cheap electricity (purchased from another authority) it appears only reasonable for the supplying authority to expect some direct return on the sale of current.

The Report carries the following signatures :—

S. L. PEARCE, *Chairman.*
B. WELBOURN, *Vice-Chairman.*
J. A. ROBERTSON, *Hon. Secretary.*
JOHN A. F. ASPINALL,
R. BLACKMORE,
S. E. BRITTON,
H. DICKINSON,
E. H. EDWARDES,
JOHN PURRETT,
S. J. WATSON,
P. P. WHEELWRIGHT,
W. J. H. WOOD,
} *Members of the Committee*

THE CONFERMENT OF ADDITIONAL POWERS UPON THE JOINT BOARD IN REGARD TO THE ESTABLISHMENT AND CONTROL OF ALL FUTURE AND EXISTING POWER STATIONS AND HIGH-PRESSURE TRANSMISSION LINES.

The Committee recognise that the matters dealt with under this section of the Report are somewhat outside the strict terms of their reference, but the future economical development of electricity generation and supply on a large scale is so bound up with the question of interconnection of existing undertakings that this Report would not be complete without a reference to the larger question.

During the course of its deliberations on "Interconnection" the Committee had under consideration the necessity in the near future of making provision for a much larger output than is at present called for, thus necessitating the erection of new power stations or additions to existing stations which would be used (in conjunction with the new and existing systems of high-pressure interconnecting mains) to furnish supplies to areas now served by a number of existing undertakings.

The units generated by the undertakings included within Groups A, B, C and D amounted to 421,000,000 units for the year ending March 31, 1916. Under normal conditions the rate of increase is about 20 per cent. per annum, so that during the next five years the output may be expected to increase to at least 1,000,000,000 units and the maximum load which for the year ended March 31, 1916, amounted to 138,429 kw., will have correspondingly increased to 300,000 kw. The average increase in load is therefore equal to 32,000 kw. per annum for the whole of the groups.

The Committee have carefully considered how this increase in production can be met so as to achieve the most economical results both in the employment of capital and in reduced operating expenses.

In some districts it may be desirable to increase the capacity of existing stations, while in others it will be necessary to erect new power stations. In both cases the new plant will consist of large units which will be used in conjunction with the new and existing systems of high-pressure interconnecting mains to furnish the total supply to certain statutory areas and to augment the existing supply to others.

The Committee have considered whether the new power stations required to supply more than one authority should be erected and operated by a combination of the authorities more immediately interested in the use of such power stations as contemplated in Section 8 of the Electric Lighting Act, 1909 (subject to the powers of the Joint Board as previously set out), or whether the erection and operation of such new power stations should be provided at the cost of, and be operated by, the Joint Board, thus necessitating the conferment of financial and administrative powers upon the Joint Board.

In the ordinary course of development, as indicated in Clause 37, a considerable improvement would no doubt result over present methods if, in certain localities, new power stations were erected at the cost of those authorities who, for the present or immediate future, will obtain their supplies from such a source, but as such power stations increase in size and the area over which their supply is given also increases, a larger number of authorities become interested in the operation of the stations, and will naturally require representation in their administration.

As the new stations will be interconnected with each other, it appears inevitable that there must be a general co-ordination of effort first in localities, then in districts, and finally in the larger area covered by this Report. In view of this inter-relationship between existing statutory authorities in the different localities and districts, the Committee are of opinion that ultimate developments may lead to a complete federation of the interests of the whole of the different authorities in the area.

Many advantages would be derived if the financial and controlling powers now exercised by the various company and municipal undertakings in the areas under consideration were centred under one owning and operating authority. The time involved and expense at present incurred by individual undertakings and Government Departments in connection with the procedure for raising and repaying capital would be greatly reduced. The apportioning of the capital and maintenance charges on plant and mains used for interconnected supplies between the various participating authorities would be avoided. All questions of profit, direct or indirect, between one authority and another, would be eliminated, and by reason of centralised and collective ownership there would be more effective control than would be possible under any scheme of individual ownership.

The initiation of such a scheme at the present time presents certain difficulties which cannot be overlooked. The capital expenditure per kilowatt of plant installed, the cost per unit generated and the selling price to industrial consumers varies so considerably as between one authority and another that the owning and operating of the whole of the existing power stations by a central authority might, unless adequate safeguards are provided, adversely affect those authorities who at present have the benefit of low capital expenditure, low generating costs, or favourable local conditions, to the immediate benefit of other authorities who do not possess these advantages.

Under the interconnection scheme it seems inevitable that some of the less efficient power stations must be superseded in favour of more economical supplies from the new power stations, or from new plants installed in the more favourably-situated existing stations, and it appears to the Committee that in such cases the undertakings so affected must necessarily be relieved of the financial obligations resting upon them in respect of superseded plant.

The difficulties referred to above will be largely overcome as the less efficient power stations are superseded, because the capital expenditure per kilowatt and the generating costs of the remaining stations in the various localities will tend to become approximately the same. The Committee feel, therefore, that while the rights of the statutory authorities should be maintained as regards the distribution and sale of energy, it may be desirable in order to secure a closer co-ordination of effort to invest the Joint Board with further powers to erect new power stations, and to acquire when and where necessary the ownership and control of existing power stations. The Committee recommend that powers to acquire existing stations should only be exercised after the Joint Board has approved thereof by a two-thirds majority, and would be subject to the sanction of the proper Central Government Tribunal. Any authority whose undertaking is being acquired would have the right of appeal to the Tribunal on all questions, financial and otherwise, relating to the action of the Joint Board.

In the case of companies, these proposals would probably involve the purchase of their entire undertakings.

In the event of a power station being purchased, the Joint Board shall supply energy to the authority owning such power station at a price not exceeding the cost at which energy was produced at the said power station during the preceding 12 months, but all such prices shall be subject to revision at the close of each financial year, due regard being had in each case to all the factors entering into the costs of production.

A Joint Board, constituted on the lines already set forth, consisting of nominated or elected representatives of all the statutory authorities in the area, together with an advisory committee of engineers, would, in the opinion of the Committee, form the most suitable authority to exercise full statutory powers in regard to all power stations and transmission lines in the area of Lancashire and Cheshire.

In Lancashire and Cheshire the majority of electricity undertakings are owned and operated by municipal authorities. Amongst these undertakings are some of the largest and best-equipped stations in the

Digitized by Google

country, and the prices charged for industrial purposes compare favourably with the lowest charges made elsewhere. There would appear to be no valid reason, therefore, why the present measure of control by municipalities should be disturbed in setting up the constitution of the Joint Board, the important point being to constitute one single authority for the whole area so that future developments can be co-ordinated along sound, technical and commercial lines.

The Committee feel that the time has passed when power to generate electrical energy, which is so vital to the interests of the trade of the nation and to the efficient employment of the nation's principal source of wealth, *i.e.*, coal, should continue to be exercised solely for the purpose of supply within a limited area, and, in order to deal efficiently with future requirements, they consider it essential that extensions of existing power stations or the provision of new power stations should only be proceeded with after due consideration has been given not only to the requirements of the particular area in which such power stations may be situated, but also of the actual or potential requirements of the surrounding districts. In other words, the provision of efficient generating plant has ceased to be a matter which only concerns each separate undertaking as at present constituted, but has become an important element in the welfare of whole districts, without regard to municipal or other boundaries.

In order to secure the most efficient results, developments should take place along the following lines :—

(*a*) Large units of plant—of not less than, say, 10,000 kw. to 15,000 kw. —must be provided in order to obtain the most economical employment of capital expenditure.

(*b*) Such plants must be concentrated in the most suitable localities for the purpose.

(*c*) High-tension transmission lines for interconnecting purposes must be constructed between the large power stations, so that the large plants may be used to the greatest advantage.

(*d*) All suitable sources of waste heat must be utilised.

By effecting these changes not only would there be a considerable reduction in the annual costs incidental to a lower capital expenditure per kw. of plant installed, but there would be an enormous saving in the fuel consumption per unit generated, in addition to reductions in other working expenses.

The Committee would point out that under these proposals supplies would be given to authorised distributors at cost prices, and, whilst reserving to the authorised distributors their full and existing rights under their Provisional Orders, it may be necessary to introduce safeguards to ensure that the advantages of cheap production arising out of a federation of interests shall not be neutralised by the distributing authorities charging unduly high prices to the consumers within their area.

THE RELATION OF THE JOINT BOARD TO THE EXISTING GOVERNMENT DEPARTMENTS, OR TO ANY NEW ELECTRICITY TRIBUNAL THAT MAY HEREAFTER BE SET UP.

The Committee are in accord with the recommendation tendered to the Board of Trade Electrical Trades Committee, advocating the appointment of a new Tribunal consisting of a limited number of Electricity Commissioners, who would be entrusted with the jurisdiction of matters affecting the supply of electricity.

The Committee would go further and suggest that the Commissioners should be the Central Authority in technical matters, and should possess all other powers now exercised by Government Departments and such other powers as may hereafter be conferred upon them by Parliament, with regard to electricity supplies for the *whole* country.

This section of the Report carries the following signatures :—

The signatories to both sections of this Report wish to make it quite clear that the recommendations and suggestions contained in the Report represent their own personal opinions and do not necessarily represent the views of the respective undertakings with which they are connected.

S. L. PEARCE, *Chairman.*
B. WELBOURN, *Vice-Chairman.*
J. A. ROBERTSON, *Hon. Secretary.*
S. E. BRITTON,
H. DICKINSON,
S. J. WATSON,
P. P. WHEELWRIGHT,
W. J. H. WOOD,
Members of the Committee.

Sir John A. F. Aspinall, Mr. Edwardes and Mr. Purrett did not sign this section of the Report, owing to the position that would be created for their companies if the foregoing proposals were given effect to. Mr. Blackmore did not sign as he is not in agreement with the proposals to invest the Joint Board with the following powers :—(1) The purchase of the existing power stations owned by the municipalities ; (2) the purchase of the undertakings owned by the companies ; (3) the erection of new power stations.

The report is followed by six schedules. Schedule 1 is a list of the various distributors, showing the number of representatives each would have on the District Boards (90 for 35 undertakings). Schedule 2 shows how the 20 representatives of the Joint Board would be allocated and Schedule 3 the allocation of the Committee of six advisory engineers.

Schedule 4 shows how the costs are made up. Capital charges are based on a capital cost of £10 (at continuous rating) per kilowatt demanded, depreciation being taken at 5 per cent. and interest at 5 per cent., giving a total of 10 per cent., or £1 per annum per kilowatt demanded. Fixed working expenses include standby coal, oil, waste water and stores, wages and salaries, repairs, maintenance and management, but no rates or taxes, and are put at a total of £1. 6s. per annum per kilowatt demanded. For the running costs (coal) the fuel is taken at 17s. 6d. per ton, or 0·168d. per unit delivered to the feeders, provision being made pro rata for variations in price of fuel. The fuel costs include a sum sufficient to cover the removal and disposal of ashes. Thus the total cost at a 30 per cent. load factor becomes £2. 6s. per kilowatt demanded plus 0·168d. per unit. The following additions and deductions are suggested for load factors other than 30 per cent. :—

	Per KW.D. per annum
For a Load Factor of 50 per cent. and over ...	A deduction of 5s.
„ „ 45 per cent. but under 50 per cent.	„ 3s.
„ „ 40 per cent. but under 45 per cent.	„ 2s.
„ „ 35 per cent. but under 40 per cent.	„ 1s.
„ „ 30 per cent. but under 35 per cent.	— —
„ „ 25 per cent. but under 30 per cent.	An addition of 2s.
„ „ 20 per cent. but under 25 per cent.	„ 6s.
„ „ 15 per cent. but under 20 per cent.	„ 14s.
„ „ 10 per cent. but under 15 per cent.	„ 22s.
„ „ below 10 per cent.	„ 34s.

Schedule 4 expresses the total costs per unit at station 'bus bars as follows :—

Load Factor of 50 per cent. and over	0·280d.
„ 45 per cent. but under 50 per cent.	0·298d.
„ 40 „ „ 45 „	0·318d.
„ 35 „ „ 40 „	0·344d.
„ 30 „ „ 35 „	0·377d.
„ 25 „ „ 30 „	0·430d.
„ 20 „ „ 25 „	0·524d.
„ 15 „ „ 20 „	0·715d.
„ 10 „ „ 15 „	1·100d.
„ below 10 per cent.	1·440d.

Schedule 5 gives an example of reciprocal supply costs at a 30 per cent. load factor. Here the capital charges are reduced to 33⅓ per cent., giving 6s. 8d., and the general working expenses to 25 per cent., giving 6s. 6d. ; or a total of 13s. 2d. per annum per kilowatt demanded, to which must be added the running charge for coal of 0·168d. per unit. This is subject to variations in price of coal and to the corresponding variations for different load factors.

Schedule 6 gives financial details of the undertakings in the areas A, B, C and D, which are summarised as follows :—

Group of Undertaking.	Capital Expended.		Capital redeemed	Depreciation, renewals and reserve funds.	Capital indebtedness at March 31, 1917.
	Power stations.	Mains and sub-stations.			
Municipal Undertakings.	£	£	£	£	£
Group A	1,851,282	2,075,365	1,865,979	223,019	2,206,602
„ B	1,001,960	492,600	557,051	60,743	864,824
„ C	712,940	331,425	376,022	20,915	695,562
„ D	590,072	369,622	367,222	32,995	572,195
Total	4,156,254	3,269,012	3,166,274	337,672	4,339,183
Company Undertakings.					
Group A	209,963	124,710	59,990	274,682	
„ B	406,192	335,117	13,228	762,954	
„ C	32,039	16,779	—	—	
„ D	124,450	92,440	53,349	163,541	
Total	772,644	569,046	126,567	1,201,177	

Use of Selenium Cells in Photometry.—Mr. J. R. Randolph, in an article in the " Electrical World," describes some experiments with selenium cells for the photometry of electric lamps. It is generally recognised that this is not a safe method of comparing the candle-powers of lamps having widely different spectrum composition, but there seem to be opportunities for its use in making comparative measurements of lamps of the same type. The author suggests that it is very suitable for getting out the polar curves of lighting units, particularly those of the larger type, the testing of which in the ordinary way requires a considerable amount of space.

Digitized by Google

A NEW METHOD FOR THE DETERMINATION OF MAGNETIC FLUX-DENSITY AND PERMEABILITY.*

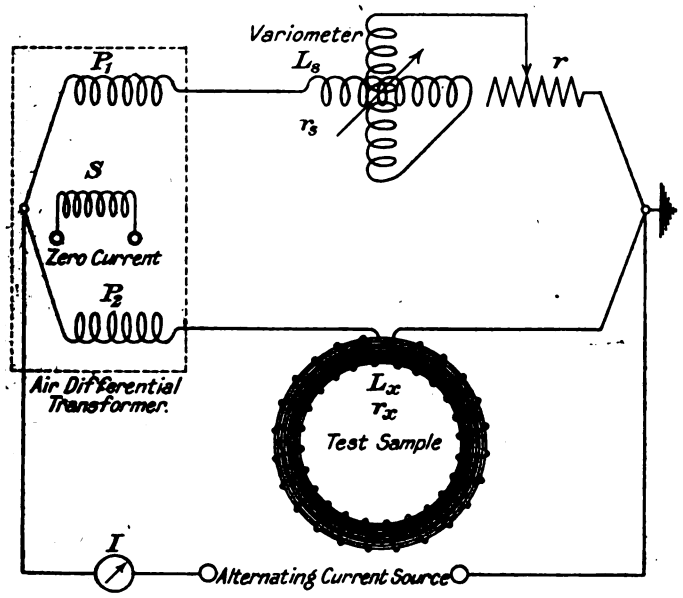
BY AUGUST HUND.

The method described by the author is well adapted to the measurement of permeability and magnetic induction in test samples at any desired frequency.

The samples to be tested are compared with a known and progressively variable self-induction, or "variometer" consisting of air-core coils, in series with a non-inductive resistance. The performance of the differential system is based upon the following principle :—

When the currents in the two branches of the system are equal in effective value and in phase their inductive effects on the secondary coil of the differential transformer will exactly neutralise each other, and no voltage will be induced in the coil. The two primary coils (P_1 and P_2) are symmetrically placed with reference to the secondary coil S, and have exactly the same number of turns, which are wound in opposite directions. Any kind of alternating-current detector connected across the terminals of the secondary coil will then give a no-current indication when the currents P_1 and P_2 are equal and in phase (*see* diagram).

A no-current adjustment is established when the coefficient of self-induction of the variometer is equal to the effective coefficient of self-induction of the test coil, and when the effective resistance



of the test coil is also exactly balanced by the resistance of the variometer and the series resistance r. An absolute disappearance of the differential field, however, can generally not be obtained, since the wave-form in the one branch is somewhat distorted, due to the presence of the ferro-magnetic substance; but in most practical cases the minimum of the differential field can be very readily and accurately detected. For very precise measurements it is advantageous to insert a condenser in series with the indicator in the secondary circuit of the differential transformer, and tune this circuit to resonance with the required frequency. (This is especially recommended at higher frequencies, since tuning is then readily obtainable). For frequencies up to about 2,000 cycles a Wien vibration galvanometer may be used as a current indicator and the condenser dispensed with.

The author then proceeds to work out the relations enabling flux-density, permeability, &c., to be determined.

Starting from the usual relation for the E.M.F. induced by a flux, $B_{max.}$, in a given number of turns at a specified frequency, he deduces the relation

$$B_{max.}=0{\cdot}7075\,.\,\frac{L_s(\text{henrys})}{NS(\text{cm.}^2)}\,.\,I(\text{amps.})\,.\,10^8 \text{ lines per sq. cm.},$$

L_s being the coefficient of self-induction as read on the variometer, N the number of turns in test sample, S the cross-section of iron core, and I the current as measured by the ammeter in the main branch of the differential arrangement. The constant in the equation is based on the assumption of a sine wave; otherwise appropriate correction must be made for the form factor.

* Abstract of a contribution to the "Proceedings" of the Radio-Institute of Institute of Radio Engineers (New York).

Similarly, the maximum magnetising force H is defined by the formula

$$H_{max.}=\frac{4\pi}{10}\sqrt{2}\frac{NI_m\,(\text{amps.})}{l(\text{cm.})} \text{ gilberts per cm.},$$

where I_m is the magnetising component of the effective current traversing the coil of the sample and l the mean length of the magnetic path in centimetres.

The author then proceeds to discuss by the aid of vector diagrams and mathematical equations the relations between applied voltage, magnetising current and flux, and ultimately deduces the following detail relations for $H_{max.}$ and μ, the permeability

$$H_{max}=k_4 I(\text{amps.})\sqrt{1-\left(\frac{\Delta r_c(\text{ohm})}{2(\text{ohm.})}\right)^2} \text{ gilberts per cm.},$$

$$\text{and } \mu=k_5\frac{L_s(\text{henrys})}{\sqrt{1-\left(\frac{\Delta r_c(\text{ohm})}{2(\text{ohm})}\right)^2}}.$$

In these equations $k_4=0{\cdot}8875\,\frac{N}{l(\text{cm.})}$,

$$k_5=0{\cdot}798\times 10_8\times\frac{l(\text{cm.})}{N^2S(\text{cm.})^2}.$$

Z is the resistance operator of variometer resistance combination. Δr_c is the increase of resistance of the test sample caused by iron loss.

It is also shown how, on certain assumptions, relations for the iron (hysteresis and eddy current) losses in the sample can be determined. The conditions to be aimed at in securing a satisfactory differential arrangement and the various disturbing factors are also discussed in some detail.

It is pointed out that the arrangement readily enables $B_{max.}$ values to be compared for very long wave-lengths with the corresponding values determined at higher frequencies, and an insight thus obtained into the skin effect of an iron core. As stated, the various iron losses can also be analysed at different frequencies; in particular, the dependence of the magnetising force and permeability on the frequency of the applied alternating E.M.F. can be conveniently studied.

PREVENTION OF TRAINS BEING USED WITH INSUFFICIENT AIR PRESSURE.

An arrangement has been in use on the Central London Railway for some years, and is now being extended to the London Electric Railway, to safeguard the working of trains if the air pressure for working the brakes becomes insufficient. The arrangement has been found desirable to prevent trains being operated with insufficient air in the train pipe. This control apparatus consists of an air pressure governor similar to that which controls the working of the compressor for the maintenance of a proper pressure of air for the operation of the brakes, except that this governor is reversed. It is arranged to open the circuit when the pressure in the train pipe falls to 40 lb. per square inch, and to close the circuit when the pressure rises to 50 lb. per square inch. The electric circuit which opens and closes is in the "forward" wire from the controller to the reverser, so that the train cannot be operated in the forward direction unless the air pressure in the train is at least 40 lb. per square inch, but it can always be operated in the reverse direction.

Advantage is taken of this reverse governor to facilitate more rapid stopping in the event of the train being tripped when passing a signal at danger. The air pipe which controls the governor is connected to the train line between the tripcock and the tripcock isolating cock. In the event of a train being tripped, the train pipe is, of course, opened to atmosphere, and the point at which the tapping to the reverse governor is taken is quite close to the tripcock, and not only is the brake applied, but the control circuit opened. A release pinhole is also fitted to the tripcock isolating cock in such a way that when the tripcock isolating cock is closed—that is to say, when the tripcock is cut out of operation—the air between the isolating cock and the tripcock is exhausted, and therefore the reverse governor is opened, and no control current is available. This prevents a train being run unless the tripcock is cut into action.

A short-circuiting switch is provided in the cab of the motor car sealed in the open position. In the event of failure of the reverse governor, or failure of the tripcock, necessitating the tripcock being cut out, before the train can be operated it is necessary to break the seal and close the switch, which short-circuits the reverse governor. The fact that this switch is sealed, and that any man breaking the seal must explain the reason for so doing, affords a safeguard against the train running with the tripcock isolated.

Digitized by Google

The Electrician.
FRIDAY, AUGUST 24th, 1917.
Editorial and Publishing Offices:—
8, BOUVERIE STREET, LONDON, E.C. 4.
Telephone: City 9853 (4 lines). Telegrams: "Bentrotric Fleet London."

INTERLINKING IN LANCASHIRE AND CHESHIRE.

Of the committees that have been formed to consider the problem of interlinking the various supply undertakings in certain districts of the United Kingdom, that dealing with Lancashire and Cheshire has made the greatest headway. This Committee have now issued a second report, making definite recommendations for a Joint Board, consisting of representatives of the various local authorities and companies, according to population in the one case and according to capital outlay in the other. Such a board would have wide powers, but not the right to raise capital, at least under present conditions, as it is felt that there is no advantage to be gained in relieving each undertaking of its statutory obligations. In this respect the recommendations differ from those of the previous interim report. On the other hand, there is a supplementary report, which is not signed by the representatives of companies owing to the effect which it might have on the companies' undertakings, nor by Mr. BLACKMORE. This part of the report contemplates the conferment of important additional powers on the Joint Board.

It will be seen that the supplementary report goes very much further than the main report and contemplates the state of affairs to which electricity supply in this country must inevitably come if it is to reach a satisfactory position. While retaining the existing rights of undertakings with regard to the distribution of electricity within their statutory areas, the committee proposes that the Joint Board for the area should have power to erect and operate new power stations and to purchase the less efficient stations where it is desirable that these should be superseded. In such cases the undertakings so affected would be relieved of their financial obligations in respect of the superseded plant. If such inefficient power stations were not purchased there would be obvious inequalities, and those authorities operating highly efficient stations might be adversely affected by the inclusion of the less efficient stations with high capital expenditure. The elimination of the less efficient stations will tend to level down the generating costs of the remaining stations, so that they become approximately the same. It is pointed out that the average increase in load in the area considered is 32,000 kw. per annum for the whole of the groups, and it is stated that the proposed new stations should include units of plant of not less than 10,000 kw. to 15,000 kw. in order to obtain the most economical service. In our opinion it is a question whether this figure is not lower than it should be. There is no doubt that the increase in the use of electricity will be enormous during the next few years. There is always a natural tendency to put in that plant which is the most economical at the moment. This no doubt gives the best financial result during the first few years, but it may well be desirable to look forward, and to put down plant which, although too large for immediate requirements, would give better financial results at no very distant date.

In the main part of the report the policy is outlined in regard to bulk supplies, and it is laid down that only those stations now employing, or about to employ, individual sets of not less than 5,000 kw. capacity should in future be used for this purpose. The selection of so low a power shows that, so far, we have not made great progress in large scale power generation. With regard to the basis of cost, a figure of 10 per cent. on the capital outlay is taken for the capital charges per annum, and the working expenses, expressed in £ per annum per kilowatt of maximum demand, include standby coal, oil, waste, water and stores, wages and salaries, repairs, maintenance and management, so that the only item as a running cost is the remainder of the coal. This, of course, is not a strictly accurate way of looking at the matter, but it may be sufficiently accurate for the purpose, and it has the advantage of simplicity, provided that the figure for standby coal can be easily agreed. It is noticeable that the total consumption of fuel per kilowatt-hour delivered to the feeders at stations with a 30 per cent. load factor, is taken on the basis of 28,000 B.Th.U. per kilowatt-hour. For modern stations giving a bulk supply this strikes one as a distinctly liberal allowance, and is a figure which we hope will be very rapidly improved. In passing it may be mentioned that the calorific value of the coal is not stated in arriving at the cost. Briefly, it may be said that although the capital per kilowatt of demand is as low as can be expected, the item for fuel (which is taken at 17s. 6d. per ton) is high, and thus the total charge with a load factor of 30-35 per cent. is 0·377d. per kilowatt hour, and this only falls to 0·280 d. with a load factor of 50 per cent.

Apart from ordinary bulk supply, the Committee have also considered standby, emergency and reciprocal supplies. Standby supplies, *i.e.*, during periods of breakdown, &c., are charged on the same basis as bulk supplies. But in the case of emergency supplies, it may well be that no energy will be required and the financial position is therefore made as easy as possible by reducing the capital charges to one-third of the normal.

We are glad to note that no allowance has been made for the purpose of rate aid, and the Committee express the opinion that the practice of making profits for the purpose of handing over substantial grants in aid of local rates is detrimental to the interests and advance of electricity supply. On the other hand, the report lays stress on the necessity of making adequate provision for depreciation and obsolescence of plant. The view is stated that, broadly speaking, no direct profits should be made, but a possible exception is admitted in the case of electricity supplies given to new industries established in an area other than that of the authority maintaining the source of the supply. We presume that the Committee have in mind the fact that the consumers so placed would bring in no rates to the local authority supplying electric power. This, it seems to us, is a somewhat narrow view to take. New industries should be encouraged rather than handicapped irrespective of local interests.

The Committee have done well to push forward their scheme so energetically and to provide a definite workable scheme. At present, they appear to be well ahead of the other committees with which they are presumably working —*i.e.*, with the committees for the other districts into which the country has been divided by the National Electric Power Supply Joint Committee. On the other hand, we think there may be some advantage in working up schemes of this kind, so that they resemble one another as far as possible, more particularly in their main powers. It may well be that different parts of the country are best served by different schemes, but, even so, reasonable co-ordination will probably lead to the best results.

Digitized by Google

THE PRODUCTION AND DISTRIBUTION OF POWER AND ITS INFLUENCE ON THE DEVELOPMENT OF IRISH INDUSTRY.*

BY J. F. CROWLEY, D.SC., B.A.

(*Concluded from p.* 785.)

SOURCES OF POWER OTHER THAN COAL.

Peat.—We may now consider our second alternative—viz., the development of other sources of power. Firstly, as regards peat, I propose dwelling very briefly on the principal features of this important question. In the Coal Commission (1905) Report † it is stated that "In Ireland, Scotland and some parts of England there are vast peat bogs, but there are no means of estimating correctly the quantity of peat they contain." Made some 12 years ago, this statement is unfortunately, as true to-day as it was then, and it is also true to say that few figures giving the nitrogen content of the peat from the various bogs are available, although this determines the commercial success or failure of any process for the production of power from peat, which, as all large schemes must, involves by-product recovery. The principal problems to be solved, if peat is to be successfully used on a large scale for power purposes, are :—

(*a*) The securing of rights over an area of bog containing peat with a suitable nitrogen content and sufficiently large to provide power for a period long enough to justify the capital expenditure involved; This may be difficult in some cases, owing to vested interests and the existing turbary rights of small holders.

(*b*) The development of a suitable method of "winning" peat on a large scale from the bog.

(*c*) A commercial process for the removal of surplus water from the required quantity of peat. Air drying has already been successfully employed on a small scale, but how far it would be practicable commercially on a large scale has still to be determined. I have looked into a number of methods of removing this surplus moisture artificially, and am not satisfied that a commercially sound system has yet been evolved.

Granted a satisfactory solution of these problems—viz., the provision of a continuous supply at a sufficiently low cost of peat with a water content not much exceeding, say, 50 per cent., it may at once be said that there are no insurmountable *engineering* difficulties to prevent peat being used on a large scale as a substitute for coal for the production of power in gas engines for small and medium powers, and preferably in steam engines for large powers.

Oil.—Oil may form a substitute for coal to a certain extent, provided the supply can be made more reliable and the price per ton brought down to a sufficiently low figure and kept out of the realm of speculation. It may be interesting to note in passing that the largest oil engine so far built is a two-cycle single-acting Diesel engine, completed during the present war, to the order of Messrs. Harland & Wolff, of Belfast. This engine was built in Switzerland for an output of 3,750 H.P., and gave 4,500 H.P. on the test bed.‡

Natural Gas.—It is not generally considered that natural gas is available to any practical extent in the United Kingdom, though in some countries it forms a useful addition to existing sources of power.

Volcanic Heat.—The natural heat of the earth has not been harnessed for power purposes except where abnormal conditions prevail. In Larderello, near Volterra, Italy,§ steam issues from the ground in jets. This steam was first successfully applied to the operation of a 40 H.P. reciprocating steam engine. In the course of time the cylinder walls became corroded by the acid present in the steam, and the outbreak of war causing a great increase in the cost of fuel in Italy, the steam was used to heat boilers. These boilers now provide steam for two 5,000 H.P. steam turbine units, and a further unit of this size is in contemplation, the energy being transmitted by means of electricity to the towns in the neighbourhood.

Various Sources.—Wood, sawdust, tan, &c., have been used to a small extent for the production of power both in producers and as fuel in special fire boxes. Alcohol prepared from vegetation, as for instance from potatoes, has also been written up to a considerable extent in the technical press; but I do not think it will become a serious competitor of coal, at any rate in the present generation.

Tides and Wind Power.—The utilisation of the tides is dismissed by one authority† with the remark that "all engineers are agreed that the cost of impounding the tides is prohibitive," and the same authority, in dealing with wind power, says that "no person has, so far as we know, gone beyond 60 H.P. in utilisation of the wind; there is no doubt that wind power can be used as a source of supply of cheap power, but its intermittent character is against it." The figure of 60 H.P. refers, of course, to the utilisation of the wind for power development on land; much larger powers being developed in the propulsion of large sailing ships at sea. It may be said that, while these statements regarding the winds and tides were made some years ago, they may be fairly taken as representing present-day opinion.

Water Power.—The only source of power other than peat that we need seriously consider in this country as a substitute for coal is water. The Coal Commissioners (1905), in dealing with this matter, say, "It is suggested, however, that it is desirable to examine into the capabilities of the water-powers in Ireland, as small sources of power might be used economically where there is little or no competition with coal." There is no doubt that it is eminently desirable that the investigation suggested by the Commissioners should be carried out.

Solar Radiation.—The greatest power so far directly developed from the radiant heat of the sun is approximately 60 H.P., which was developed* in the Sahara in 1913.

Altogether I think it may be said that, for the United Kingdom as a whole, no new facts have arisen since the Royal Commissioners' report to which reference has been made to alter the conclusion they arrived at—viz., that "coal is our only reliable source of power, and there is no real substitute."

ECONOMY IN THE PRODUCTION, TRANSMISSION AND DISTRIBUTION OF POWER.

Economy of Large Power Units.—The production and distribution of power in bulk from large suitably situated central power stations would, at a conservative figure, save us 50 per cent. of our present coal bill for power purposes, and effect a still greater percentage saving in the cost of the power generated.

Writing in 1912, I gave the following points† in favour of factory owners taking bulk electrical supply from central generating stations :

1. Economy in working due to (*a*) larger units; (*b*) units run more nearly on full load, and therefore at a higher efficiency; (*c*) greater ease with which modern labour-saving devices are installed; (*d*) saving in general attendance costs; (*e*) lower percentage capital costs, since position of plant is not determined by position of load, but by cheapness of land, &c.; (*f*) stand-by plant carried at a lower percentage capital cost.

2. That in the case of a new mill more capital can be spent on remunerative machinery.

3. Elimination from customer's consideration of all matters not directly concerned with his business, such as engineering details, fuel, costs, &c.

4. Facility with which any portion of a mill can be run without running main generating plant.

5. The important consideration that the power company's engineers are always at their customers' disposal when engineering problems arise.

Adding that "a strong point in favour of power supply companies . . . . is that, as their load increases, their capital costs must be reduced, a fact that is borne out by the steady reductions they have been able to effect in their rates, and that in time advantages from the point of view of economical working should enable them to produce current at rates considerably below those possible with the best private plants."

Admittedly the best agent for transmitting and distributing power electricity is also the best agent through which to apply it, and writing in 1911 I claimed‡ the following advantages for electrical driving independently of whether the electricity is produced in the factory itself or in the central station of a power supply company :

1. Reduced employment of line shafting, therefore low friction losses—always an important consideration, particularly when, as frequently happens, few machines in a department are required to run simultaneously.

2. Avoidance of complicated uneconomical drives, such as bevel gearing, jockey pulleys, belts, &c. Belt losses are three-fold: windage loss, friction loss consequent on slipping, friction loss consequent on the continual bending and unbending of the belt strap; and few people seem to realise how heavy these losses may be.

3. Ready readjustment of machinery positions more exactly to suit manufacturing processes.

---

* A Paper read before the Irish Technical Instruction Congress. Slightly abbreviated.

† "Royal Commission on Coal Supplies" (1905). (Cd. 2,353.)

‡ "Journal of the Royal Society of Arts," Vol. LXIII., No. 3,258.

§ "Cassier's Engineering Monthly," December, 1916, p. 442.

* A. S. E. Ackermann, "Journal of the Royal Society of Arts," Vol. LXIII., No. 3,258.

† "Electrical Power in Textile Mills," J. F. Crowley, "Journal of the Textile Institute," Manchester, September, 1912.

‡ "Electricity in Textile Factories: Some Recent Developments," J. F. Crowley, THE ELECTRICIAN, November 17, 1911.

Digitized by Google

4. Reduced risk of damage to machinery, since fuses scientifically designed may be depended upon to cut power off at a predetermined suitable overload.

5. Simplification of machinery supervision. The insertion of a watt-meter in a main circuit is an infallible check on the working conditions of a driven machine. In the writer's opinion this test will inevitably become common practice in modern installations. For small motors suitable plugs to enable portable instruments to be inserted without breaking the motor circuit are easily designed. For large motors, suitable instruments should be permanently inserted.

6. Fewer serious stoppages, since the drives are split up into small independently controlled units.

7. Easy and independent alteration of speeds of machines to suit the class of material dealt with, and the working conditions, atmospheric and otherwise. The customary poor production after Sunday and holiday rests can thus be avoided.

8. Better illumination, fewer shadows and more thorough supervision of operatives owing to the reduction in the amount of line shafting and belting.

9. Less noise, greater cleanliness and improved health of operatives.

10. Fewer accidents.

11. Ease with which extensions and alterations can be carried out without interfering with the running of existing machinery.

12. Increased production, due to higher average speeds and prompter starting.

13. Improved quality of material manufactured, due to the more even turning torque.

In addition to the points above dealt with, the following advantages can be obtained where new buildings are being erected :—

(*a*) The better utilisation of available building space.

(*b*) Lighter and cheaper buildings, considerable saving being effected, particularly in the design of the roof and main walls.

(*c*) Concentration of prime movers and generating plant in one building, and a consequent saving in working costs and supervision.

(*d*) Lower depreciation and lower maintenance charges.

Any advantages claimed for electric driving generally can, of course, be claimed for individual electric driving also; while, in addition, special advantages can be obtained with this drive in certain cases, such as :—

1. Saving in the power consumed.

2. Increased production due to (*a*) peculiar advantages in the case of certain machines, resulting in some cases in an increase in production varying from 10 to 25 per cent.; (*b*) better supervision, &c.

General opinions such as have to be expressed in a Paper such as this are naturally subject to revision based on developments in engineering or increases in the cost of power. Belfast may one day, for instance, receive its power electrical y from the coa fields of Scotland, but I do not see any reason to anticipate any substantial revision in the immediate future.

The importance of cheap power under the conditions of our civilisation is second only to that of cheap food, with which, indeed, modern conditions have indissolubly associated it. Its importance as a factor in the development of our industries cannot be overestimated, nor can its consideration be delayed. It should be dealt with now, when in the industrial lull caused by the great war every European country is taking stock of its economic position.

INSULATING LACQUERS.*

BY PROF. MAX BOTTLER.

Both manufacturers and electrical engineers are much in the dark about insulating lacquers, which are often prepared on very old-fashioned lines. Copals, shellac, sandarac, elemi, asphalt, tar, rubber and other similar substances are often used; these are dissolved in benzine, benzole, alcohol, turpentine, or carbon bisulphide; linseed oil, tongue oil or Chinese wood oil are also used as solvents. Lately artificial resinous products have been used, such as solutions of cellulose acetate. Generally speaking, an insulating lacquer should have the following properties—viz., a sufficient insulation resistance, non-inflammability, a capacity to repel or resist water, a reasonably long life, a power to resist oxidisation and the effects of rust, a considerable degree of hardness, and a power to resist chemical action of different kinds. An insulation resistance of 1,000 volts over a thickness of 0·025 mm. is generally sufficient. It must also resist changes of temperature, and it must adhere firmly, while possessing sufficient elasticity. If a lacquer is intended for use on overhead wires, it must dry quickly without being heated; this, of course, depends on the solvent used. If a drying oil, like linseed oil, is used with a suitable drying agent, it generally dries at ordinary temperatures in 8 or 10 hours; and a fatty lacquer, if slowly dried, is found to have greater power of resisting chemical or mechanical action, than if it is more quickly dried. A sufficient elasticity is needed so that cracks do not develop if the wire is bent. All these properties can be tested in the laboratory by appropriate means; the lacquer ought, of course, not to be attacked by dilute acids or alkalis. A great many lacquers contain substances which are of the nature of fatty, resinous or organic acids; in fact, some kind of decomposition soon sets in owing to chemical action between the lacquer and the metal which it covers. This obviously affects its insulating value. As instances of such substances of an acid character may be mentioned shellac, sandarac, elemi, linseed oil, copal, &c., which combine in some form or another with copper and iron. Farrington, in a Paper read before the Franklin Institute, says that lacquers which contain linseed oil, copal, or asphalt are unsuitable for insulating purposes. He says that after a certain period they become valueless. Arnold in his treatise on the direct-current machine says, that linseed oil should not be used in lacquers for covering copper wires, in consequence of the fact that the oxidation tends to brittleness. Still the insulating lacquers on the market, which contain copals and linseed oil, are seemingly satisfactory, but questions may arise as to their permanence. So-called Japanese lacquers (which are not to be confused with genuine Japanese lacquers) are made from asphalt, copal, resin, wood oil, tar, benzole, linseed oil, turpentine, &c., sometimes with the addition of sulphur; these lacquers, specially if they are of the kind which requires to be dried in the oven, are electrically quite good. (The next section of the author's Paper deals with the behaviour of the various common metals when exposed to the atmosphere, including iron, which is now largely used in war time in Germany as a conductor; but this portion of the Paper is omitted in the present abstract. A cellulose lacquer is recommended for iron.)

Of later years a good deal of interest attaches to the lacquers produced from artificial resins. Various processes are employed. The formaldehyde resins are the usual ones, which are obtained by reaction with carbolic acid, using generally an acid, a base, or a salt as a catalyser. The fluid or solid condensation-products are dissolved in alcohol; a number of patents describe the addition of petroleum, ether, benzol, toluol, trimethylene, and the like. A perfectly smooth and brilliant lacquer is obtained in this way. The formaldehyde resins are dissolved in alcohol, benzine, &c.; they are only soluble at an early stage of their preparation. At a later stage they are entirely insoluble, but they then form substitutes for all sorts of materials such as ivory, horn, celluloid, amber, vulcanite, galalith, &c. Chiefly, it may be said that the best lacquers are prepared by a new so-called "dry" process by the reaction between "formin" and carbolic acid, "formin" itself being prepared from the reaction between formalin and ammonia; these lacquers have excellent insulating properties. The resins are dissolved in alcohol or acetone, or when dry, they resist almost any form of chemical action, and have very high insulating properties. Laboratory tests have conclusively proved that these artificial lacquers are far better than the old-fashioned ones; no comparison of any sort is possible between the two.

Hitherto we have only considered those formaldehyde resins which are soluble in alcohol, benzole, &c., but they always have the well-known smell of carbolic acid. Lately this objection has been removed, and resins have been produced which have no smell at all, and are soluble in oil. The processes are described in the German patents Nos. 254,411, 269,659, 281,939, 289,968. The physical properties, such as consistence, colour, brilliance, covering power, ease of applying, drying characteristics, hardness and elasticity are as good as those of the best copal varnishes. They do not discolour, and are chemically indifferent to almost any reagent. They are very suitable for protecting iron against rust. They only break down if a voltage of 5,000 is applied to the surfaces of a film 0·085 mm. thick. The great difference between this new lacquer and the older types of the same kind is that it is without smell, and it does not discolour.

* Abstracted from the "Elektrotechnische Zeitschrift," No. 11, 1917.

CORRESPONDENCE.

BRITISH METHODS IN FOREIGN TRADE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of May 11th, under the heading "Imperial Notes," you quote a statement regarding the ignorance of engineers in New Zealand as to the capability of English firms to manufacture high-tension plants of large size. Such lack of knowledge is not surprising if engineers in the Dominions are not kept better advised of what some of the principal firms in England are doing than are those in India.

Digitized by Google

A few weeks ago the representative of a large English concern called upon me, and complained that no orders had been received from the company with which I am connected although it was more than three years since his firm opened branch offices out here and notwithstanding the fact that many thousand pounds' worth of electrical machinery had been ordered for this undertaking during that period. In reply, I told him that I was unaware that his company was even represented in India; that I had not received a single catalogue or pamphlet from them in the last 10 years, and that having become tired of seeing the same old and uninteresting advertisement which his firm had inserted in the technical papers week after week for as long as I could remember, I had ceased to take any interest in them. He replied that his company did not attach much importance to advertising, so his reason for expecting to receive orders was not evident.

It has to be remembered that the electrical trade must be considered in conjunction with other lines of business, in order that a good reputation may be established for things English in general.

Although I have not visited New Zealand, I was in Australia last year, and in a fairly large town there the principal contractor was most surprised when I informed him that dry cells could be obtained from England at all, let alone at a lower price than he was paying for them. In the largest ironmonger's shop in the same town I saw an elaborate display of American adjustable spanners, and inquired of the proprietor why he did not obtain such tools from England. He told me that he did not know of any English firm making them, and after I had given the name of one from whom they could be obtained at a lower cost, he remarked upon the necessity for England to "wake up." He also gave me several instances of inattention and carelessness on the part of English firms to whom he had sent orders in his desire to be patriotic, and he certainly could not be blamed for deciding to obtain his supplies elsewhere. In one instance he ordered a large number of expensive agricultural implements from a leading English manufacturer, *whose representative had never called upon him*, and was obliged to pay cash for them against shipping documents, but every one of them was delivered minus an essential working part. He lost the season's sales, and was obliged to warehouse the machines for many months until the missing parts came to hand; yet he received no redress. Being interested in the question, I made numerous inquiries on the same lines, and many of the replies were most disheartening.

The show-room of one supply company at which I called was almost filled with electric heating apparatus of various descriptions, but there was not a single article there which had been made in England. The ignorance of the person in charge of it as to what could be obtained from the Old Country was appalling. I feel fairly confident that no one had previously taken the trouble to furnish him with any information on the subject.

The above-mentioned instances would be more credible to some of your readers if they had seen the attractive display of American magazines in many booksellers' windows and railway bookstalls in Australia, and nearly all such publications contain alluring advertisements which undoubtedly lead to business.

Before the war, for every catalogue and brochure I received from England, I suppose I received at least a dozen from America and Germany, or from firms parented in those countries; in fact, as a general rule, if I saw a notice of the issue of a new English pamphlet I had to write for a copy, although in charge of a well-known large plant.

An engineer resident abroad is not merely interested in theories and people's ideas on various subjects, but also in the details of what has actually been done and in learning where to obtain what he requires from a firm which has made more than a sample or an experiment. For that reason I, in common with a number of others turn to the advertisements of a certain American paper before I think of reading through the English journals, and it is the latter that would be set aside if there was not time to read them all. There are, of course, a few notable exceptions amongst English firms; they exercise their ingenuity and vary their advertisements, but many seem content if their address is published, and I know of several which have never yet stated in print that they are in a position to manufacture certain articles which they make and which are undoubtedly of the best of their respective kinds. For example, household labour-saving devices, operated electrically, should be at a premium, under present conditions, yet they are advertised very little.

The advertisement which carries weight is one including the reproduction of a photograph of plant actually installed; woodcuts giving an idea of what a firm could make if it had the opportunity are almost valueless; moreover, it would give manufacturers a handsome return if, when paper supplies become normal, they would pay a sufficiently high price for advertisements, to enable publishers to print their journals on paper equal in quality to that used in America, merely to show their advertisements to the greatest advantage.

Then again the thorough knowledge displayed by American salesmen of the goods they have to sell—how an article is made, where it has been used and why it is to be preferred to other makes—is in strong contrast to the feeble advocacy of the glorified clerks who are often selected to represent some English firms abroad, presumably because they will accept lower salaries than competent salesmen who have had a practical training in their particular line of business.

To return to the quotation in your paper—certain firms in England are prepared to make transmission line towers, but if they cannot erect anything better than some of the overhead lines illustrated in their rare advertisements, orders are likely to go elsewhere. The advertisements of line material are so meagre that they are unlikely to complete "the education" of the engineer far from the Mother Country, and the amount of patriotism which has been shown in continuing to send orders there, considering the lack of enterprise shown by many manufacturers, is little short of marvellous.

I desire to make it quite clear that I am not criticising American goods or methods. I admire them; but when equally satisfactory articles can be purchased in England for use in British possessions it is regrettable that British capital should be diverted to other countries to buy what is required. The American himself will appreciate this point of view, for he is the last person in the world to send orders anywhere else than to his native country if he can possibly avoid it; he is far more patriotic in trade matters than the Englishman, partly because he conscientiously believes in the superiority of things made in his own country.

Even in your columns a few months ago a more powerful boost was give to the wares of two foreign concerns than competing English firms often receive, and as only London addresses were mentioned, some engineers abroad may have concluded that the goods were produced in England. It is a rare occurrence when an English product is even mentioned in the American journal to which reference has already been made, and it is still more unusual for it to receive favourable comment.

English manufacturers may possibly be able to prevent trade in England from being filched from them again without adopting more up-to-date methods of advertising, but certainly the expansion of trade they dream of will never take place unless they alter in that respect.

As far as my observation goes, the principal failing of many English, as compared with foreign, firms is that they expect a branch business to be profitable from its inception. They are therefore unable to launch out in the very way that would lead to success. A bolder and more intelligent policy is needed.

I rarely write to you, and that must be the excuse for a lengthy letter.—I am, &c.,

India, June 27. TRUMPETER.

Digitized by Google

INDUSTRIAL RECONSTRUCTION.

The Executive Council of the Federation of British Industries has issued, in response to a request by the Ministry of Labour, a memorandum setting out its recommendations for dealing with industrial unrest contained in the Whitley Report. It will be remembered that this report was officially described as the interim report on Joint Standing Industrial Councils by the sub-committee on relations between employers and employed of the Reconstruction Committee. The following is an abstract of the memorandum of the Federation :

1. The Federation cordially endorses the view of the Reconstruction Committee as to the vital importance of securing co-operation between employers and workpeople after the war. Few can fail to realise the serious consequences to our commercial and national position which may result from failure to secure harmony between employers and employed. Efficiency of production is a prime consideration. For this it is necessary to have co-operation and agreement with labour, who in return will, and are entitled to, demand improved conditions of employment, a higher standard of comfort generally, and opportunity of appreciating the true interests of the trade in which they are engaged.

The complement of efficiency of production is efficiency of management, whether in the organisation of works and of business, in inventiveness, or in the study and capture of world-wide markets. Such management is at the base of an intensive demand for labour, and must be guided and controlled by the best individual brains of the country. Care must therefore be taken not to interfere with their work, but to afford them the fullest scope, for without an intensive demand for labour it is hard to see how the best conditions can obtain

Any scheme for reconstruction must, therefore, have regard to the importance of efficiency both in business and productive methods, and in commercial management, and nothing in the suggested councils should tend to impair or interfere with development in this direction.

2. The Federation cordially welcomes the views expressed by the committee as to the important part which must be played by associations in the settlement of these difficult questions, and expresses the opinion that it is, indeed, only by the establishment in each trade of organisations representative of employers and workpeople respectively that the object can be achieved. The Federation, therefore, would lay particular emphasis upon the views expressed in par. 23 of the report—

" It may be desirable to state here our considered opinion that an essential condition of securing a permanent improvement in the relations between employers and employed is that there should be adequate organisation on the part of both employers and workpeople. The proposals outlined for joint co-operation throughout the several industries depend for their ultimate success upon there being such organisation on both sides, and such organisation is necessary also to provide means whereby the arrangements and agreements made for the industry may be effectively carried out."

While agreements in the fullest sense can only be made between organisations representing each side, it is almost impossible to provide security for such agreements if any appreciable portion of workpeople on the one side, or manufacturers on the other, are not members of their respective organisations, and are consequently not bound by the agreements. In the opinion of the Federation this point is so important that they suggest that the Government ought to go far to recognise and give an official standing to organisations representative of employers and workpeople respectively, and to encourage the development of such organisations.

3. The recommendations of the committee are far-reaching and important, but it will be readily admitted that the constructon of an organisation on the lines suggested is a delicate matter, and the Federation notes with satisfaction that in the creation of the proposed organisation it is not contemplated that the Government shall actively interfere. The Federation desires to emphasise this point, and to urge that while sympathetic Government assistance may be, and doubtless will be, of great value, it is most important that there should be no suggestion whatever of Government pressure or coercion, and that each trade shall be free to build up its own organisation voluntarily and on lines best suited to its peculiar needs.

4. It may be pointed out that the descriptions in the report of the various Councils are somewhat vague and uncertain. The Federation, however, understands that the National Industrial Councils referred to are councils of individual trades, and not national in the literal sense. The Federation is of opinion that the basis of the scheme should be Trade Councils of masters and men ; that is to say, that each trade or section of an industry should form a council representative of the employers' organisation or organisations, and of the trade union or trade unions concerned with such particular trade or section of an industry. This council should have sole power of dealing with agreements of all kinds, and any other matters appropriate to the particular trade or section of industry. Some difficulty arises in this connection owing to the existence of unions in certain cases overlapping various different sections of trade. This, however, is a matter of detail which could no doubt be easily overcome.

5. In the opinion of the Federation devolution of constructive work to District or Works Committees would be very dangerous. It should only be permitted to develop in the light of experience.

6. It is suggested that the main value of District Councils would be to constitute a court of arbitration in the case of any difference between employers and employed in the trade in the district, having regard to the general and any peculiar conditions obtaining in that district.

7. In the opinion of the Federation the works committees should be entirely voluntary in the case of each individual firm, and not in any way officially constituted. They should consist entirely of representatives of the employés, and they should, if possible, be elected by secret ballot. Where instituted their duties should be confined to reporting to, or receiving from, the management complaints regarding breaches of any agreements which may have been made between the employers and employed.

8. It appears to the Federation that the general principle underlying these suggested councils should be the centralisation of policy and the decentralisation of administration.

9. The Federation suggests that, while the proposed trade—or, as they are designated in the report, National Councils—may be well suited for discussing questions peculiar to the trade, and may provide a suitable court of first instance for the settlement of disputes, it would be highly desirable that superior bodies should exist consisting :—

(1) Of representatives of employers and employed in each group of trades forming an industry which might possibly be styled " Councils of Industry."

(2) Of representatives of the employers and employed in all industries, which might possibly be styled the " National Industrial Council."

The Councils of Industry and the National Industrial Council would provide suitable courts of appeal from the Trade Councils in cases of differences between employers and employed in any trade which cannot be settled by the Trade Councils. The Federation is of opinion that provision of methods for preventing or settling differences is almost as important as provision of facilities for co-operative action, and the Federation is of opinion that if no strike or lock-out could take place until the question had been submitted to final arbitration by a truly National Council of employers and employed, there would be good grounds for hoping that the time for reflection afforded, and the pressure of popular opinion, would ensure the loyal adoption of the award.

10. With regard to the consideration of general questions, the Federation is of opinion that these should be dealt with primarily by the National Industrial Council, which should delegate to the Councils of Industry, and possibly to the Trade Councils, the consideration of matters of peculiar trade interest in such cases as the National Industrial Council may think desirable. The final decision in all matters of general policy should be taken by the National Industrial Council, after providing reasonable opportunities of criticism on the part of the Councils of Industry and Trade Councils. Nothing in this suggestion, however, is intended to prevent Trade Councils or Councils of Industry from initiating the consideration of any matter of general interest.

The Employers Parliamentary Council has also issued a memorandum on the " Joint Standing Industrial Councils " recommended in the interim report by the sub-committee on " Relations between Employers and Employed."

It is pointed out that the labour unions do not represent the whole of the workpeople of the country. It may be true that in certain industries the unions do, in a large measure, if not fully, represent the workpeople employed therein ; but, taking the workpeople throughout the country, the overwhelming majority are not members of labour unions. The Employers Parliamentary Council submit that freedom and security for industry are impossible until all combinations of capital and labour are subjected to the ordinary law of the land, and conspiracies for " paralysing the country " by means of general strikes and lock-outs are rigorously suppressed. The repeal of the Trade Disputes Act must be regarded as a condition precedent to the establishment of that close co-operation between employers and employed which has now become more than ever vitally essential to industrial prosperity.

The report emphasises the need of the relations between employers and employed being of such a character as will " offer to workpeople the means of attaining improved conditions of employment and a higher standard of comfort generally, and involve the enlistment of their active and continuous co-operation in the promotion of industry." To this end the sub-committee recommend " the establishment for each industry of an organisation, representative of employers and workpeople, to have as its object the regular consideration of matters affecting the progress and well-being of the trade from the point of view of those engaged in it, so far as this is consistent with the general interest of the community." To provide means for carrying out this recommendation the sub-committee submit proposals for " the formation of joint standing industrial councils in the several industries, where they do not already exist, composed of representatives of employers and employed ; " and they give examples of the questions with which the councils should deal. The memorandum says : " It may be doubted (*a*) whether any industry is completely and perfectly covered by organisations either of employers or employed ; (*b*) whether it is possible or practicable to bring within the scheme those industries where no organisation exists, or where the organisation is imperfect." It will be observed that the sub-committee have been driven by the pertinent questions addressed to them by the Reconstruction Committee to admit certain fundamental and serious difficulties ; and that when confronted by the questions : " Is it intended that decisions reached by the councils shall be binding upon the bodies comprising them ? If so, is such binding effect to be conditional upon the consent of each employers association or trade union affected ? " the sub-committee can only answer that agreements reached by the councils will " carry with them the same obligation of observance as exists in the case of other agreements between employers associations and trade unions." The significance of this will be appreciated by employers associations which have had experience of the " binding

Digitized by Google

character" of such agreements. It is idle to suggest that the agreements reached by the industrial councils could be of any real or lasting consequence, or be considered as possessing any guarantee that their terms would be enforced, unless they were of a legal character with provision for penalties recoverable out of funds reserved to meet liabilities involved.

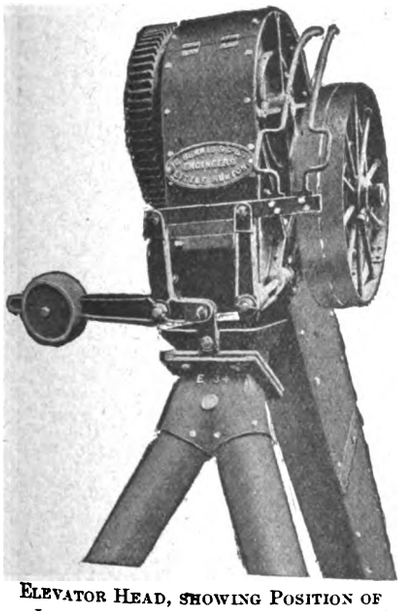
The sub-committee confess that the question of the restoration of trade union rules and customs suspended by the war is "one of the chief factors in the problem" presented by their report, and, in answer to a question by the Reconstruction Committee, the sub-committee say: "It is clearly intended that all pledges relating to the restoration of trade union rules shall be redeemed without qualification unless the particular trade union concerned agrees to alteration; and it is not intended that the Council shall have power to decide such questions by a majority vote of the workmen's representatives from all the trade unions in the industry." This leaves the whole matter open to discussion and arrangement. May it be assumed that "the lessons of the war" have convinced even the labour unionists responsible for the old and fatal policy that the rules and customs referred to can, in the very nature of things, never be restored? There are many indications that warrant this assumption; and if it can be made a matter of mutual agreement between employers associations and the labour unions, the outlook for British industry will be full of hope and promise.

Taking the report under review as a whole, the Employers Parliamentary Council express their appreciation of the efforts made by the sub-committee to propound a solution of the problem by which the country will soon be faced. While many of the recommendations are, in the opinion of the council, in themselves, laudable, and to some extent practicable—as a matter of fact, certain of the recommendations are already, and have for long been, in operation in several industries—others are of a nebulous character, suitable more for academic discussion than for practical experiment. The report will, however, serve the useful purpose of presenting the problem of industrial reconstruction on definite lines; and in this respect the recommendations of the sub-committee should be studied and digested by those concerned with a view to a true and lasting solution being found.

BOILER HOUSE ELEVATORS.

One of the chief problems to be faced in connection with boiler-house economies is that of getting the coal to the boilers. This can be solved by the mechanical filling of the hoppers, and it has become necessary in estimating the value of mechanical stoking to combine therewith a complete coal and ash elevating system.

A booklet issued by Messrs. Ed. Bennis & Co. (Ltd.) contains an illustrated description of various small elevators erected at low initial cost, and maintained at a figure which is regarded as negligible. Attention is drawn to the use of gravity buckets as employed in the Bennis elevator, and a calculation is presented showing how the installation of small elevators of this type may result in a saving of 50 per cent. of the outlay. This is based on the estimated wages saving; it is assumed that a saving of 14s. out of a wages bill of £3. 15s. could thus be readily made.



ELEVATOR HEAD, SHOWING POSITION OF LEVER WHEN ELEVATOR IS STOPPED.

A device of special interest is the self-starting and self-stopping mechanism, shown in the adjoining illustration.

The shoots feeding the fuel to the elevator head are swung on a balanced lever, the tail end of the elevator being supported by a chain rod or wire rope. Coal is fed into a small hopper forming the upper end of the shoot. When the shoot is empty the weight on the balance lever draws the belt on to the driving pulley, so that the elevator is running; similarly when the shoot is full the lever pushes the belt on to the loose pulley and motion ceases. When the shoots are about half-empty the elevator starts up again, so that there is always sufficient coal to keep the hoppers full. The rate of revolution of the rotary feed can be adjusted by raising or lowering a handle, and the device can be applied to any existing elevator. In the elevator-head shown in the figure the balance lever is in the position stopping motion

In the remainder of the booklet particulars of a number of installations are given. These include: Messrs. Carus & Sons (Hoddlesden), T. M. Hesketh & Sons (Ltd) (Astley Bridge and Norwich), Cortaulds (Ltd.) (Coventry and elsewhere), and Crosses & Winkworth (Ltd.) (Bolton).

PARLIAMENTARY INTELLIGENCE.

HOME PETROLEUM SUPPLY.

In the House of Commons on the 15th inst. a Bill was introduced to authorise provision being made for searching and for boring and getting petroleum in the United Kingdom.

Mr. WALTER LONG said that a Committee, which had discussed some of the questions relating to the development of possible oil supplies at home, had been advised that it was quite probable that oil existed in parts of this country, but it was not easy of location and it was a matter which should not be left entirely to private enterprise. The Bill would place in the hands of the Government all rights to get petroleum, enabling them to lease and to find oil areas, to provide for getting the oil by persons or companies on terms or conditions under schedules to be fixed by the Board of Trade, and to set up the necessary machinery for the purpose. The work done during the war would be under the Defence of the Realm Act, and after the war under the provisions of the Bill, or by private bill or by provisional order.

GOVERNMENT COMPETITION WITH CONTRACTORS.

In the House of Commons on the 15th inst. the Chief Secretary for Ireland was asked whether he was aware that the electric light contractors of Dublin were asked by the Board of Works to estimate for the electric lighting of Coleraine House, Dublin, and that after receiving estimates they approached the General Post Office (Telegraph Department) and asked them to undertake the work; was it the intention of the Post Office or other such Government Departments to enter into competition with contractors, and what action he intended to take?

In reply, Mr. BALDWIN said five Dublin firms were invited to tender for the electric lighting of the office of the Registrar of Business Names at Coleraine House. Three tenders were received, but all were much in excess of the Board's estimate, and inquiry showed that there was no chance of obtaining a substantial modification of any of them. The work was very urgent, and the Commissioners, therefore, to avoid further delay in negotiation, deemed it expedient to ask the Post Office to undertake the work, more particularly as the necessity for the works at Coleraine House arose from the fact that a portion of the General Register Office which would otherwise have been available for the registration of business names, and been more suitable for the purpose, had been temporarily assigned to the Post Office and electric lighting works were being carried out there by that Department.

Leaving Certificates Abolished.—In the House of Commons last week Mr. Churchill asked for leave to recommit the Munitions of War Bill. He said it would not be in the broad interests of the country or of the supply of munitions that the House should separate for the holidays without giving effect to the definite pledges which had been given. The working classes expected the abolition of leaving certificates and that course had been approved by the Employers' Association.

The motion was agreed to.

The Channel Tunnel.—In the House of Commons on Thursday last the Chancellor of the Exchequer, Mr. Bonar Law, announced that the Government had again carefully considered the question of the construction of the Channel Tunnel, and they were still of opinion that it was not practicable to proceed further with the matter during the continuance of the war.

LEGAL INTELLIGENCE.

Breach of Electrical Regulations.

In the Falkirk Sheriff Court last week the Greenock & Grangemouth Dockyard Co. was charged with permitting the use (on June 7) of a portable electric lamp in their shipyard which was in direct metallic connection with the guard, contrary to the electricity regulations made under the Factory & Workshops Act.

A plea of not guilty was made by defendants and witnesses stated that there was an extraordinary number of breakages among the electric lamps in use. One witness stated that he had seen men deliberately breaking lamps by throwing them about, the object being apparently to get an idle hour while the lamps were being repaired.

The foreman electrician of the yard also said the firm from which he got his supplies was unable to meet his demands for lamps conforming to the Home Office Regulations and he had been supplied with others having a different kind of guard. He had done that on his own responsibility and without communicating with the directors of the Company. The work which was being carried out was of great national importance and they could not work without the lamps. A great deal of overtime was being worked.

For the Company it was also contended that it had discharged its responsibility under the Factory Act and the regulations made thereunder by publishing copies of the Home Office Regulations, with instructions that they should be enforced.

In giving his decision, Sheriff MOFFAT said the use of the lamp had unfortunately resulted in a man's death, which proved the necessity for the Regulations. He had listened with some degree of horror to the evidence of men engaged on Government work of the greatest importance wasting time in the manner alleged, and if they had been caught they would justly have been severely dealt with. He imposed a fine of £5.

Digitized by Google

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

10,174 B.T.-H. Co. (G.E. Co.) Dynamo-electric machines. (19/7/16.) 107,439.
10,386 COLLINS, G. H. & COLLINS, H. F. Electrical connectors or junction pieces. (24/7/16.) 107,831.
10,535 POLLAK. (Soc. Anon. des Etablissements L. Bleriot.) Electric resistances for compensating and like purposes. (26/7/16.) 107,675.
10,588 WALSALL ELECTRICAL CO. & DELEBECQUE, V. Attachment of ammeters and voltmeters to supports particularly in connection with motor-driven vehicles. (27/7/16.) 107,836.
10,589 WALSALL ELECTRICAL CO. & DELEBECQUE, V. Ammeters and voltmeters. (27/7/16.) 107,836.
10,720 MIDGLEY & VANDERVELL & Co. Combined starter and lighting dynamos. (28/7/16.) 107,680.
10,875 WILLIAMS, I. Ammeters for the measurement of alternating current and electric oscillations. (2/8/16.) (Cognate application, 11,337/16.) 107,844.
11,055 INDO-EUROPEAN TELEGRAPH CO. & MORSE. Electric oscillating or wireless systems and apparatus. (4/8/16.) 107,682.

A device comprising a number of inductances, capacities or spark-gaps disposed between two parts, such as discs or the like, and having terminal members on the said two parts respectively, and a pair of brushes or the like adapted to co-operate with said terminal members in such a way that by relative movement between said terminal members and brushes or the like any one of the said inductances, &c., may be connected in circuit as desired.

11,623 CAMPBELL & SOC. ELECTRO-METALLURGIQUE FRANCAISE. Electric furnaces. (16/8/16.) 107,465.
11,684 SIGNAL GES. Submarine electric leakage telegraphy. (16/3/15.) (Addition to 13,919/13.) 101,223.
11,812 WEST, A. & WEST & Co., A. Electric lifting magnets. (19/8/16.) 107,856.
12,016 B.T.-H. Co. (G.E. Co.) Electromagnetic switches. (24/8/16.) 107,472.
12,352 TURNER. Automatic train-control systems. (1/4/16.) 105,324.
13,097 CROSBEE & SONS, T. & WILKS, H. W. Sparking plugs for internal combustion engines. (15/9/16.) (Cognate application, 13,899/16.) 107,873.
13,487 PRESTON. Galvanic batteries. 22/9/16.) 107,485.
13,659 ELLISON. Controllers for electric motors and like apparatus. (26/9/16.) (Addition to 12,882/13.) 107,699.
13,767 HOPE. Electric switches. (28/9/16.) 107,493.
14,293 BULLERS LIMITED & TWISS. Means for supporting lengths of wire, particularly applicable to line insulators. (7/10/16.) 107,497.
14,703 GABELL. Holders and supports for incandescent electric lamps. (16/10/16.) 107,705.
15,597 ALLEN. Commutators for dynamo-electric machines. (1/11/16.) 107,512.
16,492 KUNZMAN. Spark-gaps. (17/11/16.) 107,520.
17,061 AKT.-GES. BROWN, BOVERI ET CIE. Resilient pivotal connection between an alternating-current electromagnet and its armature. (10/1/16.) 103,641.
17,603 GILES. Detection of earth connections in electric cables. (9/12/15.) 102,621.
17,936 FABRIQUE DES LONGINES FRANCILLON & Co. Energy meters for alternating electric currents. (22/4/16.) 106,465.
18,145 BURNEY & BLACKBURNE & COBB, E. M. Terminals for electric wires. (18/12/16.) 107,924.

1917 SPECIFICATIONS.

3,958 COOKE. Magneto-electric generators. (19/3/17.) 107,741.
5,529 HEURTLEY, E. S. Telegraphy. (6/6/16.) (Divided application on 7,995/16 Cognate application No. 5,533/17.) 107,950.
7,093 SIEMENS & HALSKE, AKT. GES. Automatic selectors for telephone systems. (4/5/16.) (Addition to 23,336/13.) 106,506.
8,553 INDO-EUROPEAN TELEGRAPH CO., MORSE, A. H. & MOORE, H. R. RIVERS-. Electric oscillating or wireless systems and apparatus. (12/7/16.) (Divided application on 9,833/16.) 107,958.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

May 29, 1917.

7,651 Moss. Automatic electric control for trains.
7,656 PILKINGTON. Telephone transmitters.
7,659 REILLY. Electric generator or dynamo.
7,676 POTTS. Magazine telegraph transmitters.
7,679 B. T.-H. Co. & CARTER. High-speed electric locomotives.
7,680 OSRAM-ROBERTSON LAMP WORKS & DOWNES. Transmitting valves for wireless telegraphy.
7,681 HARVEY. Transmitting valves for wireless telegraphy.
7,682 DURDLE. Transmitting valves for wireless telegraphy.
7,683 W. T. HENLEY'S TELEGRAPH WORKS CO. & CLEMENTS. Electric plug couplings.
7,684 OLDHAM. Secondary or storage batteries.
7,702 SOC. DE PARIS ET DU RHONE. Electric generators. (26/5/16, France.)

May 30, 1917.

7,710 NIX. Electrically-operating contact breaker for magnetos.
7,712 HEYWOOD. Overwinding switch for electric cranes.
7,718 DEAN. Rectifying interrupters for X-ray purposes.
7,720 MCBERTY. Machine switching apparatus.
7,730 B. T.-H. Co. (G. E. Co.) Voltage regulators.
7,731 JUNGGREN. Elastic fluid turbines.
7,735 GREVILLE. Arc lamp for medical and surgical purposes.
7,738 BROWN, BOVERI ET CIE. Regulating steam or gas turbines. (2/6/16, Switzerland.)
7,739 BROWN, BOVERI ET CIE. Magneto ignition for internal combustion engines.
7,756 SVENSKA TURBINFABRIKS AKTIEBOLAGET LJUNGSTROM. Radial flow double turbines. (23/5/16, Sweden.)

May 31, 1917.

7,806 B. T.-H. Co. (G. E. Co.) Centrifugal compressors.
7,814 ELEKTRIGITATSWERK LONZA. Obtaining nitrogen from air. (17/6/16, Switzerland.)
7,821 SUCHOSTAWER. Generation of mechanical and electric power by different currents.
7,826 HOLMANN. Electric fuse box.
7,836 BLAIZOT & BROLLY. Sparking plugs.
7,846 SUBMERSIBLE & J. L. MOTORS (LTD.) & WHITEHORN. Dynamo-electric machines.
7,847 KENNINGTON. Sparking plugs.

June 1, 1917.

7,881 B. T.-H. Co. (G. E. Co.) Centrifugal compressors.
7,882 MULLER. Electric insulating materials.
7,900 DOWNES. Telegraph, &c., poles.

June 2, 1917.

7,925 BEECROFT. Electric arc lamps.
7,943 B. T.-H. Co. (G. E. Co.) Wireless signalling systems.
7,953 CHEETHAM. Electric measuring instruments.
7,957 GILES. Electric spark-gap protective devices.

June 4, 1917.

7,973 HARDY PATENT PICK CO. & SMITH. Magnetic separators.
7,984 MOORE. Production of solutions of nitric acid in sulphuric acid or in fuming sulphuric acid by electrolysis.
7,986 BREEDEN, LUCAS & TURNER. Dynamos.

June 5, 1917.

8,012 ASHBURY & KING. Collectors for trolley wheels of electric trams and railways.
8,058 DAIMLER CO., LANCHESTER & BOUGHTON. Electric power transmission for motor vehicles.

June 6, 1917.

8,089 HARFIELD. Motor to drive vehicles on its own induced current.
8,100 B. T.-H. Co. (G. E. Co.) X-ray apparatus.
8,109 QUINN. Electric switches.

June 7, 1917.

8,147 DOWNS & FITT. Electric appliance for inspection of interior of casks, &c.
8,150 PREECE. Driving power looms by electric motors.
8,151 BAUMANN. Steam turbines.
8,158 CULMER. Arc lamps, searchlights, &c.

June 8, 1917.

8,176 WATSON & CO., ETCHELLS & GREAVES. Electric furnace regulators.
8,183 BURGESS. Utilisation of molecular energy.
8,193 B. T.-H. Co. (G. E. Co.) Centrifugal compressors.
8,228 PESCATORE. Electrodes for arc soldering, &c.
8,232 BETHENOD. Radiotelegraphy and radiotelephony. (26/5/16, France.)

June 9, 1917.

8,271 POHL. Alternate current machinery.

June 11, 1917.

8,297 SANDEMAN & WALLACE. Telemotor apparatus for controlling movements of searchlights, &c., from a distance.
8,300 DAY. Switch-controlling means for electric lamp-holders, &c.
8,318 GOLDSTON & WOOD. Electric switch apparatus.
8,343 MULLER. Insulating materials.

June 12, 1917.

8,385 LAVINE. Device for use with telephone, &c., receivers and transmitters.
8,415 GREEN. Timing of magneto-electric machines, &c.
8,416 STERLING TELEPHONE & ELECTRIC CO., BELL & DAVEY. Electric signalling.

June 13, 1917.

8,446 SCOTT. Electric sparking plugs.
8,448 BROWN. Electric cables.
8,450 DENNETT. Secondary generators.
8,459 SUCHOSTAWER. Magneto motor.
8,460 BUFSILL. Measurement of strength of magnetism of permanent magnets.
8,463 HIRST. Electric safety alarm for water-gauges of boilers.
8,467 B. T.-H. Co. (G. E. Co.) Contact making meters.
8,468 BREEDEN, LUCAS & TURNER. Dynamo-electric machines.
8,470 FERGUSON, PALIN & Co. Switchboards.
8,478 SAHLIN. Electric furnaces.
8,482 WESTERN ELECTRIC CO. (Soc. Anon. Materiel Telephonique.) Telephone system for aeroplanes.

June 14, 1917.

8,491 MERCER & POLLITT. Electric welding.
8,507 MILLS & MORGAN. Ignition system for internal combustion engines.
8,532 VILLIERS ENGINEERING CO., FARRER & FUNCK. Electric ignition and lighting systems.
8,551 ATHERTON. Dynamo-electric generators.
8,552 WESTINGHOUSE GEAR & DYNAMOMETER CO. Reduction gearing. (16/6/16, U.S.)
8,553 INDO-EUROPEAN TELEGRAPH CO., MORSE & RIVERS-MOORE. Electric oscillating or wireless systems and apparatus.

June 15, 1917.

8,579 HARRISON. Watertight fitting for electric lamps, &c.
8,585 DONOVAN. Electric switches.
8,586 BAILEY. Zinc cups of electric batteries.
8,589 CASSAN. Storage batteries or cells.
8,598 ROBINSON. X-ray tubes.
8,606 ADAMS. Coin-in-slot machines for telephones.
8,621 ELLERD-STYLES. Electric switches.
8,622 BREEDEN, LUCAS & MOORE. Dynamo-electric machines.
8,627 TALLENT-BATEMAN. Protective apparatus for dynamo-electric generators.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for the Week :—

Officer for the Week.—Platoon Commander C. Campbell.

Resignation.—Platoon Commander A. Gerard resigns his appointment.

Monday, August 27th.—Technical instruction (searchlight) for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class. Recruits' drill, 6.30.

Tuesday, August 28th.—Lecture, 6.30. Physical drill and bayonet fighting, 7.30.

Wednesday, August 29th.—Drill and elementary bridge construction for No. 1 Company, Right Half Company.

Thursday, August 30th.—Drill and elementary bridge construction for No. 2 Company, Right Half Company. Ambulance Class.

Friday, August 31st.—Technical instruction (searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Signalling Class. Recruits' drill, 6.30.

Musketry.—All N.C.O.s and men who have signed the "A" and "B" agreements are required to attend during this month to re-classify in order to enable the Corps to obtain the capitation grant. Preference will be given to these men in firing.

Armlets.—The new issue armlets can now be obtained at headquarters and every enrolled man must obtain one without delay, and all old (red) armlets must be returned to the orderly room.

NOTE.—Unless otherwise indicated, all drills will take place at headquarters (Balderton-street, Oxford-street).

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

Workmen's Compensation.

One of the effects of the new Workmen's Compensation (War Addition) Bill, which increases by 25 per cent. the compensation to be awarded to total cases of injury, has been to cause the tariff accident insurance offices to increase the premium rates by 10 per cent. as from Sept. 1, except in the rates for insuring domestic servants. The fact that the bill is retrospective may lead to some confusion, for employers, who had thought they had covered all their risks by insurance will now, apparently, be called upon to make addit onal payments after their annual accounts have been closed.

* * * *

Commercial Education.

The Minister for Education (Dr. Fisher) recently received a deputation of members of the Commercial Education Committee of the London Chamber of Commerce, who waited upon him in order to submit proposals for the advancement of commercial education.

The subject is an important one, and it is possible that in the discussion of our numerous education problems—the improvement of technical training and education, the necessity for greater attention being paid to the teaching of science, the apprenticeship question, &c.—the claims of commercial education and the teaching of modern foreign languages for commercial purposes may not receive that consideration which they certainly deserve. We are glad, therefore, to see that one of the members of the deputation submitted that commercial education should have equal recognition with technical education; that adequate facilities should be given to the training of teachers in commercial subjects for which business men rather than teachers should be trained; that separate schools or institutes should be established at which commercial training should be given to those intended for commerce; that employers be requested to arrange for the continuance of the commercial studies of their staffs during the daytime and until they reach their eighteenth year; and that grants be paid for the efficient educational teaching of commercial subjects, particularly in the case of modern foreign languages for commercial purposes.

After various members of the deputation had spoken, Sir ALBERT ROLLIT summarised the views of the deputation. He assured the Minister of their support of his bill, and suggested that the Chamber might be brought within its scope, and co-operate under clause 5. He enforced the need of more facilities for commercial education, and welcomed the continuation system in the new bill as likely to induce commerce students to unite commerce and culture. Sir Albert also announced that the Senate of the University of London had recently agreed to establish a degree in commerce. In this respect it may be noted that the Senate is only following the lead of many other modern universities, notably Birmingham, Durham and Edinburgh.

Dr. FISHER thanked the deputation, referred to the various points raised, and said he thought clause 5 of the bill would cover the case of associations of classes less than districts as put to him by Sir Albert Rollit.

* * * *

Commercial Intelligence.

Lord Robert Cecil recently intimated to the Commercial Committee of the House of Commons that the Cabinet has now approved a new scheme for a commercial intelligence service.

On Tuesday Lord Robert Cecil attended on behalf of the Foreign Office a meeting of the Committee in order to give an explanation of the new Commercial Intelligence scheme. After a lengthy discussion it was unanimously resolved to thank Lord Robert Cecil for his attendance and for furnishing members with a copy of the scheme for constituting a new and more efficient commercial intelligence department in connection with the Foreign Office and the Board of Trade. In view of the many complicated questions involved and the short time available for their consideration, the Committee could not at the moment do more than express the view that the agreement arrived at seemed to make a considerable step forward in the direction desired by the industrial and commercial community; but in order to be in a position to express a more definite opinion at a later period the Committee authorised the Sub-Committee already appointed in reference to the proposal for a Ministry of Commerce, to deal with the matter, and to confer thereon with the Chambers of Commerce and the Federation of British Industries.

* * * *

Registration of Business Names.

It is announced that the office of the Registrar of Business Names, 39, Russell-square, W.C.1, will be open to the public for inspection of documents filed and for the issue of certified copies of or extracts from such documents from Sept. 1.

* * * *

Swedish Chemical Industry.

It is announced that steps have been taken to form a chemical industries bureau in Sweden for the purpose of assisting in the development and management of chemical industries in Sweden.

Trade Catalogues and Price Lists.

The Royal Commission on Paper has relaxed the paper restrictions and has made a concession in regard to the issue of catalogues.

It is now announced that tradesmen's catalogues and price lists and all classes of advertising circulars, with certain exceptions, may be issued and dispatched from now up to Jan. 31, 1918, to the extent of one-third of the weight of paper used for the catalogues and price lists and advertising circulars issued by tradesmen between Aug. 1, 1916, and Jan. 31, 1917. The expression "advertising circulars" includes any advertising sheet or periodical in the form of a newspaper or magazine, whether registered as a newspaper or not, which is distributed gratuitously and of which advertising is the main and not merely an ancillary purpose; diaries, almanacs and calendars issued gratuitously and containing advertising matter; but does not include circulars requesting the verification of information for books of reference.

* * * *

Employment Exchanges.

It is announced that a scheme is under consideration for the transference of the employment exchanges from the Ministry of Labour to the National Service Department.

Local machinery will be required for some of the branches of Sir A. Geddes' department, and the "Daily Chronicle" states that it is thought this could be supplied by the employment exchanges, and would obviate the expense of creating new local organisations. Objection is, however, offered to the proposal on the ground that the administration of the exchanges, in addition to recruiting, labour substitution and national service, would over-burden the department.

* * * *

Munitions Factory Valuation.

The Ministry of Munitions has announced that, in dealing with the question of values of plants, buildings and machinery erected or installed in controlled establishments for munitions work, the Board of Inland Revenue have made arrangements to retain the honorary services of the Valuation Advisory Committee of experts, formed by the late Mr. Howard Chatfeild Clarke and consisting of:—

Mr. Basil Mott, M.Inst.C.E., Capt. H. Riall Sankey, C.B., R.E., M.Inst.C.E., Lieut.-Col. C. L. Morgan, M.I.C.E., director of the London, Brighton & South Coast Railway Co.; Mr. Leslie R. Vigers, past president of the Surveyors' Institution; Mr. H. M. Jones, F.S.I., Receiver of Crown Lands; and Mr. George Head, F.S.I., past president of the Auctioneers' and Estate Agents' Institute.

* * * *

A Munitions Council.

Owing to the great increase in the staff and duties of the Ministry of Munitions a "Munitions Council" has been established in order to ensure closer organisation and the employment of more economical methods in the work of the Department.

The Council is composed of the Minister of Munitions, the two Parliamentary Secretaries to the Ministry and representatives of groups of departments. The following are the groups of Departments under members of Council:—

F. *Finance*	Sir Herbert Hambling.
D. *Design*	Maj.-Gen. Hon. F. R. Bingham, C.B.
S. *Steel and Iron*	John Hunter, Esq.
M. *Materials, &c.*	Sir Ernest Moir, Bart.
X. *Explosives*	Sir Keith Price.
P. *Projectiles, &c.*	Sir James Stevenson, Bart.
G. *Guns*	Sir Glynn West.
E. *Engines*	Sir Arthur Duckham, K.C.B.
A. *Allies*	Sir Frederick Black, K.C.B. (Temporarily, Sir Charles Ellis, K.C.B.)
L. *Labour*	Sir Stephenson Kent, K.C.B.
S. *Secretarial*	

* * * *

Trade Commissioners.

In connection with the scheme for the extension of the Trade Commissioner system in the self-governing Dominions and other parts of the British Empire, it is now proposed to make a few appointments of gentlemen to serve as Trade Commissioners. Applications should be addressed to the Secretary of the Civil Service Commission, London, W.1, and will be considered for submission to the Selection Committee by which recommendations for appointment will be made to the President of the Board of Trade after interviews held in London. The most important qualifications for the appointments are a good knowledge of import and export trade and commercial experience at home and abroad. Candidates should be under 50 years of age.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Finchley.—At the last meeting of the Council it was announced that additional plant was necessary at the electricity works. The estimated cost was £14,000, but as the Ministry of Munitions has refused to sanction the scheme a new one is being prepared.

Louth.—The General Purposes Committee is considering a communication regarding proposals for the erection of electricity supply works in the town immediately after the war.

Sheffield.—At the meeting last week the proposals for the erection of plant in the emergency power house at Blackburn Meadows were under consideration.

Ald. HOBSON moved that the minutes of the Electric Supply Committee, so far as they related to the proposed expenditure of £560,000, be referred back, so that it might be considered by the Consultative Committee or the Finance Emergency Committee. He did so, he said, so that they might be furnished with details of expenditure.

Ald. STYRING thought the members of the Council should bear in mind that there was at this time great danger in delaying contracts. They might get a tender to supply a certain article, and if they took too long in making up their minds whether they would have it or not the tender might be withdrawn and the price considerably increased. He would agree to the amendment if the words were added "with power to the Committee to authorise the work to be proceeded with."

Ald Hobson agreed and the amendment was agreed to.

Councillor GRAVES then proposed an amendment directing that the resolution of the Committee relating to the expenditure of the £560,000 be sent back to the Committee, with instructions to supply the Council with information upon which they advocate this expenditure at the present time. He was not satisfied that they were developing their undertaking on sound and satisfactory business principles. In his judgment, no case had been made out as to why this contract should be placed at present.

The LORD MAYOR intervened, and said the Council was committed to the purchase of machinery to that amount.

The minutes with the agreed amendment were then passed.

Tonbridge.—A loan of £18,000 for extensions of the electricity works will be advanced by the Treasury at 5½ per cent.

GENERAL.

Beverley.—The Council has authorised Messrs. Hodgson & Sons to lay an electric cable between their two factories.

Crickhowell.—The Rural Council has decided to grant Mr. H. O. Wenham an opportunity of putting before its members particulars of an electric supply scheme.

Llandudno.—The Electricity Committee reported to the Council last week that "they had written to various consulting electrical engineers asking for their terms for advising on the technical and financial aspect of the electricity undertaking of the Council in relation to the supply of current to the Light Railway Co.," and after consideration of the answers it was decided to appoint Mr. W. H. Patchell at the fee of 40 guineas, plus out-of-pocket expenses.

Mr. O. W. ROBERTS moved the omission of the words "in relation to the supply of current to the Light Railway Co.," contending that the engineer should be instructed to report upon the undertaking generally. A greater loss was shown on the current for lighting than for traction. In 1915-16 the Colwyn Bay undertaking, on 338,000 units generated, made a profit of £181 after paying the whole of the expenses, although their expenditure was only £450 less than that of Llandudno in respect of interest on loans. In the same year the Llandudno undertaking generated 1,116,780 units, which brought in an income of £11,457, and upon that there was a loss of £1,300.

The Council decided to ask Mr. Patchell to report on the economical working of the undertaking generally.

London Electricity Supply.—At a conference recently held between the Electric Supply Committee of the London County Council and representatives of the City Corporation, Metropolitan Borough Councils and the London electric supply companies upon the question of the electricity supply in London, the followng resolutions were passed:—

(1) That, in the opinion of this conference, it is desirable that, before formulating a scheme for the electricity supply of London, the L.C.C. should consult the Metropolitan Borough Councils owning electric undertakings, the Metropolitan Borough Councils not owning electric undertakings, the City Corporation and the London Electric Supply Companies.

(2) That, in the opinion of the Conference, it is desirable that Metropolitan Borough Councils owning electricity undertakings, Metropolitan Borough Councils not owning electricity undertakings and the various companies should appoint a committee or committees to confer with the Electricity Committee of the County Council.

Mytholmroyd.—Some time ago the Council refused to assent to the application of the Electrical Distribution of Yorkshire (Ltd.) to an intending application for a provisional order authorising them to supply electricity in the district, and the Council subsequently made arrangements with Halifax Corporation to provide a supply.

Members of the Council, however, expressed surprise at the meeting last week when the Yorkshire Electric Power Co. informed the Council that Halifax Corporation had applied to them for a supply of electricity to Mytholmroyd consumers, and that they had agreed to provide it. It was further stated that but for the war the main would by now have been extended to Mytholmroyd.

The Council felt they could do nothing more, the chairman remarking that they had a veto on the minutes.

Newcastle (co. Down).—The Council have entered into an agreement with the local electricity supply company for the supply of electricity for public and private lighting.

Reigate.—The chairman of the Electric Lighting Committee (Mr. Priest) informed the Council last week that a crank shaft of one of the Diesel engines had broken.

At the request of Mr. A. H. Dykes, consulting engineer, of the firm of Messrs. Handcock, Dykes & Trotter, they dismantled the engine and ascertained the cause of the breakage. Mr. Dykes assured them there was no flaw or defect. He also suggested that the other engine should be dismantled, and they proposed to do so. There was no possible chance of getting delivery of another crank shaft for 12 or 18 months. Therefore more steam power would be necessary. The accident was a serious matter, as it would run them into an extra expense of about £800 a year.

Ruthin.—The local Electric Supply Co. claim £179 from the Council for loss sustained by reason of the restricted lighting, and counsel's opinion is to be obtained by the Council.

Sunderland.—Last week the Electricity & Lighting Committee recommended the Corporation to accede to the application of the Board of Trade (Coal Mines Department) for the partial use of the general manager's services temporarily in connection with the economy of coal consumption scheme.

Ald. BRUCE said that the Board of Trade wanted the services of Mr. A. Blackman, the manager, so that he could perform national service in conferring with local authorities on what steps might advantageously be taken to conserve the use of coal. The matter was unquestionably one of national importance and that was the reason of the committee's recommendation. There was no salary attached to the duties Mr. Blackman was to perform for the Government, and it was estimated that those duties would require Mr. Blackman's services at most for three days per week for a period not exceeding two months and for one day per week for a further month or so.

Ald. J. H. TURNBULL, who moved that the recommendation be struck out, said "we have half a million of money involved in the Electricity and Lighting undertaking, and we want all the skill we can get to bring it to success."

After discussion the amendment was carried by 21 votes to 15, but with this exception the report was agreed to.

LIGHTING AND INDUSTRIAL POWER.

Electricity in Dockyards.—The new dry dock for the U.S.A. Navy Department at Norfolk (Va.) will be 1,000 ft. long, 110 ft. deep, and with 43½ ft. of water on the sills.

Besides the two seats for the caisson to close the entrance, seats are provided for an intermediate caisson, so that smaller vessels can be handled in one section of the dock. "The Engineer" states that the intermediate caisson divides the dock into two sections 650 ft. and 350 ft. long. The only present vessels larger than 650 ft. are the battle-cruisers, so that most of the large ships can be handled in the longer portion of the dock, while the other portion can be used for smaller craft. All caissons are alike and have no valves for flooding the dock. Their only equipment is for flooding and pumping out the caisson itself. This is electrically operated, and can pump out the water in 15 minutes. The pumping plant for the dock is in separate units, to prevent complete disablement. Around the dock will travel a 50-ton electric crane and having a horizontal jib reaching far enough to serve the floor of the dock. There will also be electric capstans to handle two lines, and the use of electric towing locomotives—as at the Panama Canal—has been proposed.

Electricity in Indian Collieries.—The "Colliery Guardian" reports that the collieries of India, and especially those in Bengal, have during the past few years been gradually adopting electric power in place of steam. Companies owning a number of collieries have recently effected an economy by installing units at a central station and distributing electricity to the various collieries. Coal-cutting machines have not made much headway, but there are several in use, chiefly of the "hammer" type, worked by compressed air.

Electricity in Mining.—In the recent report of the Halkyn District Mines Drainage Co. it is stated that a pumping scheme had been under the consideration by the Drainage Board—viz., to instal an electric power station at North Hendre, provide (at an estimated cost of £30,000) pumps to unwater the North Hendre, South Halkyn and Llynypandy mines to such a depth that lead can be gotten in large quantities at an estimated cost of £30,000. The Board were

Digitized by Google

of opinion that it would place the mines in the area in a position to produce lead in large quantities. The scheme was submitted to the Controller and received his approval. An application to provide the money to carry out the scheme in order to meet national requirements was acceded to on favourable terms, and on the authority of the Controller the preliminary work was put in hand at once.

Electricity Supply in Germany.—The "Frankürter Zeitung" recently announced that regulations are about to be issued restricting the consumption of electricity in all parts of Germany and consumers are advised to consider at once what economies they can effect. Great efforts are being made to reduce the industrial consumption of coal, with a view especially to reducing the waste which is found to be caused by unskilled labour.

Fuel Economy in the United States.—In a recent report by Mr. V. H. Manning, director of the Bureau, it is stated that fully $500,000,000 was wasted last year in the United States through the inefficient use of coal. and the waste was continuing at an even greater rate and constituted a much larger penalty upon the country because of the increase in the price of coal.

Mr. Manning states that last year the United States mined 600,000,000 tons of coal, the greatest production ever witnessed in the world, and of that amount 150,000,000 tons (or 25 per cent.) were wasted through inefficient use. In the modern efficient power plants of the country 20 per cent. of the heat in the coal consumed was converted into power, but in the small power stations the efficiency frequently dropped below 10 per cent. Although the average efficiency of all kinds of steam-power plants in the United States could be only a matter of guess-work, it was quite probable that the average was somewhere in the neighbourhood of 5 or 6 per cent. of the energy of the coal transformed into useful energy ready for distribution. If it were possible to elevate the average efficiency to something near the maximum now attainable in steam plants about three times as much energy would be available for the productive industries of the country.

Power Station in South Yorkshire.—Mr. Chas. Markham, of Chesterfield, is a strong advocate of a scheme for the erection of a large power station close to the South Yorkshire coalfield after the war.

Mr. Markham thinks a great saving can be effected if the coal used for generating electricity were obtained on the spot. A good water supply is assured at the Bullcroft Main Colliery. The scheme is put forward in connection with the proposal to form a joint board for sewage, water, gas and electricity for Sheffield, Rotherham and Chesterfield. The result of the recommendations of the representatives at the recent joint meeting to their respective authorities is, therefore, awaited with much interest. It is expected that there will be a great demand for cheap electrical power when peace comes again. Even now in Sheffield and the other industrial centres concerned the adoption of electricity is making rapid progress.

ELECTRIC TRACTION.

Bath.—The electrical engineer (Mr. F. Teague) recently reported to the Electric Lighting Committee that he considered it necessary to obtain a motor-lorry for the use of the department for taking away clinker and bringing coal from the colliery to the works.

The cost of a new vehicle of a suitable type is put at £800. Mr. Teague has been instructed to make inquiries with a view to the purchase of a lorry, and to report on the matter to the chairman. Councillors G. J. Long and Sims, owing to the urgency of the matter, have been authorised to take the necessary steps to procure a suitable motor-lorry.

Belfast.—The revenue of the municipal tramways for the four months ended June 30 was £108,204, compared with £100,287 for the corresponding four months of 1916, but the additional expenditure wiped out the increase in revenue, and left a deficit after allowing for all fixed charges of £1,981.

Bolton.—The Tramways Committee has referred an application from the Lancashire District Council of Tramway Workers for an advance of 7s. 6d. per week for all the members 18 years of age and over (including motormen, conductors, inspectors, and general staff) to the Committee on Production for decision.

Dover Tramcar Accident.—A rather bad tramcar accident occurred on Sunday la t.

A tramcar was on a journey from Dover to River, and when descending from Crabble Hill to the Lower River-road it got out of control. At the bottom of the hill the car left the rails, dashed into a wall and fell over on its side. Ten persons were killed and about 35 persons were injured, some rather seriously. One of the injured has since succumbed, and an inquest on the victims was opened on Tuesday.

Dunfermline-Rosyth Tramway.—It is announced that the construction of the tramway line between Dunfermline and Rosyth will be begun in the immediate future.

The First Lord of the Admiralty has fixed a time limit for the construction of the line which leaves no room for delay. A conference was held in Edinburgh on Friday between representatives of the Admiralty, the L.G. Board and the Town Council, and as a result of it a financial arrangement was practically settled between the Dunfermline & District Tramways Co. and the Admiralty whereby the necessary capital will be forthcoming for the undertaking. It is expected that the widening of the road and the alteration of its gradient to Pitreavie, for a distance of two miles, will be proceeded with simultaneously with the construction of the line. The cost to Dunfermline of remaking the road is estimated at £15,000.

Isle of Thanet Tramways.—Great difficulty is being experienced by the Isle of Thanet Electric Tramways Co. in providing a tramway service owing to the number of men called up for active service.

At the local Tribunal last week the manager said that if any more of the men were taken and substitutes were not found it would be impossible to continue the service. The Tribunal, however, decided to withdraw the certificates of eight more of the men, but allowed time in each case, and the manager was told that it was his duty, not that of the military, to find substitutes.

Portsmouth.—The salary of the general manager of the tramways, Mr. W. R. Spaven, has been increased from £500 to £550 per annum, with a further increase of £50 in 12 months' time; and the salary of the resident electrical engineer, Mr. V. G. Lironi, has been increased from £400 to £550, with an increase of £50 in 12 months.

Rothesay.—A special meeting of the Council in committee will be held on Sept. 3 in order to consider a communication from the Rothesay Tramway Co. asking for powers to give a service of cars on Sundays, to make the minimum charge 2d., and to reconsider the annual payment for the upkeep of the roadway.

TELEGRAPHY AND TELEPHONY.

Morse Code and Submarine Cables.—Mr. Wm. M. Bruce, president of the United Telegraph Cable Co., Springfield, Ohio, recently announced that he had practically completed an arrangement by which the Morse code could be employed on trans-oceanic cables. A contract has been concluded with the Commercial Pacific Cable Co. for the equipment of the San Francisco–Shanghai cable. Mr. Bruce's patents include a method for the use of the Morse manipulator and sounder on submarine cables and also for a relay which can be used, not only for the Morse, but also for the Recorder signals. It is stated that experiments with the apparatus have proved very satisfactory.

Telephone Directory.—In the House of Commons on Monday the Assistant Postmaster-General, Mr. Pike-Pease, announced that it had been decided to postpone the issue of the new edition of the Telephone Directory until January next. In future the Directory will be issued at intervals of nine months instead of six months as heretofore.

The Telephone in Spain.—It is stated that a scheme has been prepared by the Director-General of Communications for the reform of the national telephone system.

The scheme proposes to establish telephone offices in the greater number of town and rural communities hitherto unprovided with services, which now only exist in 108 of the principal cities and towns. To carry out this project, it is proposed to impose on the provincial deputations the obligation to contribute up to 20 per cent. of the cost of their respective networks, and to call into being a National Telephone Institution with power to raise 60,000,000 pesetas, the estimated amount which the 40 provincial networks would cost, including the purchase of existing private rural lines.

IMPERIAL NOTES.

British Columbia.—The general manager of the British Columbia Electric Railway Co., Mr. Geo. Kidd, has intimated that the company is willing to dispose of the entirety of its undertakings (electricity supply and tramways) in the province, provided satisfactory terms can be secured.

The "Electrical News" reports that the company's holdings on the lower mainland are valued at approximately $30,000,000; but the company is prepared to accept $25,000,000 in bonds bearing interest at 5 per cent. and the remaining $5,000,000 without interest for five years.

Canadian Manganese.—It is announced that practically inexhaustible deposits of manganese dioxide have been found in the Cypress Hills, in South-East Alberta. About 800,000 tons of the value of £11,000,000, have been blocked out by ordinary post hole augurs in the last few months. The manganese lies at the top of the ground, and the deposits are very easily and cheaply worked. The staff of the Department of Mining of the University of Toronto have discovered a process by which low-grade concentrates of molybdenite can be made at little cost. Quebec is a larger producer, and the new process will render available the deposits of low-grade molybdenum ore which have been discovered in Manitoba and British Columbia.

India.—At a recent meeting Bandra Municipal Council resolved that the Government electrician, Bombay, be requested to prepare a detailed scheme and estimate, and that the municipality of Bandra be prepared to pay not more than Rs.500 towards a scheme for public and private electric lighting in Bandra.

Digitized by Google

FOREIGN NOTES.

Italy.—The following hints to British manufacturers are abstracted from the report for 1916 of the British Chamber of Commerce at Nice :—

Many German goods are simply cheap imitations of British manufactures. When British labour is fully occupied it would be undesirable to divert it from making high-grade goods (for which there is a good demand) i order to turn out low-grade goods in which competition is severe. Nevertheless, colonial and foreign buyers often find German articles more convenient if not of better value. In many cases British goods are better by much more than the difference in price, but where it is impossible to cheapen production the buyer should be stimulated by a more active advertising policy, and by other methods. The primary need is however, to supply goods so that they can be disposed of with a minimum of trouble. Another point of great importance is that few manufacturers do their own shipping. If they are working on too small a scale to do their own shipping at rock-bottom cost, they should utilise the services of merchants or adopt some co-operative method which will enable them to share in a single efficient and economical selling organisation.

Niagara Falls Diversion.—On June 30 President Wilson signed the Bill permiting the present maximum diversion of 20,000 cubic ft. of water per second on the United States side of Niagara Falls. But for the Bill 50,000 H.P. would have been cut off, and up to the present only 19,000 cubic ft. have been used.

Russia.—The Canadian Trade Commissioner at Omsk states that the Russian Department of Trade and Industry has drawn up a plan whereby Chambers of Commerce are to be established in the leading trade centres of the country.

The Siberian towns of Omsk, Novo-Nicolaievsk, Irkutsk and Vladivostock are to be included in this plan. The object of the Chambers will be to bring together persons in the district concerned interested in the promotion of trade and industry, to establish institutions useful for the purposes of trade and industry and keep a register of trade and industrial enterprises in their district. It is not proposed that the newly-created Chambers should replace the existing exchange committees. The chambers of commerce will be under the supervision of the Ministry of Trade and Industry, and will co-operate with the Government. Periodical provincial and national assemblies of representatives of the various chambers will be held, subjects of Allied and neutral countries may become members of the chambers, provided they have lived in Russia for over five years.

EDUCATIONAL.

University of Edinburgh.—The next session opens on Oct. 9. The preliminary or entrance examination is held in September. There are complete courses of instruction in civil, mechanical and electrical engineering, qualifying for the degree of S.Sc. in engineering, and extending over three years. Particulars of examinations, scholarships, &c., from the Matriculation Office, the University, Edinburgh.

University of Birmingham.—There are full courses in mechanical, civil and electrical engineering. The full courses extend over four years, and students who e ter after matriculation and pass successfully the examinations at the end of each year will be entitled to the degree of B.Sc. in engineering. The session 1917-1918 commences on Oct. 2, 1917. Detailed syllabus can be obtained from the Secretary.

University of Bristol.—We have received a copy of the prospectus of the Merchant Venturers' Technical College, which provides and maintains the faculty of engineering, from which we note that the courses include schemes of study for persons intending to engage in civil, mechanical, or electrical engineering. The department of automobile engineering has been closed for the duration of war, as the professor of that department is doing important work in connection with munitions. The session for the day classes begins on Sept. 18.

Armstrong College, Newcastle-on-Tyne.—The session 1917-18 will commence on Sept. 24. Full courses leading to the degree of B.Sc. in engineering are provided in mechanical, marine, civil and electrical engineering, naval architecture, mining and metallurgy, &c. Particulars can be obtained from the secretary, Mr. F. H. Pruen, M.A.

Finsbury Technical College.—The programme of the City & Guilds Technical College, Finsbury, for the 1917-18 Session has been issued, but it is notified that it is subject to such revision as circumstances may require.

The present courses of instruction are in mechanical, electrical and civil engineering and applied chemistry. In engineering the courses last two years, with an optional third year. There are day and evening courses, and in the day classes the instruction and practical work are arranged with the object of providing a training on broad practical and scientific principles. Particulars may be obtained from the Dean, Leonard-street, London, E.C.2.

Manual Training in Schools.—At the Education Conference at the Bedford College on the 16th inst. Sir William Mather, who presided at one of the meetings, said unless we had confidence in our elementary school system there would be poor chance of continuation schools repaying the country for their cost.

In his workshops, where boys were employed, Sir William said, day schools had been established at which attendance was reckoned as part of the week's work, with the result that the dullest boys were quickened and brightened up to the general level. That was the effect of manual training on boys of 14, and if there were something of the kind in every elementary school—training in some kind of work—the necessity for continuation schools would be less than it was. He hoped the leaving age would be raised to 16, and if manual training were given during the two years the boy would be better fitted to use the capacity he possessed.

Salaries of Teachers in Secondary and Technical Schools.—The President of the Board of Education (Mr. Fisher) has appointed a Departmental Committee to inquire into the principles which should determine the fixing of salaries for teachers in secondary and technical schools, of art training colleges and other institutions for higher education other than university institutions.

The members of the committee are Sir H. L. Stephen (chairman), Mr. P. W. H. Abbott, Miss M. M. Allan, Miss C. R. Ash, Miss S. L. Beszant, Dr. H. B. Brackenbury, Mr. W. R. Davies, Mr. G. D. Dunkerley, Mr. B. J. Fletcher, Mr. D. B. Harris, Mr. C. S. Jones, Mr. A. J. Mundella, Lieut.-Col. H. A. Powell, Mr. W. Reynolds, Mr. F. Roscoe, Mr. P. Sharp, Dr. H. S. Snape, Miss A. T. Steele, Mr. E. Talbot and Miss K. Wallas, with Mr. W. E. Urwick (H.M. Inspector) as secretary, to whom all communications should be addressed, at the Office of the Board of Education, Victoria and Albert Museum, Exhibition-road, S. Kensington, S.W.

In view of the appointment of the above-mentioned committee it may be of interest to know that the undermentioned minimum scales of salaries for technical teachers have been recently adopted by the Association of Teachers in Technical Institutions :—

A. FUNDAMENTAL PRINCIPLES.—In fixing salary scales for technical teachers regard must be paid to the following :—

1. The initial salary must be sufficiently large to attract men and women who are possessed of high qualifications and should be at least equal to those commonly paid in other professions which require a similar standard of intellectual capacity and outlay of time and capital in the period of training.

2. The prospects of future salaries should be sufficiently good to offer attractive careers to men and women of ability and scientific training In this connection the competition of industries for scientifically trained men must be borne in mind.

3. It should be reasonably possible for a properly qualified technical teacher to attain a salary of at least £300 per annum when he has reached the age of 30.

B. SALARIES FOR FULL-TIME TEACHERS.—There is considerable difficulty in laying down scales which will apply in all cases, since the size and nature of the institutions vary so greatly. This is especially so in the case of heads of departments, since the size of the department, the responsibility and nature of the work are subject to wide variations. The following must be regarded as approximate minimum scales for teachers possessing qualifications approximating in standard to a university training or technical qualifications of an admittedly good standard :—

1. *Qualified Assistants.*—£200 to £300 by annual increments of £15 per annum. Then rising to £450 by increments of £20. In cases where assistants have special qualification or responsibilities higher salaries should be paid.

2. *Heads of Departments.*—Initial salary £350 to £500 according to work and responsibility, rising by annual increments of at least £25 to a maximum of £500-£750.

C. PART-TIME TEACHERS.—The following salaries are sessional fees, and refer to a period of two hours per week for a session of about 30 weeks :—

1. Teachers in charge of a subject, £30 as a minimum, rising to a maximum dependent on the experience and standing of the teacher.

2. Assistant teachers, in charge of a class, but working under the supervision of another teacher, £20 rising to £30.

In the opinion of the council of the association adequate scales of salaries for technical teachers should be approved by the Board of Education and their adoption by local authorities should be a necessary condition for receiving grants. A substantial part of the payment of such salaries should be borne by the Board of Education, whose grants should be increased for that purpose.

MISCELLANEOUS.

Fatality.—A labourer named Joseph Taylor, who was engaged in emptying water which had collected in a "sump" in the power house at Messrs. Rylands' works, Warrington, accidentally touched a part of the switchboard and received a fatal shock last week.

Import Restrictions.—CORRECTION.—The "Board of Trade Journal" of July 26 announced that the general licence permitting the importation of electric lamp holders (brass or ebonite), with or without switch-key, had been revoked, but consignments of such goods which could be shown to have been in transit direct to the importers before Aug. 1 would be admitted under former general licence. The note in our issue of Aug. 3 (p. 713) stated, erroneously, that the restriction upon the importation of such goods had been removed.

Digitized by Google

Insurance Employment.—The Umpire has decided that contributions are payable in respect of the following :—

Students at technical institutes receiving training under arrangements made by the Ministry of Munitions.

Workmen engaged wholly or mainly in the manufacture of accumulator cell boxes or of lead linings for such boxes.

Workmen engaged in making wrought or welded iron pipes for use as telegraph poles.

Workmen who are engaged wholly or mainly in making and fitting together wrought-iron parts of small forges for heating rivets.

Contributions are not payable in respect of :—

Workmen engaged wholly or mainly in wolfram streaming.

Switchboard attendants and workmen engaged wholly or mainly in minding, tending or driving electrical machinery in connection with uninsured trades.

Joiners engaged wholly or mainly in making by hand wooden drums for electric cables.

Workmen engaged wholly or mainly in making vulcanised fibre parts of electric light fittings which are not intended for use in war.

Trading with the Enemy.—The "London Gazette" of Aug. 17 contains further additions to the list of firms and persons with whom trading by firms and persons in the United Kingdom is prohibited.

These include : *Spain.*—Sociedad Espanola de Aparatos Electricos (Pasages, Guipuzcoa) *Sweden.*—A. Ekström's Maskinaffär A. B. (St. Vattugatan 10, Stockholm).

The Controller of the Foreign Trade Department has issued a revised list of additions to the statutory list of firms of enemy nationality, or enemy association, with whom persons in the United Kingdom are forbidden to trade, copies of which can be obtained from the Superintendent of Publications, H.M. Stationery Office, Imperial House, Kingsway, W.C.

Tribunal Case.—At the Frome Tribunal last week two appeals were made by the Frome Electricity Works for temporary exemption. Both were single men who had been passed for general service and were 22 years of age. The military representative suggested the Tribunal should deal with the cases, and then leave it to the company to make application to the munition areas recruiting officer for temporary exemption certificates. Both men were willing to go, but in view of the shortage of qualified men and the demands for power, the company felt they could not release them until suitable substitutes were provided. A month definite was granted in each case.

Wills.—The late Mr. John H. Tucker (of Messrs. J. H. Tucker & Co., electrical fittings manufacturers, Birmingham) left property of the gross value of £230,760, and £161,552 net personalty.

The late Mr. Geo. J. Harford, electrical engineer, of Birkdale, left estate worth £2,668 gross, with net personalty of £2,412.

TENDERS INVITED AND ACCEPTED.

Tramway Stores.

PORTSMOUTH Tramways Committee require tenders by Aug. 28 for six months' supply of Stores and Materials, including Tyres, Car Repair Stores, Insulating Materials, Lamps, Motor Windings, Overhead Line Materials, &c. Specification, &c., from the Engineer, Vivash-road, Fratton, Portsmouth.

Rotary Converter.

BERMONDSEY (London) Borough Council invite tenders for a 500 kw. rotary converter. Specifications from the borough electrical engineer, and tenders by noon Sept. 7 to the town clerk, Town Hall, Bermondsey, S.E.

Coal Bunker.

BOOTLE Corporation invite designs and tenders for erection of an Overhead Coal Bunker at Marsh-lane generating station (for at least 400 tons of coal). Particulars from the Borough Engineer. Tenders to the Town Clerk by noon Sept. 12.

Cable, Feeder Pillars, &c.

KETTERING Urban Council require tenders by noon Aug. 28 for the supply and laying in stoneware troughing of 754 yds. 0.6 sq. in. Concentric Lead-covered Paper Cable (600 volts), with Three-core Pilot, Cable, Feeder Pillar, Dividing Boxes and Switchboard Instruments. Specification, &c., from Engineer, electricity works, Kettering.

Electrical Accessories.

The COMMISSIONERS OF H.M. WORKS, &c., require tenders by 11 a.m. Aug. 24 for six or 12 months' supply of Electrical Accessories. Forms of tender, &c., from the Controller of Supplies, King Charles-street, Westminster, S.W. 1.

BATH.—The Electric Lighting Committee has placed an order for a hand-operated transporter with Messrs. Morris (Ltd.) at £95. 7s. 6d.

Transformer Contracts.—Messrs. Ferranti Limited, Hollinwood and Central House, Kingsway, W.C., have secured the following orders :—

Rotherham Corporation, four single-phase transformers, 2,085 k.v.a. each ; Manchester Corporation, annual contract for transformers, 250, 500 and 1,000 k.v.a. sizes ; Salford Corporation, one three-phase 250 k.v.a. transformer.

APPOINTMENTS VACANT AND FILLED.

An assistant constructional engineer is required by the City of Birmingham Electric Supply Department. Forms of application, which may be obtained from the secretary of the department, 14, Dale-end, Birmingham, should be sent to the city electrical engineer (Mr. R. A. Chattock) by Aug. 25.

A temporary lecturer in engineering is required for the University College of South Wales and Monmouthshire, Cardiff. Salary £200 per annum. Particulars from the Registrar.

An assistant master to teach applied mechanics and machine drawing (salary £160, rising to £200 per annum), and a metal workshop instructor (commencing salary £160) are required by Leyton Higher Education Committee for their engineering and trade school. Forms of application from the Clerk to the Governors, Town Hall, Leyton, to whom applications by Aug. 24.

A shift engineer is required for the W. D. Power Station, Upton Lovell, Wilts. Wages 50s. per week. Applications to Station Engineer, Power Station, Upton Lovell, Wilts.

An electrician is wanted at once for a country mansion. Applications to Mr. E. S. Sturdy, Harewood, near Leeds.

Mr. F. H. Rudd, acting electrical engineer at Rochdale electricity works, has been appointed borough electrical engineer, at a commencing salary of £400 per year.

BUSINESS ITEMS.

Owing to the offices of the British Electric Traction Co. (Ltd.) and the British Electrical Federation (Ltd.), with the affiliated companies, having been requisitioned by the Government, the temporary address of the companies will in future be Manchester Hotel, Aldersgate-street, London, E.C. 1.

Plant for Sale.—Oldham Corporation Electricity Committee advertise for sale two Willans-Siemens 740 kw. sets. Particulars from Mr. F. L. Ogden, joint engineer and manager, Electricity Works, Greenhill, O'dham.

BANKRUPTCY.

A first and final dividend of 2s. 2½d. will be payable on Aug. 27 at the O. R.'s, Byrom-street, Manchester, to creditors of Chas. Benjamin Orlvie, electrical engineer, 43, Dudley-road, Whalley Range, Manchester.

CATALOGUES, &c.

SWITCHGEAR.—Messrs. George Ellison, of Perry Barr, Birmingham, have recently issued lists Nos. 151 and 304.

The former deals with totally enclosed industrial unit type switchgear for continuous and alternating-current circuits up to 1,000 kw. at 750 volts for use in factories and mines. Each panel is a self-contained unit, and a switchboard comprising any reasonable number of units can be readily assembled on site. The panels are built up from standard switches, &c., on strong iron frames designed to withstand the rough wear and tear of large works. The list, which cancels prior publications, gives standard connections, dimensions, weights, prices, &c.

List 304 is devoted to quick make-and-break switches which are operated by a tappet on a crane, hoist, &c. The switches are made in two sizes ; No. 1 is suitable for small currents and No. 2 for heavier duties. The larger switch can also be made for hand operation as an ordinary circuit interrupter. The switch contacts are closed by a copper roller, which is made to swivel ; thus the contacts remain cool and pitting is reduced. A special double toggle mechanism ensures the switch being positively open or closed. Diagrams, dimensions, prices, &c., are included.

TRACK GRINDING.—The subject of track grinding is one which is occupying the minds of many tramway managers at the present time, and consequently they will be interested in the pamphlet recently issued by Mr. Fred. J. Down, 90, Fenchurch-street, London, E.C., giving particulars about the reciprocating track grinder for which he is agent in this country.

It is claimed that reciprocating track grinders are simpler than machines of the rotary type and that the mechanism is sufficiently light in weight to permit of operation during daylight hours without interference with ordinary car schedules. The abrasive used is in the form of a block and is made in various grades of hardness to accommodate the various types of rails. The machine has been in use for more than nine years, and it is said to have proved satisfactory and efficient for all classes of track grinding, including removal of corrugations, surfacing new or defective joints and special work in connection with welded joints. The machine is driven by a 3½ H.P. motor and is supplied with current from the track circuit. Illustrations in the pamphlet show the method of operating the machine and the purposes for which it can be used.

ENGINEERS' STORES.—Messrs. Sterns (Ltd.), Finsbury-square, E.C. 2, have issued a leaflet giving particulars of palagrip bricks for balata belts and of Excelsior sternoline for use in screw and automatic lubricators. Packages of either are sent on approval.

Digitized by Google

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Bexhill.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £82,024 (increase £409), of which £42,612 is outstanding.

Revenue was £11,745 (compared with £11,353 in previous year) and total working cost was £6,551 (£6,674), leaving gross profit £5,194 (£4,679). Interest and repayment of capital required £5,413 (£5,422) and depreciation £64 (£139), the net result being a deficit of £284 (£973). Average revenue per unit sold was 3·13d. (3·22d.), working cost was 3·13d. (3·22d.), and interest and repayment required 2·5d. (2·5d.). Total connections are equal to 66,221 (63,632) 35-watt lamps. Total maximum demand was 396 kw. (422 kw.). Units generated were 677,983 (665,338) and sold 501,961 (496,795). Average cost of coal was 28s. 1d. (23s. 7d.) per ton, but working costs were reduced 0·09d. per unit sold.

Greenock.—The accounts of the electricity department for the year ended June 30 show total capital expenditure £439,242 (increase £49,216), of which £318,426 is outstanding.

Revenue was £96,843 and total expenditure was £54,781, leaving gross profit £42,062. Repayment of loans and interest and commission on loans required £25,549, income and property tax £676 and depreciation £3,005, leaving credit balance for the year of £10,831, and a total credit balance of £33,419. Total maximum supply demanded was 7,783 kw. (compared with 7,480 kw. in previous year). Units generated were 25,576,509 (compared with 23,235,816) and sold 21,149,458 (19,001,464).

Heston and Isleworth.—The accounts of the electricity department for the year ended March 31 show gross capital outlay £79,426 (increase £474), of which £53,698 is outstanding.

Revenue was £12,015 (compared with £11,246 in previous year), working and general expenses were £7,100 (£7,031), and capital charges £4,922 (£4,927), the net deficit being £7 (£712). Units generated were 1,608,588 (1,564,473) and sold 1,216,822 (1,288,371). Total costs per unit were 1d., or 1·74d. including capital charges, and average price obtained was 2·37d. (2·02d.). Total maximum demand was 710 kw. (681 kw.), and load factor 20 (21·5) per cent.

The engineer and manager (Mr. P. E. Rycroft) says in his report the total increase in revenue from power and lighting consumers was £1,253, and but for the advance in price of 12½ per cent. (which was in operation for three-quarters of the year) the net deficit would have been £952.

King's Lynn.—At March 31 the gross capital expenditure of the electricity department was £57,804, of which £18,182 is outstanding.

Income was £8,759, and total expenditure £5,727, leaving gross profit £3,031 (compared with £3,868 in previous year). Interest required £708 (£820) and repayment of capital £2,017 (as in previous year), and the net profit was £290 (£1,018), of which £200 is to be applied to reduction of capital account. Fuel cost 1·08d. (0·73d.) per unit, total costs were 2·25d. (1·82d.), or 3·61d. (3·19d.), including maintenance of public lamps, capital charges and war allowances. Average price obtained was 2·96d. (2·75d.). Total maximum demand was 311 kw. (396 kw.) and load factor 18·65 (16·93) per cent. Units generated were 552,782 (572,333) and sold 507,724 (529,610).

Southampton.—The accounts of the tramways department for the year ended March 31 show gross capital expenditure £261,888 (increase £988), of which £137,328 is outstanding.

Income was £88,183 (compared with £79,828 in previous year), and after providing for working expenses and war service allowances, the gross profit was £27,177 (£26,854). Interest, &c., required £10,508 (£9,123), and redemption and sinking fund charges £7,399 (£7,614). £5,218 (£4,460) has been placed to depreciation and renewals fund, and £3,000 (£5,000) contributed in aid of rates. Average income per car-mile was 11·67d. (11·71d.) and gross profit was 3·59d. (3·94d.). Passengers carried were 17,718,810 (15,494,366) and car-miles run 1,813,547 (1,636,103).

Mr. W. T. Robson, manager and engineer, says in his report all the conductors except 10 are women, and four women car washers are employed. In July, 1916, an Edison accumulator tipping wagon was purchased, and it has realised the most favourable anticipations, the amount spent on maintenance being quite negligible. The tower wagon of the same type also gives satisfaction. The charging plant necessary for these vehicles has enabled the department to adopt electric welding. Repairs by this means are carried out exceedingly quickly, and such a plant is a great acquisition to the undertaking. Mr. Robson is confident that there will be no need to increase fares.

West Bromwich.—The income of the electric supply department for the year ended March 31 was £52,047, compared with £24,173 in the previous year.

The expenditure was £29,458, an increase of £8,403; gross profit was £2,589, a decrease of £528. Loan charges amounted to £7,285, so that the net loss was £4,696. The balance remaining in the reserve fund is £2,162.

The scale of charges has been increased during the year, but as these have not been sufficient to meet the additional cost of generation and distribution the Council has further increased the price of electricity both for lighting and power.

York.—The accounts of the electricity department for the year ended March 31 show capital expenditure £211,383 (increase £495), of which £124,180 is outstanding.

Revenue was £41,736 (compared with £37,860 in previous year) and working and special expenses were £24,062 (£21,300), leaving gross profit £17,674 (£16,559). Interest required £5,046 (£6,615), sinking fund £9,851 (£8,070) and tax on profits £836 (£418), leaving net profit £1,441 (£1,456), which has been placed to reserve. Total maximum demand was 3,660 kw. (3,487 kw.). Units generated were 11,354,970 (11,044,629) and sold 9,754,254 (9,364,009)

The accounts of the tramways department show capital expenditure £201,688 (increase £6,796), of which £11,445 has been repaid. Revenue (including motor omnibuses) was £40,197 (£35,735) and working and special expenditure was £30,938 (£24,532), leaving gross profit £9,258 (£11,202), plus £100 interest on sinking fund. Interest required £5,893 (£6,138) and sinking fund £4,160 (£3,272), and the net deficit for the year was £694 (compared with a surplus of £1,792 last year.)

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

ARGILLA ALUMINIUM CO. (LTD.) (148,228.)—Private company. Reg. Aug. 15, capital £7,500 in 5s. shares. Manufacturers of aluminium and other metals, &c. Agreement with R. D. Mackintosh, M.B.E. Permanent directors, R. D. Mackintosh and P. Evans. Reg. office, 92, Victoria-street, S.W.

A. CHASE & CO. (LTD.) (148,214.)—Private company, reg. Aug. 14, capital £3,000 in £1 shares; electrical and general engineers, &c. Agreement with A. M. Cole and A. R. Cole. First directors are:—A. M. Cole, A. R. Cole and T. B. Hill. Reg. office: 97, High-street, Teddington.

CHEMICAL ENGINEERING CORPN. (LTD.) (148,216.)—Private company, reg. Aug. 14, capital £5,000 in 20,000 management shares of 1s each and 4,000 ordinary shares of £1 each; contractors, chemical, mechanical, electrical, constructional and general engineers, &c.

CHEMICAL ENGINEERING & WILTONS PATENT FURNACE CO. (LTD.) (148,912.)—Private company. Reg. Aug. 13, capital £20,000 in £1 shares, to take over the business formerly carried on at Hendon as the Chemical Engineering Co. and Wilton's Patent Furnace Co., also to carry on the business of electrical engineers, &c. Agreement with N. Wilton and T. O. Wilton. First directors are N. Wilton and T. O. Wilton. Reg. office, Hendon, N.W. 4.

GRIMSBY ELECTRIC VEHICLE CO. (LTD.) (148,210).—Private company, reg. Aug. 11, capital £5,000 in 1,800 7 per cent. cumulative preference and 3,200 ordinary shares of £1 each, to take over four electric vehicles and the business of an automobile proprietor and carrier and baker, carried on by J. Morris. First directors are:—J. Morris (managing director) and Mrs. E. R. Morrison. Reg. office: 67, Wellowgate, Grimsby.

MARCONI INTERNATIONAL CODE CO. (LTD). (148,204.)—Private company. Reg. Aug. 10, capital £5,000 in £1 shares, to take over from the Wireless Press (Ltd.) all inventions, patents and rights acquired by that company or to which it is entitled, to print, publish and deal in codes, magazines and books, &c. First directors are Godfrey C. Isaacs, Capt. H. Riall Sankey, Chas. V. Daly, Wm. W. Bradfield and Hy. W. Allen. Reg. office, Marconi House, Strand, W.C.

MORTGAGES AND CHARGES.

STUART TURNER (LTD.)—Mortgage on freehold premises at Henley, dated July 31, 1917, to secure £1,250. Holders, L. H. Hanbury, A. T. Hawes and W. Simonds.

WILLIAM TAYLOR ELECTRIC LAMP CO. (LTD.)—Particulars of £400 debentures created Jan. 29, 1917, have been filed, the whole amount being now issued. Property charged, company's undertaking and property, present and future. No trustees.

CITY NOTES.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units sold to consumers, during the four weeks ended June 29, 1917, amounted to 2,230,711, compared with 1,866,546 units in the corresponding four weeks of 1916.

CROSSLEY BROS. (LTD.)—An interim dividend at the rate of 5 per cent. per annum has been declared on the ordinary shares.

ELECTRO-BLEACH & BY-PRODUCTS (LTD.)—An interim dividend of 3½ per cent., less tax, has been declared on the preference shares.

STEWARTS & LLOYDS (LTD.)—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 10 per cent. on the preferred ordinary shares.

TYNESIDE ELECTRICAL DEVELOPMENT CO. (LTD.)—An interim dividend of 3 per cent. has been declared on the preferred ordinary shares in respect of the half-year ended July 31, and will be paid (less tax) on the 31st inst.

Digitized by Google

THE ROUND TABLE.

By "KVA."

The Irrepressible Youth (after the declaration of peace): How and where did you get *your* petrol in the Great War, Daddy?

* * * *

There's nothing like being perfectly frank in an advertisement, as instance this:—

Munitioner wishes to purchase 2-3 seater or de luxe ¾ coupe, late model.

The "de luxe" makes me think the enquirer is a "munitioness."

* * * *

Soon the members of the Engineers' Club, Manchester, will have their digestions improved. The management have decided to adopt electric cooking; they should make it a strong point of their membership campaign that electric cooking leaves all the "extractives" which are good for the digestion.

* * * *

America is getting on with the war. I notice that while over here we speak of a man being of military age, he is referred to over there as "liable to draft." The motto would seem to be not to sit too near an open window!

* * * *

It has been said that the development of the aeroplane would encourage smuggling of very light but expensive commercial products—saccharine, for instance. A correspondent in commenting on this, also calls my attention to drawn wire for metal lamps, and remarks that a reel with enough wire for about 500 lamps only weighs about half an ounce. Why, a few score would go in the petrol tank and not be noticed!

* * * *

A correspondent informs me of a rather amusing incident in the life of a station engineer of a small seaside electric lighting company who had trouble with his mains. A fault had developed in a feeder section of the harbour front where, owing to the effect of heavy seas, the conductors had been laid "solid" under a mass of concrete. In wiring for assistance to the headquarters of the company which were in London, he remarked that both the "pick and shovel" test and the "column of smoke" test were quite useless in locating the trouble!

* * * *

The "Daily Telegraph's" N. Y. correspondent reports that "Mr. Thomas Edison, America's greatest inventor, who has practically isolated himself since the war began, is devoting his entire time to study a device to defeat the enemy. He has already turned over to the Navy Department one invention which officers believe may be adapted to naval usages with excellent results. Only a few naval officers have had the opportunity to see the tests of the invention and they are satisfied that it will prove valuable if its nature is kept secret until it is taken into action." It all reminds one of the famous "F Rays" of some years ago!

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, August 21, 1880.]

THE ELECTRIC LIGHT IN THE CITY.—Tenders are invited for the necessary apparatus to light several City bridges and streets with electricity.

"SAVING AT THE SPIT."—If the Indian Government have been spending at the military bunghole they appear to be sufficiently economical at the telegraphic spit. In a telegram just published from the Viceroy, explaining to the home authorities some obscure item of estimated improved resources, we notice the following parsimonious phrase, "betterness public works explains part."

ELECTRICITY AFFECTED BY A MAGNET.—The phenomenon recently described of the action of a magnet in altering the path of a current of electricity in the conductor which carries it, has formed the starting point for two investigations, which have appeared separately in the "Wegner Anzeiger," by Boltzmann and Von Ettinghausen respectively, in which they point out that this discovery may be applied to determine the absolute velocity of the electricity in a conductor.

THE ELECTRIC LIGHT.—So satisfied have the Great Eastern Railway Co. been with the electric light at their Liverpool-street terminus that they have increased the number of lamps from 16 to 31. Three of the new lamps are outside the station, one being close to Liverpool-street, a second at the foot of the approach to the main line, and a third on the approach to the suburban booking offices on the higher level. The system is also extended into the booking offices, and instead of being confined, as heretofore, to the main platform, has now been carried to the suburban platforms also.

Invention Departments.—In the House of Commons on the 16th a question was asked as to the lack of co-ordination and the overlapping between the various invention departments, and Mr. Bonar Law stated that the subject of instituting an inquiry in order to discover what improvements were practicable in the present organisation and development of inventions was under consideration.

Electrical Progress in France.—At the recent meeting of the Compagnie Electro-Mecanique (of Le Bourget and Lyons) it was stated that the Company had carried out much work of considerable value for national defence. The Company was, in fact, devoting itself entirely to national work. It had either delivered or had on order steam turbines and electrical machinery of more than 400,000 H.P. This high figure was reached owing to specialisation and the highly developed organisation of its works, and it showed what services had been rendered for naval and military as well as industrial purposes. The company, which is the French branch of the Brown, Boveri Co., declared a dividend of 8 per cent. for the year 1916.

Electric Annealing Furnace.—An electric annealing furnace 193 ft. in length is being built by the Electric Furnace Co., of Alliance, Ohio, for use by a company in the Pittsburgh district for annealing bright strip steel, and it is guaranteed that the steel will come out of the furnace as bright as it went in.

The following list is given in the "Iron and Coal Trade Review" as some of the uses to which furnaces of this type have been put: Annealing steel castings and car axles, heat treating steel castings and shells, carbonising, annealing aluminium, copper and brass, and melting copper, brass, aluminium and silver. To these will be added shortly electric soaking pit furnaces for steel plants and rivet furnaces for structural and bridge shops, as well as the car type of annealing furnaces, continuous pusher type furnaces, automatic heat-treating furnaces, and brass melting furnaces. In the use of the electric furnace for melting non-ferrous metals the tilting type is the one offering the greatest saving in cost over fuel-fired furnaces of any type; as the metal loss is lower, the crucible cost is eliminated, and the labour item is low. It is stated that the following figures may be taken as working conditions in melting yellow brass in a plant operated 24 hours a day: Electricity, 400 kw.-hours per ton at ½d., 16s. 8d. per ton; metal loss, 1 per cent. zinc at 5d. per lb., 8s. 4d.; labour, one man per hour per 600 lb., at 1s. 8d. per hour, 5s; total cost per ton of metal, £1. 10s.

Electric Vehicle Progress.—The electric delivery fleet of Messrs. Harrods (Ltd.) now amounts to 60 vehicles.

The electric fleet was started in 1913 with about 10 vehicles, ranging from 10 cwt. to 2 tons carrying capacity. The whole of the vans are exclusively of American design and construction, and the Edison battery is utilised. Electric delivery has proved a complete success for the requirements of the Stores. The control of the vehicle does not require the high degree of skill, physical effort and nerve which its petrol competitor sometimes demands, and many of the electric vans are driven by women. The company has its own power plant. The vehicles are rated to cover round journeys up to 50 miles—25 out and home respectively—the maximum speed being 25 miles an hour, although the average normal speed is much lower. The average working day is about seven hours, and, although the maximum mileage per battery charge ranges from 38 to 50 miles, the average is about 20 miles a day. The average life of the tyres is said to be 12,000 miles.

L.P.S. INSULATING MATERIALS.
INSULATING VARNISHED
Silk, Cloth, Linen, Paper and Tapes (Straight and Bias Cut).
COTTON and SILK TAPES and RIBBONS of every description.
LEATHEROID AND PRESSPAHN.
THE L.P.S. ELECTRICAL COMPANY,
14, Howick Place, Westminster, London, S.W.1.
Telephone: Victoria 7346. Telegrams: "Engineyor, Sowest, London."

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 100, WARDOUR STREET, W.
"Cosliplat, Ox., London." 4746 Gerrard.

Digitized by Google

SIEMENS

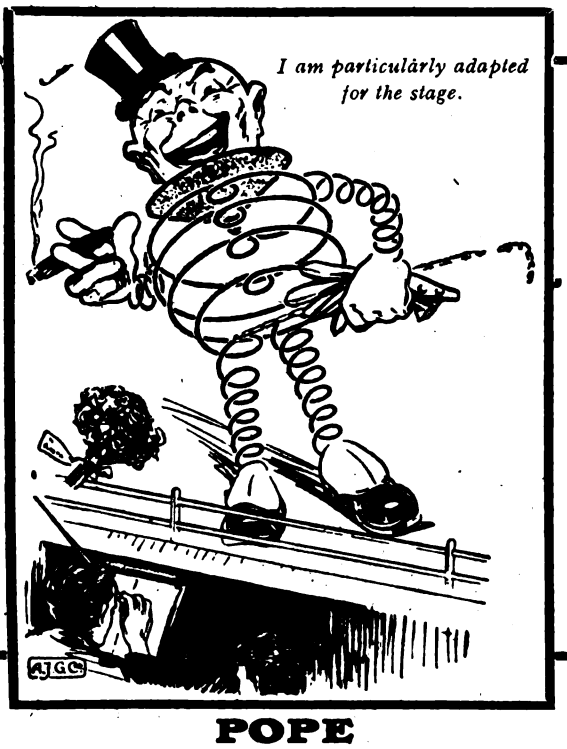
IRONCLAD
SWITCHGEAR
FOR ALL
PURPOSES

Control Pillars
Distribution Boards
Main Switchboards

Write for particulars to —

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350 Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

For Theatre Lighting.

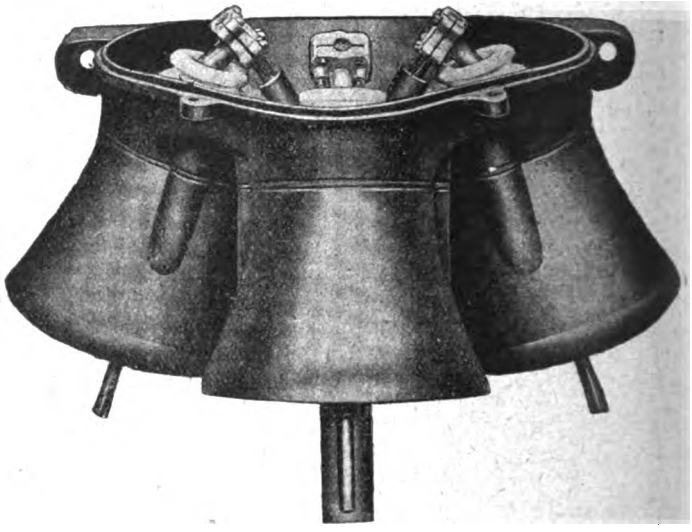


POPE
ELASTA
(British Made)
WIRE LAMPS

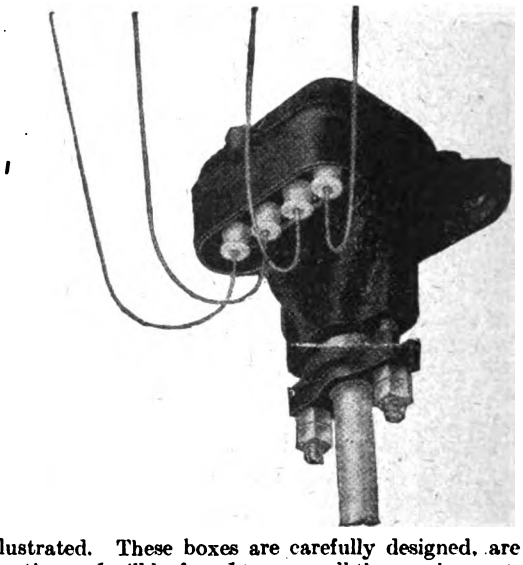
Advt. of Pope's Electric Lamp Co., Ltd., Hythe Road, Willesden, N.W. 10.

HENLEY'S TERMINAL BOXES.

Messrs. W. T. Henley's Telegraph Works Co., Ltd., of Blomfield House, Blomfield-street, London, E.C., have recently issued a handsome catalogue and price list of terminal boxes and distribution accessories. The catalogue, which runs to some 110 pages, is profusely illustrated. The majority of the boxes shown are covered by



patents, nearly all the designs being original and registered. At the outset particulars and dimensions are given of the Henley patent lead cone gland and the Henley standard wiping gland, and then about 70 pages are devoted to terminal boxes. Distribution engineers will find a great variety of boxes for low-tension, high-tension and extra high-tension, both for indoor and outdoor use, described



and illustrated. These boxes are carefully designed, are of sound construction and will be found to cover all the requirements of supply engineers. About a dozen pages are assigned to terminal boxes for telephone and multicore cables, and some good specimens of colliery terminal boxes for low-tension and high-tension three-core cables are also given. Porcelain terminal ends for single and concentric cables occupy three pages, and the section concludes with some nice

GENUINE
M & M VULCANISED FIBRE.
MOSSES & MITCHELL, 122 & 124 GOLDEN LANE LONDON, E.C.

INSULATION BEADS

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

PRESCOT INSULATING VARNISHES

We have a good range of these well tried varnishes and enamels.

The following are some of their principal features:—

PERMANENTLY ELASTIC
HIGH INSULATING VALUE (even when insufficiently stoved)
PENETRATING
CONSISTENT
LASTING
WITHSTAND HIGH TEMPERATURES
MAY BE STORED WITHOUT A SPECIAL LICENSE
NO EXCESSIVE LOSS BY EVAPORATION

Our Yellow and Black Stoving are eminently suitable for Field, Armature, and Transformer Coils, and have been proved of great value in protecting metal surfaces, both as an electrical insulator, and as a preservative against adverse atmospheric conditions.

Let us know your requirements, and we are confident we can meet them.

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED SECOND HAND
MOTORS
THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Victoriator, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.
ELECTRICAL MACHINERY
Engineers, Edinburgh.
See our Illustrated Advt. next week.

Digitized by Google

MASTER

BATTERIES FLASHLIGHTS

MASTER
Tungsten - Light Batteries:
Guaranteed to satisfy.
Give brightest light and longest life.
Will not corrode or leak on shelf.

PERFECTION
Best describes MASTER Flashlights;
Novel and unique in design.
Handsomely finished.
Carefully constructed of durable materials.

Investigate the MASTER line of Batteries and Flashlights—a Product with a Profit. Direct importations from the U.S. or deliveries from our complete London stock.

Request catalogue and quotations for full business, with guaranteed deliveries.

LONDON OFFICE FOR MASTER BATTERIES
RIVER PLATE COMMERCIAL CO. INC. OF NEW YORK,
15, GEORGE STREET, MANSION HOUSE, LONDON, E.C. 4.

FOR
High and Low Tension
SWITCHGEAR
THE
NEW SWITCHGEAR CONSTRUCTION CO., Ltd.
SUTTON, SURREY, ENGLAND.
ABC Code 5th Edition. Telephone: Sutton 773.

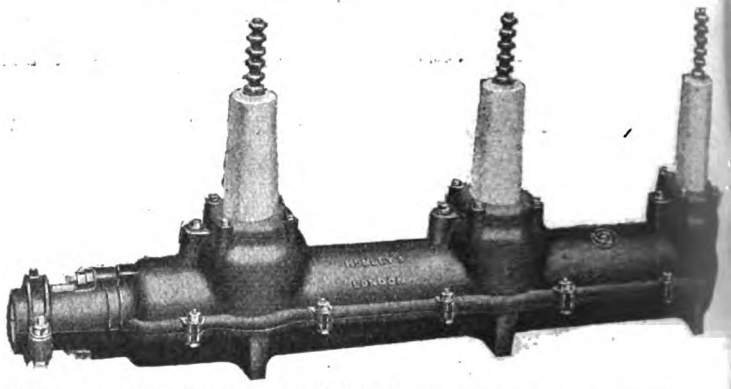
Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE

TRADE MARK.

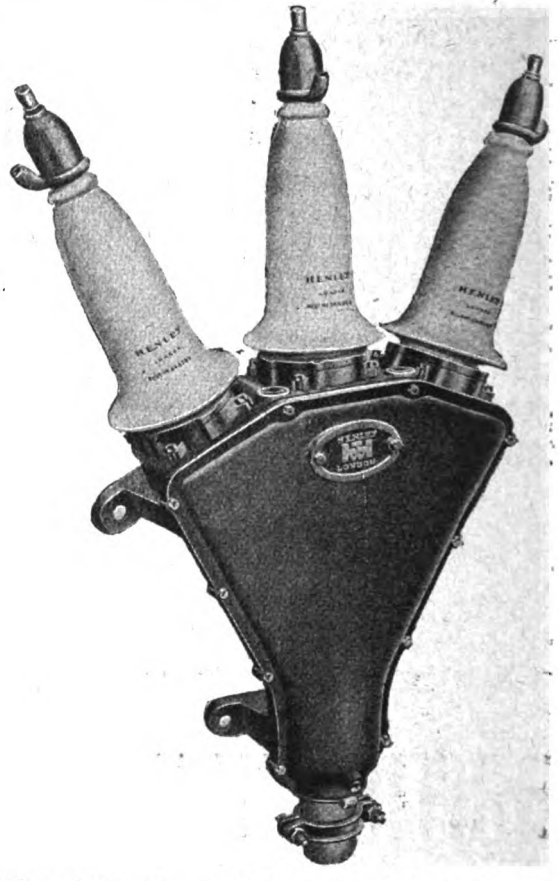
Brass & Copper
Tubes and Sheets.
BRASS CONDENSER TUBES FOR STANDARD SHIPS, &c.

CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.

illustrations of miscellaneous terminal boxes designed to meet the special requirements of particular customers. A few pages at the end of the catalogue are devoted to accessories, such as spare conduit



fittings, porcelain insulators, jointing sleeves, lead cone grips, wood bushes, joint box compounds, &c. The illustrations are uniformly good and clear; sectional views and the principal dimensions are



included, and the other particulars given include the amount of compound required, the prices, &c. We reproduce a few typical examples of the company's manufactures. The first illustration is a

LEWIS'S SCIENTIFIC CIRCULATING LIBRARY.

ELECTRICAL, MECHANICAL & GENERAL ENGINEERING TEXT BOOKS & TECHNICAL WORKS.

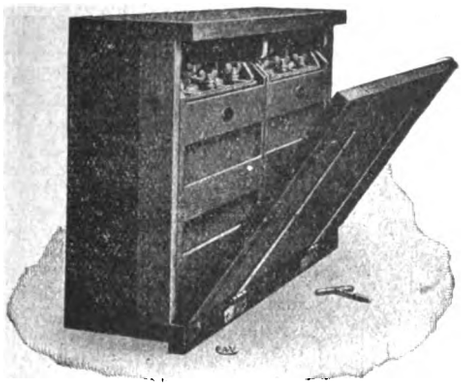
New Works and New Editions can be had from the Library immediately on Publication. Telephone: MUSEUM 1072.

SUBSCRIPTION, Town or Country, from ONE GUINEA.
READING ROOM open Daily to SUBSCRIBERS.

H. K. LEWIS & Co. Ltd.,
136, GOWER STREET, and 24, GOWER PLACE, LONDON, W.C.

Digitized by Google

C.A.V. BRITISH BATTERIES for American Vehicles.



C.A.V. BATTERY—L.G.O.C. Type.
110 amp. hrs. Usually fixed at side of driver.

C.A.V. Batteries were known and appreciated years before the dawn of the motor industry. To-day with 24 years' experience, we produce accumulators for every purpose and every climate.

THE unit most likely to require renewal in an American vehicle is the Battery.

We therefore designed and now offer British Batteries of correct shape, dimensions, voltage, and capacity for every make and model of American car, private or commercial, which is or ever has been in general use.

British Made.

C.A. Vandervell & Co. Ltd.
ELECTRICAL ENGINEERS,
ACTON, LONDON, W.3.
Paris, Birmingham, Dublin, Manchester.

Members of

FERRY

FERROZOID

CONSTANTAN

CHRONIC

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:
HENRY WIGGIN & CO., Ltd.
George Street, Birmingham.
TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."

AGENT:
LIONEL ROBINSON,
3, Staple Inn, London, W.C.
TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

Digitized by Google

Co-efficients of Friction.

Hard Oak on Oak .19 to .48. Metal to Metal .14 to .30
Leather on Metal .15 to .46. Hemp on Oak .35 to .53
FERODO FIBRE .4 to 8.
FERODO BONDED ASBESTOS .3

Ferodo Fabric and Ferodo Bonded Asbestos not only possess a higher co-efficient of friction than hard oak, leather, cast iron, hemp, or *any* other practical friction surface, but they are infinitely more durable. They save power by giving maximum acceleration and deceleration, and absorbing more pounds of energy per square inch than any other friction surface.

FERODO FRICTION SURFACES—give equally good results when brand new and when worn to the thickness of a sheet of paper.

—cannot spark—cannot char—cannot throw off metal dust—cannot seize.

—are always reliable. Each weaving is thoroughly tested by experts before leaving our works.

Write for Lists to—

The Herbert Frood Co. Ltd.

Works: Chapel-en-le-Frith.

Contractors to the War Office and Admiralty, London General Omnibus Company, and Underground Electric Railways of London and Paris.

Depots at London, Birmingham, Belfast, Bristol, Cardiff, Edinburgh, Glasgow, Liverpool, Manchester, and Newcastle.

FERODO
Friction Surfaces.

bell type of box suitable for 6,600 volt three-core cables, and the second shows a small inverted form of terminal box. The third illustration, which does not appear in the catalogue, is a right angle terminal box for 11,000 volt three-core cables; while the fourth exhibits a vertical wall type of terminal box for three-core split conductor cables and for a working pressure of 20,000 volts. The present is the fifth edition of the company's terminal box list. Several additions appear to have been included and large reductions in prices have been made in the section devoted to telephone terminal boxes. A good index at the end renders the work easy of reference.

ELECTRIC TRUCK ECONOMY.

The New York Electric Vehicle Association has recently issued figures as to the relative cost of operating and maintaining an electric vehicle and a small horse-drawn delivery outfit, consisting of three horses and two small wagons. The record is an account for one year for three horses and two wagons, in New York City:—

Board at $1 per day, $1,095; shoeing at $2.25 per month, $81; services of veterinary surgeon, $30; clipping, $5.55; repairs and painting of wagons, $200; repairs to harness, $45; amortisation for horses at 20 per cent. (assuming value of a horse at $200), $120; amortisation for wagons and harness (assuming value at $375), $75; insurance $25.86; interest on investment, $103.50; total, $1,780.91.

An electric vehicle of the type capable of doing the same amount of work as the horse and wagon equipment can be operated and maintained at a cost from $900 to $1,000 a year. This figure is based on a compilation of costs exactly the same as for the horse-drawn equipment. In addition to the economy of approximately $800 per year, there are many other advantages in favour of the electric: Its life is from twice to three times that of a horse, its average working speed is more than double the speed of a horse, it is cleaner and requires less space. Statistics of the Association show a number of merchants and large corporations now using the electric vehicle.

Among the firms who have adopted the electric vehicle are Messrs. Obermeyer & Liebman, brewers, of New York, who have found in its vast delivery system that it costs less to ship goods on short hauls by electrics than any other way. The detailed daily reports show not only the current and oil used and the resulting mileage, but they also trace the transit of the machine from point to point. Petrol trucks are used on runs from New York to Tarrytown (60 miles away), Bay Shore (110 miles), Mount Kisco (90 miles) and Pathogue (some 115 miles).

THE D-P STORAGE BATTERY

FOR TRAIN OR YACHT LIGHTING

THE D-P BATTERY COMPANY, LTD.

Telephones: 2 Bakewell; 291 Westminster.
Telegrams: "Battery, Bakewell"; "Cumulose, London."
Cables: A B C Code, 5th Edition.

HEAD OFFICES:
BAKEWELL, DERBYSHIRE

London Office:
11 VICTORIA STREET, WESTMINSTER, S.W.

ESTABLISHED 1888.
CONTRACTORS TO THE ADMIRALTY AND THE WAR OFFICE.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,050. [Vol. LXXIX. No. 22] FRIDAY, AUGUST 31, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 843
On the Nature and Elimination of Strays. By Cornelis J. de Groot. Illustrated 846
Electricity in U.S A. Mines 849
Turbo Rotor Body Stress. By B. Roberts. Illustrated 850
Electricity in the Pulp and Paper Industry. By W. W. Cronkhite. Illustrated 852
The Determination of the Sequence of Phases from Wattmeter Readings. By Dr. Gisbert Kapp. Illustrated 854
Inductive Resistances for Weakening the Field of Tramway Motors. By Dr. L. Adler. Illustrated 855
THE STREET LIGHTING SPECIFICATION 856
REVIEWS 856
The Justification of the Differential. By C. G. Conradi, M.I.Mech.E. 860
Direct-Current Watt-Hour Meters. By R. Ziegenberg. Illustrated 860
The Lubrication of Resistance Box Plugs. By J. J. Manley 862
The Prescot Twin House Wiring System. Illustrated 863
Patent Record 864
Volunteer Notices 864
COMMERCIAL AND INDUSTRIAL SECTION 867
Electricity Supply 868
Tenders Invited and Accepted 871
Financial Matters 872

NOTES.

The Scientific Instrument Industry.

WE notice, in a recent number of "Nature," a review of the steps necessary to reorganise British trade in scientific instruments. Few people realise the strides this industry has made on the Continent during recent years. Before the war Germany is stated to have exported to Russia alone mathematical, chemical and physical instruments to the value of £2,000,000, and in one branch at least—namely, in optical instruments—she has established a predominant position. Her efforts in this direction are not likely to slacken, and we notice that at the last Leipsic Fair, an account of which recently appeared in the "Elektrotechnische Zeitschrift," optical and photographic instruments formed a very important section. It is difficult to estimate the British production in this field, but it appears certain that it amounts only to a small proportion of that in Germany. Efforts to "capture German trade" since the outbreak of war have too often been pursued in directions where business is easily gained and easily lost, where the processes of manufacture involve no deep scientific knowledge, but mainly rapid and cheap production, and which have no deep educational value. To our mind the scientific instrument industry, although one in which success is not to be lightly achieved, is well deserving of study. We should be guided not only by the intrinsic value of the trade, though this is by no means inconsiderable. More important factors are the bearing of facility in this industry on the development of many others, and the educational value of the effort to achieve predominance in this highly scientific field. We gain an insight into these factors when we review the elements which have contributed to German success. Among the most important of these is the combination of apprenticeship with scientific education. In Germany workers are not allowed to drift into the making of scientific instruments. They are trained for years in the branch they propose to enter, and receive sufficient education in elementary science to have at least an intelligent interest in the work they are doing, which in course of time may be ripened into expert knowledge. In this field, mere mechanical ingenuity, assisted by a little rule-of-thumb knowledge, is of little value. It is essentially an industry in which education is the predominant factor. Other matters mentioned by our contemporary include the publication of journals, in which the technical details of different branches of the industry are fully discussed, and the readiness of the German manufacturer to issue up-to-date catalogues in foreign languages. In these directions, also, we look for further progress in this country.

Science Teaching in Secondary Schools.

WE have received a copy of the Report of the British Association Committee on the Teaching of Science in Secondary Schools, from which we are glad to see evidence of distinct progress in the teaching of this subject. Even on the classical side of public schools, at which the headmasters generally are classical specialists, some progress is to be noted. The report touches on the question of scientific methods and of the contention, sometimes put forward, that scientific methods can be taught without the teaching of science. The Committee do not endorse this view, and we think that anyone with a knowledge of science will agree that the teaching of, say, languages, however well done, cannot introduce scientific methods comparable with those employed in science. Passing to methods of teaching, we notice a reference to the "heuristic" method which was introduced years ago by Prof. H. E. ARMSTRONG. It may be that such methods have an advantage when teaching the very young, but we must confess (from having suffered at the hands of this method in our student days) that it by no means appeals to us for those who have reached an age when time has any value. It is quite impossible to spend all the time that is necessary to follow the experimental deduction of fundamental laws and the evolution of investigations on which chemistry and physics are largely based. Moreover, the student as a rule has not acquired the knowledge wherewith to benefit by such investigations, and he becomes unutterably bored. As the field of science extends it becomes necessary to accept many fundamental principles and to pass to the satge of obtaining useful knowledge as rapidly as possible. On the other hand, this is no reason for adopting a method of providing merely facts for assimilation. There is no doubt that much harm may be done by following wrong methods in teaching the young, and we agree with the statement in the report that the young man or woman who teaches science in schools from the point of view of the university often achieves, with the best intentions, a vast amount of harm. We are glad to see the view taken that the object should be to arouse interest in the young. This can very easily be done if physics and chemistry are taught on the right lines, but in so doing there is no need to go in for the proving of any very exact laws. It is probably for this reason that mechanics as a subject is not popular, since it largely consists of verification, and there is very little in it to arouse the imagination. The object of the teacher should be to make the pupil wish for more knowledge, and then the course of both pupil and teacher alike will be comparatively easy.

Digitized by Google

Meetings of Scientific Societies in War Time.

ONE result of the participation of the United States in the war has been the cancelling of a number of meetings and conventions of various technical and scientific societies. We observe that Dr. COLIN G. FINK, the President of the American Electrochemical Society, has issued a statement deprecating the cessation of the activities of scientific societies in war time, and urging bodies in the United States to follow the example of England in maintaining so far as possible their usual programme. Such societies, he remarks, can do good service by the frank discussion of many technical problems that are already making themselves felt in the present emergency. But, in any case, such gatherings act as a "clearing house" for the best thoughts and ideas of leading scientists and engineers; and to check needlessly such activities is to retard the spread of scientific information and impose a check on progress which will be severely felt in the future. The problem in the United States, where members have frequently to travel long distances in order to take part in discussions, and where conventions are arranged with a frequency and on a scale not usual in this country, no doubt differs in some respects from that which is being faced in England. In the press of new duties, some of the more ambitious annual events may have to be sacrificed. But we entirely agree with Dr. FINK'S contention that in the present circumstances there is every reason to desire the continuity of scientific and engineering educational work. In England the work of most societies has inevitably suffered, or rather their activities have been largely in special and usually confidential channels. But everyone who has leisure to do so should consider it his duty to co-operate in maintaining the machinery for the dissemination of scientific knowledge, both through the medium of society's meetings and in the scientific and technical journals. In all the countries at war there has been a sound instinct towards the preservation of such channels for information, and in the circumstances it is marvellous that scientific work has been continued with such comparative freedom from interruption. The continuity of this work in the United States has been much appreciated in this country. We hope that the welcome co-operation of our friends across the Atlantic in our common task will not deter American scientists and engineers from doing their utmost to maintain, and even to extend, their normal scientific work.

The Order of the British Empire.

THE creation of the Order of the British Empire will be welcomed as a means of recognising the work of many civilians who are serving their country at the present day. There is a vast amount of work of this kind now being done either voluntarily or on financial terms which entail considerable personal sacrifice, and it is fitting that such work should receive recognition. Means for doing so were already in existence, but they were of an inadequate character and were largely restricted to Civil Servants or to those in political circles. The present Order is much more general in its application. In another column will be found the names of those most closely connected with the electrical industry who have been honoured by inclusion in the first list. Opinions may vary as to who should have found a place; there may be omissions, and it may be felt that some who have been included should have been more highly placed; but the main feeling must be one of satisfaction that the need for such an Order has been felt and recognised. Let us hope that in future, in more peaceful times, these new distinctions may also be conferred on engineers and scientists who contribute in a marked way to progress by inventions or research, for work of this character is also eminently to the advantage of the Empire, and has too often lacked recognition.

The Metric System in China.—According to "L'Industrie Electrique," the metric system is finding favour in China, and is likely to be adopted in the near future. It is stated that since Feb. 15 firms in Pekin have adopted new metric measures, and that the measures are officially recognised by the Ministry of Agriculture and Commerce. This, if confirmed, is an interesting development, and one would like to know fuller particulars regarding the exact nature of the measures adopted.

Iron and Steel Institute.—The autumn meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, St. George-street, Westminster, on Thursday and Friday, Sept. 20 and 21, commencing at 10.30 a.m. on the 20th and at 10 a.m. on the 21st. Among the Papers that are to be read we notice one by Messrs. E. D. Campbell and W. C. Dowd on "The Influence of Heat Treatment on the Electrical and Thermal Resistivity and Thermo-electric-potential of Some Steels."

Literature on Submarines.—The United States is now taking a lively interest in the submarine problem, and a useful compilation of literature on the subject appears in the "General Electric Review" (U.S.A.) for August. The contribution is divided into two sections, dealing respectively with (*a*) books and articles, and (*b*) patents. The former occupies about ten pages of small type, and covers the period 1873–1917, while the latter occupies about seven pages, and the patents being divided into those dealing with (1) submarine vessels, (2) life and vessel-saving devices, and (3) torpedoes.

British Empire Producers' Organisation.—This Association is now issuing a monthly report giving an account of its progress. The report before us gives an abstract of an address by Mr. E. Saunders on "Industrial Concentration in South Africa," extracts from Sir Robert Hadfield's translated account of the meeting of the German Iron and Steel Institute, an article by Mr. A. W. Tilby on "Reconstruction and Demobilisation," and notes on various topics of interest. One of these refers to the desirability of manufacturers altering their methods where necessary in order to utilise raw materials produced within the Empire.

The Ramsay Memorial Fund.—The honorary treasurers of the fund for erecting a memorial to the late Sir William Ramsay have received donations and promises amounting to £21,352. Recent subscriptions include £835 from members of the British Science Guild, £500 from Sir George Beilby, and £100 each from the Worshipful Company of Clothworkers, Lord Rosebery and the Salt Union (Ltd.). Prof. D. Orme Masson, of the University of Melbourne, Victoria, has undertaken to act as the representative and corresponding member of the committee for Australia, and Prof. Charles Baskerville, of the College of the City of New York, has already secured the support of a number of leading American scientists.

A National Association of Engineering Foremen.—A correspondent of "Engineering" points out that there is an opening for a National Association of Engineering Foremen. Even in normal times one would imagine that such an organisation would be beneficial to its members, and would afford opportunities of discussing the technical problems met with in their work. In the present circumstances, it is pointed out, the proposed Association is particularly needed, in view of the increased difficulties arising through the war. Foremen not merely act as a buffer between management and men, but undertake, very largely, instruction and direction of diluted labour. In addition, various war measures, notably the establishment of leaving certificates, have increased the difficulty of their position in dealing with men under them; yet it is stated they have not participated in the advances in wages which engineering workmen have recently received.

Franklin Medal Awarded to Dr. H. A. Lorentz and Dr. D. W. Taylor.—The Franklin Institute has awarded Franklin Medals for this year, in recognition of distinguished scientific and technical achievement, to Dr. Hendrik Antoon Lorentz and Dr. David Watson Taylor. Dr. Lorentz's researches in electricity and optics are of Euro-

Digitized by Google

pean reputation. He was called to the chair of Mathematical Theoretical Physics at Leiden University in 1878. Among other achievements, he is largely responsible for the present theory of electro-magnetics in relation to optical phenomena, while his work on the structure of the elementary atoms and the nature of electrons has won general recognition. In 1902 he was awarded the Nobel prize in Physics. Dr. Taylor has been responsible for a great deal of constructive work for the United States Navy, and is the author of many treatises on the subject, one of which, on "Ship-shaped Stream Forms," was awarded the gold medal of the British Institute of Naval Architects. His most important claim to recognition, however, is the work he conducted at the United States Departmental Model Basin, which he designed and constructed at Washington in 1897.

Combustion in the Fuel Bed of Hand Fired Furnaces.—A technical Paper issued by the Bureau of Mines (Washington, U.S.A.) describes some experiments on the above subject by H. Kreisinger, F. K. Ovitz and C. E. Augustine. The conditions in the fuel beds of furnaces, which act primarily as gas producers, are discussed. In general, the temperature is highest 3 in. to 5 in. from the grate, and tests undertaken by the authors show that it is not necessary to run a fuel bed thicker than 4 in. to 6 in. in order to obtain a high carbon dioxide content and a low oxygen content in the gases. A thick fuel bed, by resisting the flow of air through it, reduces the rate of combustion, and diminishes the capacity of the boiler. It also tends to form troublesome clinker. The only excuse for thick fuel beds is that the chances of burning holes in the bed are reduced, but by regular firing and placing fuel on the thin spots a skilful fireman can avoid this possibility. Since at the surface of the fuel bed the gases contain 20 to 32 per cent. combustible gases and practically no free oxygen, additional air must be introduced over the fuel bed in order to obtain complete combustion. In general about one-half of the 15 lb. of air used to burn 1 lb. of coal in a boiler furnace is supplied through the fuel bed; the other half must be supplied over the fuel bed. The series of tests on which these conclusions are based are described by the authors very fully. A copy of the pamphlet may be obtained free on application to the Government Printing Office, Washington.

New War Orders.—In June last His Majesty the King established two new Orders (the British Empire and the Companions of Honour) for the purpose of recognising voluntary and other war services rendered by British subjects and by subjects of our Allies

There are five classes of the Order of the British Empire, as follows:—(1) Knights Grand Cross (G.B.E.); (2) Knights (or Dame) Commanders (K.B.E., D.B.E.); (3) Commanders (C.B.E.); (4) Officers (O.B.E.); (5) Members (M.B.E.).

Last week the following appointments to the Order of the British Empire were made:—

G.B.E.—Lord Moulton, K.C.B., F.R.S. (Director-General of Explosive Supplies); Sir Eric Geddes, K.C.B. (First Lord of the Admiralty, formerly Inspector-General of Transportation, France); Hon. Arthur Stanley, C.V.O., C.B., M.P. (Chairman, British Red Cross Society).

K.B.E.—Dr. Dugald Clerk (Member of Panel of Board of Invention and Research, &c.); Alfred Herbert (Deputy Director-General, Machine Tool Committee); John Hunter (Director of Factory Construction, &c.); Prof. Herbert S. Jackson, F.R.S. (Optical Research Branch of Ministry of Munitions); Leonard W. Llewellyn (Director of Materials, &c.); Lynden Macassey, K.C. (Director of Shipyards and Labour, &c.) Sir Vincent L. Raven, M.I.C.E. (Deputy Controller (Navy), &c.); Richard Threlfall, F.R.S. (Advisory Council of Industrial and Scientifi;c Research).

C.B.E.—Prof. Herbert Brereton Baker, F.R.S. (Trench Warfare Advisory Committee); Leonard Bairstow, F.R.S. (National Physical Laboratory); Prof. W. H. Bragg, F.R.S. (Board of Invention and Research, Admiralty); Wm. Duddell, F.R.S. (Board of Invention and Research, Admiralty, &c.); Frank Wm. Harbord (Consulting Metallurgist, Ministry of Munitions); P. J. Pybus, M.I.E.E. (Bradford National Projectile Factory); Prof. Jocelyn F. Thorpe, F.R.S. (Trench Warfare, Chemical Advisory Committee); Sir George Croydon Marks, M.P. (Labour Department, Ministry of Munitions).

O.B.E.—Geo. Cumming (Engineering Managing Director, Harland & Wolff); Geo. K. B. Elphinstone (Elliott Bros.); M. B. Field (Kelvin, Bottomley & Baird); Prof. J. C. McLennan (University of Toronto).

M.B.E.—Granville Hugh Baillie (Chief Technical Officer, Labour Supply Department, Ministry of Munitions); Russell Clarke (Aviation Electrician, &c., Admiralty); Herbert Schofield (Loughborough Technical Institute).

The Medal of the Order of the British Empire has been awarded to a number of munition workers, including several electrical fitters.

Among the Companions of Honour are Prof. W. Ripper (Sheffield) and Lord Faringdon.

OBITUARY.

J. G. LORRAIN.—We regret to record the death of Mr. James Grieve Lorrain, patent agent, who died on the 23rd inst. at East Wittering (Chichester).

Mr. Lorrain, who was born in 1852, commenced the study of engineering as a pupil of Mr. Edward Sang, of Edinburgh, and subsequently he became a pupil of Prof. Fleeming Jenkin. After studying at Edinburgh University for two years, he went to University College, London, and afterwards to the Royal School of Mines for three years. After attending lectures at the College de France, Paris, for two terms, he returned to take up a post as chemist at the Oakbank Works, Mid-Calder, and later started in practice as an electrical engineer in Edinburgh. Mr. Lorrain erected the first telephone lines in Scotland, and in July, 1879, started the Manchester telephone exchange, the first telephone exchange formed in Europe, and soon afterwards the Liverpool exchange. In November, 1879, Mr. Lorrain founded, and was consulting engineer to, the Scottish Telephone Exchange (Ltd.) (afterwards merged in the National Telephone Co.), for which company he established the Edinburgh, Dundee and Belfast exchanges. In 1880 he founded, and was consulting engineer to, the Anglo-Indian Telephone Co. (Ltd.), the pioneer telephone company in India, which company soon afterwards amalgamated with the Bell and the Edison syndicates to form the Oriental Telephone Co. In 1881 Mr. Lorrain commenced private practice as a consulting engineer, and has specified and superintended the laying down of a number of electric light installations in this country and abroad, as well as several telephone exchanges on the Continent. Since 1886 Mr. Lorrain has devoted his attention to his practice as a patent agent and consulting engineer.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported:—

We regret to announce the death in his 25th year of Lieut. K. G. Garnett, M.C. (R.F.A.), a brother of Principal Garnett, of the Manchester Municipal School of Technology. Lieut. Garnett died on Aug. 22 of wounds. In 1912 he obtained a first class in the first part of the Mathematical Tripos at Cambridge. He was 6 ft. 5 in. in height, and, in the winning Cambridge crew of 1914, was the heaviest man in the heaviest crew that ever competed in the University Boat Race. While under treatment for a previous wound he obtained a second class in the Mechanical Sciences Tripos in 1916, in which year he took his degree. On Aug. 21, 1916, he was shot in the neck and paralysed, and from this injury he never recovered. In addition to the Military Cross he was awarded the French Croix de Guerre.

We also regret to record the death of Lieut. Lewis Aubrey Walker (A.S.C., M.T.), who was formerly resident engineer at the Southgate works of the North Metropolitan Electric Power Supply Co. It is reported that Lieut. Walker lost his life while endeavouring to rescue wounded comrades.

Sec.-Lieut. R. L. James (R.F.C.) was recently killed in a flying accident at Brooklands. He took the degree of B.Sc. at the South Wales University College, and was placed first in mathematics at his last examination.

Pte. Wm. Parker (King's Liverpool Regt.), who was formerly employed by Messrs. Dick, Kerr & Co., has died from heart failure as the result of gas poisoning.

Pte. Bowes (L.N.L. Regt.), formerly employed by the same firm, has been killed in action.

Pte. J. Prince (King's Liverpool Regt.), aged 20, another ex-employee of Messrs. Dick, Kerr & Co., has also died in action.

Pte. John Simpson (A.O.C.), aged 38, formerly a conductor on the Blackpool & Fleetwood Tramways, has died of heat stroke in Mesopotamia.

PERSONAL.

MILITARY APPOINTMENTS.—The following appointments are announced:—

County of London Volunteer Engineers.—Lt.-Col. C. B. Clay (Lt.-Col. late Lancs Vol. Artillery) to be temp. Major; E. C. P. Monson (late Maj., City of London Regt.) to be temp. Major (Second in command); W. D. Bentley, E. G. Fleming and W. Hynam (late Capt., Reserve of Officers) to be temp. Captains; F. M. Yearsley (late Capt., 16th Middlesex Vol. Rifles) to be temp. Captain and Adjutant; W. J. A. Watkins, and A. J. N. Gerard, to be temp. Lieuts.; P. Bowden and C. E. Campbell to be temp. Sec.-Lieuts.; A. Champion to be temp. Hon. Lieut. and Quartermaster.

R.F.C.—Lieut. E. Ivor David has been promoted to Captain in the R.F.C. (Equipment Dept.). He was formerly manager in South Wales for the British Thomson-Houston Co., and is the eldest of five brothers holding commissions in H.M. service.

WAR CASUALTIES.—The following casualties are reported:—

Gunner R. Llewellyn Lewis (Canadian F.A.) has been wounded and is in hospital at Northampton. He was formerly a lecturer in physics at the Toronto University.

Signaller Sergt. F. Hall, a former employee of the Blackpool, St. Anne's & Lytham Tramways Co., is in hospital in France suffering from shrapnel wounds.

Digitized by Google

ON THE NATURE AND ELIMINATION OF STRAYS.*

AN INVESTIGATION UNDER THE AUSPICES OF THE DUTCH EAST INDIAN DEPARTMENT OF TELEGRAPHS.

BY CORNELIS J. DE GROOT.

Summary.—After a general discussion of the merits of radio and submarine cable telegraphy, some stations of the Dutch East Indian service are described. The author then enters upon a classification and analysis of strays, and describes some methods for their elimination. The daily and seasonal variations in strays are discussed in detail, and it is shown that these do not support the Eccles theory of tropical thunderstorms as the origin of all strays.

RADIO V. CABLE COMMUNICATION IN THE TROPICS.

One of the most troublesome phenomena met with in connection with long-distance radio communication, where the signals are usually faint and of variable intensity, is atmospheric disturbances or strays. These interfere seriously with radio communication during the summer in temperate climates. Their magnitude increases to an overwhelming extent in the tropics, especially during those seasons when the sun attains its maximum altitude, and it is then a task of the utmost difficulty for a radio engineer to establish and maintain communication. Particularly unfavourable under these conditions is the comparison between the cost of upkeep and operating reliability for radio communication and submarine cable communication.

The difficult undertaking of establishing radio communication on a regular basis in a tropical climate was voluntarily accepted by the Department of Telegraphs of the Dutch East Indies. Special circumstances dictated the choice of radio service, assuming the feasibility of such communication, even in such an unfavourable region as the tropics.

These circumstances are as follow :—

(*a*) The East Indian Archipelago consists of a great number of islands separated by straits and seas, of enormous depth, 12,000 ft. being quite common. In this region, earthquakes and similar disturbances of the sea bottom are frequent, and the coast line rises steeply. Such conditions are not favourable for submarine cable work, rendering repairs difficult and sometimes impossible at such great depths. The great extent of the archipelago, this being nearly 3,000 miles (5,000 km.) in length, would have necessitated keeping two cable steamers, at least in commission at all times, and the great frequency of earthquakes and sea disturbances of similar character would have resulted in frequent breakdowns.

(*b*) Radio stations afford the additional advantage of maintaining communication with ships at sea.

(*c*) Another reason for embarking in the enterprise of establishing reliable radio service in this tropical region was the apparent slightness of the risk, at least at the inception of the undertaking. The Telefunken Company of Berlin entered into a contract with the Dutch Government to erect the chain of stations, and, at the time the contract was drawn up, the cost of erection, maintenance and repair of submarine cables, was well known by long years of experience. The comparison between radio communication and the cables seemed a reasonably favourable one, and competition between them not impossible. The stations have more than paid for themselves by the strategic value they have been shown to possess during the present war.

On the other hand, the necessity of enlarging these stations so as to radiate six to eight times their present energy was entirely unfavourable to the financial comparison instituted between radio and submarine communication and in a direction prejudicial to the radio service.

Nevertheless, the author is convinced that with more up-to-date radio apparatus and with freedom in choosing suitable sites, independently of the contractor's wishes, radio communication will always be preferable to submarine cable communication under certain definite conditions.

OPERATING CONDITIONS IN THE TROPICS.

The systematic research work on the propagation of the radiated energy and the nature of strays is of great interest to the scientific worker. Of this work, only that portion directly concerned with strays is summarised in this Paper. The geographical location of the stations is as follows :—

The stations consist of Landangan, 7° 40′ south, 114° east, situated in the eastern part of the main island, and two other stations at Oiba and Noesanivé, which are merely secondary Governmental centres. The contractor had agreed to furnish continuous communication between Landangan and Oiba, 680 miles (1,030 km.), and from Oiba to Noesanivén 555 miles (890 km.). The tests, however, were extended so as to include the unguaranteed direct communication between Landangan and Noesanivé, 1,010 miles (or 1,620 km.).

All three stations were of the same design and output, namely, the Telefunken musical, quenched spark set, of the so-called 5 T.K. standard type (this being 5 kw. in the antenna). The prime mover was a 28 H.P. Deutz gasoline engine, starting on compressed air, and with belt drive to a 10 kw. 500-cycle generator and exciter. The generator fed the closed core 220 to 12,500-volt transformer, which charged a group of Leyden jars. These discharged approximately 1,000 times per second through an air-cooled Wien silver-surface spark-gap, composed of 14 gaps connected in series. Since the generator system is worked near resonance, a high pitched note is produced in the receiving set.

The antenna and closed circuits were coupled closely and directly and any one of four pre-determined waves could be readily radiated. These were a 600-metre wave for ship-to-shore work, and 1,200, 1,600 and 2,300 metre waves for long-distance work. The 1,600 metre wave turned out to be the most desirable for direct communication between the three main stations, especially during the day time. At night, the 600 metre wave, which was not desirable during the day, was approximately as good as the 1,600 metre wave.

The contractor decided after preliminary tests with wave lengths up to 3,500 metres, that the 1,600 metre wave should be the working wave throughout the day and night.

The longer waves were radiated from a four-wire umbrella, or, rather, X-shaped, antenna, in connection with a counterpoise ground made of 12 wires of copper-plated steel.

Both antennæ and the counterpoise (which was elevated to the average height of 60 metres, were supported by a centre steel lattice tower, 85 metres in height. In two of the three stations, both stays and towers were insulated from each other, and from the earth by glass plate insulators, but at the Noesanivé station, frequent earthquakes made it necessary to avoid this construction, and the tower and stays were all directly connected to each other. The area of all the stations was 220 metres by 440 metres, the tower being at the centre of the rectangular area. Four additional masts only 16 metres high were provided at the corners to permit the four antenna wires to be held. These four small masts also supported eight of the counterpoise wires. Four 7 metre poles supported the remaining four counterpoise wires. The fundamental wave length of the large antenna is about 1,100 metres and the capacity at 1,600 metres wave length was about 0·00266 mfd. The corresponding figures for the smaller antennæ were 450 metres wave-length, and 0·00156 mfd. capacity. There was measured in the antenna an output of about 4 kw. for the 600 metre wave and 5 kw. to 7 kw. for the longer waves.

For reception, the normal Telefunken crystal detector receiving set was provided, consisting of an antenna tuning circuit and aperiodic secondary system coupled magnetically and closely thereto. The secondary system contained the crystal rectifier and the telephone. The coupling employed in practice gave the loudest telephone response—that is, the coupling was the so-called most "economical" one, whereby one-half of the antenna energy is converted into useful energy in the detector. The maximum possible energy conversion is thus achieved.

While this method gives the greatest signal strength, and therefore the longest transmission range, it is of doubtful value when considering the elimination of interfering signals or strays the antenna damping being doubled as compared to that of the unloaded antenna. The selectivity is therefore diminished, and the detector circuit is too closely coupled to the antenna circuit, and takes up or responds to the transferred and forced vibrations, such as strays in the antenna.

Whereas *transmission* with the large antenna and *counterpoise ground* were found best for all four wave lengths; in *reception* the best results were obtained using a *conductive* ground, the relative advantage in reception being as much as 50 per cent. as compared with the counterpoise ground.

The detectors were silicon crystals, and no special means were provided to avoid the enormous strays existing in these parts of the world.

In addition to the tests carried on between the three stations already mentioned, some tests were made in connection with the station at Aer-Melek (of the same design, but only half the power of the three former stations), with men-of-war, and with a small old-fashioned station at Batavia.

* Abstract of a Paper read before the Institute of Radio Engineers, New York.

Digitized by Google

CLASSIFICATION AND ELIMINATION OF STRAYS.

As is generally known in radio practice, these atmospheric disturbances produce in the operator's telephones a hissing, crackling and rattling noise, and are not due to other stations or electric power plants in the neighbourhood, but are propagated through the ether and therefore received in the same way as the signals originating at other points. The origin of strays, in many cases, is quite obvious, but in other cases almost untraceable. As a general rule strays are at their worst during the night time and in the tropics, and their intensity and character is a function of the time of day and of the season of the year. The worst trouble from strays is experienced during those months when the sun's altitude is greatest and consequently the poor periods of communication do not occur simultaneously over the entire earth. In the tropics, the most unfavourable time is that of the west monsoon (or trade wind), which lags somewhat behind the time of greatest altitude of the sun. The periods of maximum strays coincide with those of marked fading and diminution of signal strength during the day time. At some of the receiving stations, this diminution brought the signals down to inaudibility. However, the night disturbances were not much worse than those during the afternoon, and for the wave lengths used the night signals in these parts of the world increased to at least 1,000 times audibility, thereby becoming more than 30 times as strong as the best signals during the day time. It therefore became possible to get the delayed messages through at night, working at very low speeds and repeating messages, sometimes, as many as six times. Thus, by extraordinary stress on the operators, no message was delayed for more than 48 hours. It will be seen that for the existing stations, at least, communication of the same order of reliability as that existing on submarine cables, could not be expected. Yet during the favourable seasons of the year, the stations worked satisfactorily, and the same reliability and speed as that obtained on submarine cables was then available.

During the most unfavourable times approximately six to eight times as large an output was necessary, as compared with the favourable season, for suitable communication. Even with this increased power, there were a couple of hours each day which would have to be abandoned for working, because of the impossibility of eliminating the very worst strays and thunderstorms. Observations were arranged to classify stray disturbances as follows: (*a*) According to the trouble they gave and the interference which they caused with communication (specifically as to loudness and frequency of recurrence). (*b*) According to their apparent difference in quality or electrical characteristics, so as to enable a determination of their source. (*c*) Detailed tests were then made to separate the different classes as indicated under heading (*b*).

(A.) OBSERVATIONS ON THE LOUDNESS AND FREQUENCY OF RECURRENCE OF STRAYS.

The quantities in question were estimated by the operators, usually twice every hour, and in accordance with a scale of values stated below. At the same time the cloudiness of the neighbourhood around the station, temperature, humidity, air pressure, wind direction and strength of wind were stated. The scale of value is a practical communication scale, and is intended to be of value in connection with actual working. The scale of values follows :—

0. *No Disturbance.*—(This case *never* occurred.)

1. *Weak Strays.*—These were of such intensity as to correspond to a loudness of 100 ohms shunted across a telephone of 1,000 ohms resistance. Such an audibility is generally referred to as "ten times audibility." *This loudness of signal is referred to hereafter as the standard signal.*

2. *Medium Strays.*—These, though troublesome to some extent when the standard signal was being received, still permitted communication.

3. *Strong Strays.*—These strays while troublesome did not entirely stop communication.

4. *Heavy (or Very Heavy) Strays.*—These made communication quite impossible with the standard signal, but permitted working with very strong signals (between 500 and 1,000 times audibility).

5. *Overwhelming Strays and Thunderstorms.*—These naturally made communication quite impossible, but were almost never experienced.

The following signal strengths are desired when 1,000 sparks per second are employed at the transmitter and an ordinary speed of transmission of 12 words per minute.

Class 1: Signals of 10 times audibility (100 ohms shunt in parallel with a 1,000 ohms telephone).

Class 2: Signals of 20 to 30 times audibility.

Class 3: Signals of 60 times audibility.

Class 4: Signals of 250 to 500 times audibility.

In addition to the classification of strays, which is given, in strength from 0 to 5, these atmospherics were registered, from time to time (when they were very loud), on a tape by means of an ordinary Kelvin syphon recorder of the submarine cable type. It is clear on observing the tape that on the average afternoon of the year, atmospheric disturbances will cause the detector to generate E.M.F.s of several volts.

Strays of the worst class handled (that is, ranging between classes 4 and 4·5), forced the syphon to run off the tape, and must have produced rectified detector currents of the order of some 3,000 microamperes.

Seeing that the standard signal of 10 times audibility produced only 0·15 microamperes in the recorder coil, and that a signal of 500 times audibility (which could be received through almost all strays) produced only 7 microamperes, it is a matter for astonishment that signals can be read through strays as readily as is the case. The superiority of the musical signal is obvious, since it is picked up through noises giving direct currents in the coils of the recorder or telephone receiver as much as 400 or 500 times the current corresponding to the signal itself.

These very strong atmospheric disturbances result in a loss of some words. It is clear, however, that a signal which pierces all strays and is 500 times audibility, gives a deflection on the tape of only 0·02 mm. (0·008 in.), and therefore is not detectable. On the other hand, continuous crackling atmospherics of small amplitude, which would not cause the loss of any signals, still represented strays 20 times and more as strong as signals of 500 times audibility. This again brings out clearly the superiority of musical signals.

(B.) CLASSIFICATION OF STRAYS AS TO ELECTRICAL NATURE AND SOURCE.

The *strength* and *frequency* of *recurrence* of strays were the most important factors from the point of view of the designer, since they determined the necessary signal strength at the receiver, and therefore the output of the transmitting station.

The *source* of strays and the mode of their propagation is of the most *scientific* value, although such knowledge also assists the designer in devising improvements for rendering strays harmless, and therefore permitting the maintenance of service with smaller station outputs. In order to procure this necessary knowledge, the operators were ordered to note the typical features of disturbances which were received, in order that a possible classification thereof, relative to origin, might be considered. Three distinct types of atmospherics were noted :—

Type 1: *Loud and sudden clicks* occurring in more or less widely separated groups. When these are not mixed with other disturbances, they do not interfere seriously with communication. Generally, they will result in a loss of a single word in a message for each of the widely separated groups, and they were shown to *originate in near-by or distant lightning discharges.*

Type 2: *A constant hissing noise* in the telephone receivers giving the impression of a softly-falling rain or of the noise of water running through tubes. This type occurs only occasionally when there are dark, low-lying electrically charged clouds near the receiving antenna.

The hissing noise in the telephones as well as the fact that the condenser in series with the galvanometer altered but did not stop the deflection, proved that there were not ordinary direct current, but uni-directional impulses. The ordinary course of events with this type of strays was the following: The galvanometer gave an increasing deflection for about one-quarter hour, and a maximum of some 0·3 milliampere effective current was reached. Thereafter, the deflection decreased for another quarter hour and strays became normal again.

At the same time, incoming signals had the opposite tendency to become weaker and weaker, and after one-quarter hour they began to increase until the normal signal strength was again obtained at the close of the disturbance.

The fading away of the signals has been attributed to the alteration of the antenna constants by the passing clouds; also to the alteration of signal strength caused by overload of the detector.

As disturbances of the type are rather rare and last for only a short period, they did not interfere seriously with communication, and are rather of *scientific* than of engineering interest. These disturbances may be due to physical contact of the antenna with charged particles or to an invisible brush discharge of the antenna toward the low-lying highly-charged clouds. The fact that the current induced in the antenna grows and diminishes synchronously with the arrival and departure of the clouds hints at the correctness of the latter solution.

Type 3: This type produces a *continuous rattling noise* in the telephone something like the tumbling down of a brick wall. Such strays are *always present.* Their strength is a function of the period

Digitized by Google

of the year, and they are most troublesome in the afternoon and night.

Since these disturbances are of a continuous character, they are the most troublesome to handle; and, in fact, frequently suppress communication entirely.

Both types 1 and 3 do not affect to any noticeable extent the loudness of the signal, as do strays of type 2. The signals are merely actually overwhelmed by the superior loudness of the strays. So far as these disturbances were known in Europe, they were largely attributed to distant tropical thunderstorms. Dr. Eccles' well-known theory is based on this assumption. On the other hand, M. Dieckmann has pointed out that other disturbances may possibly be produced by sudden alterations of the potential distribution in air levels near the earth.

(C.) Tests for the Separation of Different Types of Strays.

The means of investigation in this direction were given by Dieckmann himself in that he recommended the use of an aperiodic shielding cage around the antenna. If this cage is suitably designed it will permit signals and such periodic disturbances as those of type 1 to pass through and reach the antenna; and they will be received almost unweakened. On the other hand, aperiodic variations in the static field around the earth and other aperiodic disturbances would not reach the detector, the antenna being screened from the earth field by the Dieckmann cage.

As such a cage is not easily built around extensive antennæ, a special antenna was built for this purpose, consisting of phosphor bronze wire of 1·5 mm. (0·06 in.) diameter, surrounded by a vertical cage. The length of both the wire and this cage was 30 metres (100 ft.).

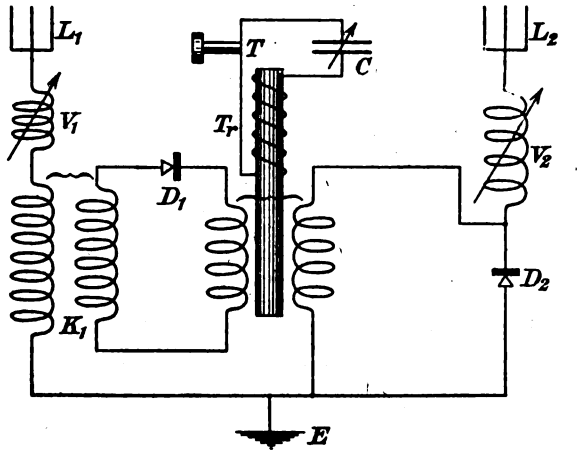


Fig. 1.—Compensation of Periodic Strays at Audio Frequencies.

Since the antenna under test was supported by a mast from which other antennæ were also suspended, these antennæ and all other parts of the masts and stays that could be set into electrical vibration had to be grounded through high resistances. This precaution is very necessary to make the cage function effectively; since otherwise aperiodic strays would cause the above systems to vibrate by shock excitation in their fundamental frequencies. The strength of the signals received when using the Dieckmann cage was not appreciably reduced. On the other hand, at night time, after thunderstorms and rain in the afternoon rattling strays that could still be heard as long as the cage and neighbouring oscillators were insulated, would be completely cut off as soon as all these conductors were aperiodically grounded. This proved that this particular type of strays (of type 3) was not of periodic character, but must have been of the aperiodic type found by Dieckmann. The only type not cut off by the cage seems to be type 1, or the lightning type of strays. These strays of type 1 are by no means the general type they were supposed to be by Dr. Eccles. Strays of type 3 are the most *important* and *main type* of strays.

The author then proceeds to cite other evidence in favour of the view that the lightning type of strays is not the most general type, as suggested by Dr. Eccles, and that the difference between day and night strays is not due to differences in absorption between the lightning centre and the receiving station.

He next describes various devices for the elimination of such strays, including a method utilising the Marconi balanced crystal receiver.

An arrangement for the elimination of strays is given in Fig. 1. Two receiving antennæ, L_1, L_2 of the same shape and dimensions were installed near enough together (10 or 20 metres apart), to make them respond in the same way to strays. (For the aperiodic disturbances, this distance could be easily increased, but for periodic disturbances, the distance of separation must be small compared to the wave length of the strays, in order to get the induced E.M.F.s in phase.) On the other hand, the antennæ must be placed sufficiently far apart so that signals set up in the one which is made aperiodic (L_2) shall not cause currents in the tuned antenna (L_1).

One of the antennæ, L_1, is tuned to the incoming signal and coupled to the detector circuit D_1 in the ordinary way. The detector D_1 will rectify signals as well as strays and send the rectified current into the telephone; or, as in the case of the drawing, into the differential transformer T_r. The antenna L_2 is tuned either to the same, or preferably a longer wave length, thus making it less sensitive to the signals and more sensitive to the long wave strays. The detector D_2 is switched directly into this antenna, thus making it aperiodic or nearly so. This arrangement makes it almost impossible to receive any distant signal on the antenna L_2, but loud signals on wave lengths different from those to which L_1 is tuned and strays give a response that is nearly as loud as can be obtained on the tuned antenna L_1.

The rectified current is sent to the same telephone mentioned before; or, as in the case shown in the drawing, to the differential transformer T_r. However, this second current from the aperiodic antenna, L_1, is arranged to act in the opposite direction from that of D_1. The telephone T is either connected in series with D_1 and D_2; or, as in the drawing, in a third winding of the differential transformer and in series with the condenser C to permit tuning to the spark frequency. Since D_2 does not respond to distant signals, there will be heard in the telephones the signals from D_1 only, whereas the strays rectified by D_1 and D_2 tend to compensate. By varying the coupling K, this compensation can be made complete.

This device will only permit complete compensation of strays of different loudness when the characteristics of both detectors D_1 and D_2 are similar. This is easily accomplished by using carborundum crystals with the best applied E.M.F. As soon as this is applied, the characteristic for rectified currents as plotted against incoming alternating current is almost a straight line. This compensation device, combined with the Dieckmann cage around the antenna to cut off aperiodic strays, solves the problem of the elimination of strays. The same principle of compensation just described for the rectified or audio frequency currents is available, too, for the radio frequency currents. For audio frequency compensation, it is sufficient that both rectified currents should be equal in frequency. Radio frequency compensation requires two antennas tuned to the same wave length and close together, and having the same decrement. Consequently, in this case, the use of an aperiodic compensating antenna is not possible.

Theory of the Origin and Propagation of Type 3 Strays.

The author then attempts to explain the type of strays previously discussed by the aid of records of daily variations for all strays received, averaged over every month of the year. These records are set out separately for the individual months, and are collected together in Fig. 2.

Fig. 2 gives the average daily variation over the whole year, with night observations included. The average day of the year gives a high value during the night time for the stray intensity—(namely, class 4; that is, requiring a signal strength of 250 to 500 times audibility for satisfactory communication). About two hours before sunrise, the strays began to weaken until at 10 o'clock in the morning, the minimum is reached. Then the strays increase until three in the afternoon, remain almost constant until an hour after sunset, after which they rise sharply to the night value.

There is enough difference between day conditions (and especially morning conditions) and night conditions to enable us to conclude that if the theory of Eccles were correct, our stations on the average are not situated near the thunderstorm centre. In Fig. 2 the curve of daily variation of stray intensity throughout the year is plotted in polar co-ordinates around the circular cross-section of the earth. The direction of the impinging sunbeams and the direction of rotation of the earth around the sun are given.

The polar diagram shows two curious half-oval curves of different sizes for the day and night observations (*abc* and *a'b'c'*) symmetrically arranged relative to the direction of motion of the earth around the sun and connected by the steep lines (*pq* and *p'q'*), these steep portions occurring near sunrise and sunset.

It is quite clear that the night phenomena are the symmetrical repetition of the day phenomena; and that the reason for the difference between night and day must be found, in all probability, in the medium between the point of origin of the strays and the receiver which is under the influence of the radiation of the sun. We find this same influence, in a much more pronounced form, in the propagation of the electromagnetic waves of the radio transmitter;

Digitized by Google

and the author has proved elsewhere that the difference must be due to ionisation of the air layers up to a height of some 200 km. (125 miles).

It is interesting to note that the diminution of strays at the point *A* begins long before the time of sunrise at the place in question. That is, as soon as the layers in the atmosphere above the place are touched by sunlight, the change begins. This indicates that the source of strays is not (as Eccles supposes) in the lower layers of the atmosphere.

Moreover, the strength of strays is not a function of the direction of the impinging *sunbeams*. The curves are symmetrical relative to times determined definitely by the movement of the earth around the sun. This furnishes a hint as to the manner in which the higher layers of the atmosphere may become the source of disturbances.

In its course around the sun the earth frequently is struck by cosmic particles which give rise to disturbances in the electric conditions of the upper layers of the atmosphere. It is clear that the disturbances must be different on different parts of the layer; and this difference between collisions in front of the earth and those in back of the earth (as referred to the earth's motion) would give rise to the oval form of the diagrams.

These oval curves would be easily explicable if we assume as the source of strays an atmospheric layer of considerable height which is disturbed by the irregular bombardment of cosmic particles of dust or is disturbed in any other plausible fashion. Though the theory of cosmic bombardment of upper layers appears to me to be

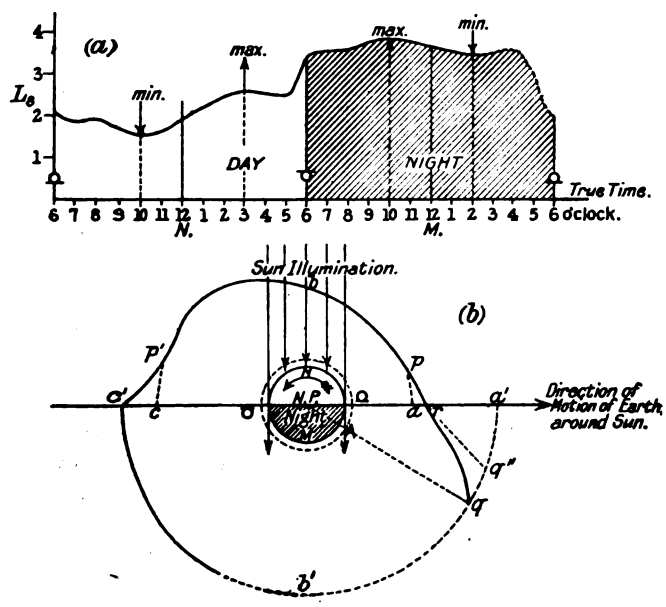


FIG. 2.—AVERAGE DAILY VARIATIONS OF STRAYS THROUGHOUT THE YEAR.

the most plausible origin of strays of type 3, particularly since such a source of strays would explain also the cause of daily variation in the strength of the earth's magnetic field, nevertheless, we are not sufficiently well informed concerning the upper layers of the atmosphere to be able at this moment to give a definite proof of this assumption. If this high layer is the source of strays of type 3, it is quite clear that not only the point directly over the station (that is, the zenith) can be the source of strays; but that in every case, the changes in electric conditions in the circular segment of this layer the centre of which is the zenith of the station will contribute to the strays observed at the station under consideration. The nearer the point of disturbance to the station zenith, the more pronounced will be the disturbance.

These and other effects noted by the author confirm the theory here given and militate against the correctness of the theory of the lightning origin of strays, as do also the demonstrations with the Dieckmann cage. It is possible from the consideration of the point *q* of Fig. 1, where the diminution of night strays to day strays begins, to approximate the *height* of the *disturbed layer*.

The daily variation in strays is quite similar in character to the curves of variation of the earth's magnetism as published in the "Wireless World" (or "Marconigraph") some time ago, which latter variations are attributed to eddy currents in the Heaviside layer. By supposing this layer to be the "secondary" source of strays of type 3, we obtain a sufficient explanation for the daily changes in the strays, these variations being analogous to those of the earth's magnetism. On the other hand, the gradually altering form of the daily characteristic is easily explained if we regard the cosmic bombardment as occurring chiefly in the place of the earth's orbit. It is also possible to explain why strays of type 3 are so heavy in the tropics and so weak in Europe. At the poles, we assume that they would be almost not noticeable. The maximum strays follow the monsoon or trade wind seasons of the year much more closely, the maxima always occurring at the time just between the west monsoon and the "intermediate period"; whereas the minimum always occurs during the east monsoon and close to the end of this season when it is passing into the intermediate period.

ELECTRICITY IN U.S.A. MINES.

In the sixth annual report of the Director of Bureau of Mines, covering the year ended June 30, 1916, a summary of the more important experiments and work carried out during the period is given.

It is stated that methods were developed for treating low-grade complex lead, silver and zinc ores, which, if commercially successful, will render available millions of tons of ore that cannot now be treated profitably.

Studies by the Bureau have shown that metal losses in melting brass and aluminium chips can be greatly reduced, and an electric furnace for melting brass was developed.

Encouraging results were obtained in the application of a process extracting zinc from low-grade oxidised ores not amenable to present processes, &c.

An investigation of manganese deposits in the United States and of methods of mining and recovering manganese was begun.

Investigations of the technology of molybdenum and its ores were completed and a bulletin describing methods of concentration and use were prepared for printing.

Hoisting equipment in coal mines, and ways and means of preventing accidents in shaft and slope hoisting were investigated

Progress was made on an improved type of oxygen rescue apparatus which is being developed by the Bureau.

Various types of electric mine-lamps have been greatly improved through recommendations made by the Bureau.

Two types of explosion-proof coal-cutting equipment were approved.

Rules setting a proper standard of safety for the installation and operation of electrical equipment in bituminous coal mines, prepared by the Bureau, have helped greatly to increase safety in mines.

During the year there were 89 fatal accidents, of which two were caused by electric shock.

The system of issuing a formal approval for apparatus meeting the safety specifications prepared by the Bureau has been further developed during the year and has been applied to seven miners' electric lamps. During the past three years the art of producing safe and practicable miners' lamps has been greatly accelerated by the efforts of the Bureau in co-operation with the manufacturers. Two types of explosion proof coal-cutting equipment were approved. The requests for tests and approval of such machines have exceeded the facilities of the Bureau and a new testing gallery has been provided by the manufacturers in order to expedite the work and to co-operate with the Bureau in its investigations. The rules for electrical equipment in mines are ready for publication and in MS. form have been commented upon favourably by many coal operators. Their general acceptance would remove a considerable hardship from the coal miners' occupations.

Tests of explosion proof storage-battery locomotives for use in gaseous mines were begun.

The specifications for purchase of fuel for Government use were simplified, and methods of analysis and sampling have been greatly improved. Several Government power plants were inspected, resulting in a considerable decrease in fuel costs through the adoption of measures recommended by the Bureau.

Investigations of non-ferrous alloys, with particular attention to the saving of waste through volatilisation of metals in brass melting and the development of electric furnaces for conserving these wastes, were conducted throughout the year. The studies in saving metal wastes in brass melting have resulted in the development of an electric furnace, which it is believed will be successful in the melting of brass. The Bureau has built and operated such a furnace on a laboratory scale, and the results show marked promise. Arrangements have been made with a large central electric power station for building and testing a large commercial furnace of this type. The Bureau has also kept in close touch with the development of other types of electric furnaces, and many firms throughout the United States have allowed the Bureau to observe tests of electric furnaces proposed for brass melting and other uses in the non-ferrous alloy industry. The importance of developing an electric furnace for such purposes is patent to all when the present high price of crucibles is considered and when it is understood that in normal times the metal losses in brass melting probably amount to as much as $3,000,000 per year, and that in the past year of large production and high metal prices this loss has probably been nearer $10,000,000.

The construction of the first units of electrical smoking treatment apparatus at the Anaconda Smelter in Montana was begun. These units cost nearly $100,000, represent only a small part of the total equipment contemplated and will be given a thorough test before a decision is reached concerning details of further installations.

Digitized by Google

TURBO ROTOR BODY STRESS.

BY R. ROBERTS.

Summary.—The author discusses the stresses in a rotor core due to the teeth, and calculates the stresses in discs with teeth, taking the two cases (1) in which there is a central hole and (2) in which there is no such hole.

The calculation of stresses that occur in the rotor core bodies of high-speed electrical machinery is a problem which, as a rule, is shelved by most designers by assuming that the specific weight of the solid part of the core is increased by the ratio of the total entrifugal forces of plate, teeth and winding to that of the plate part alone. A method such as this, however, assumes higher stresses than really exist in some cases, and in general is most unsatisfactory. A correct method of calculating the stresses occurring in a plate disc loaded at the periphery has, as far as the author is aware, not yet been published; but, nevertheless, is most necessary in view of the higher speeds and outputs to which the progressive design of electrical machines is taking us.

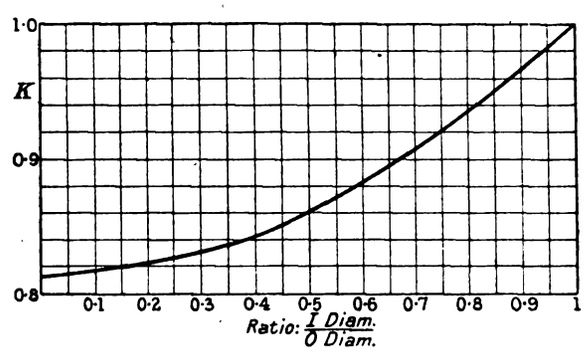


FIG. 1.

A turbo rotor core, for instance, usually consists of discs with teeth on the outer periphery, and in the slots between these teeth is placed the windings, which are kept in place by the metal wedges. The core body, shaft and teeth are frequently machined out of one solid forging.

Neglecting the tooth effects, we see that the stresses occurring in the core disc or plate will be similar to those in any plain revolving disc, and this problem has been investigated by many, notably by Grossman and Dr. Chree. The maximum hoop tensile stress is given by the formula,

$$P_{y\max.} = \frac{w\omega^2}{g4m}\{(3m+1)R_1^2+(m-1)R_2^2\} \quad . \quad . \quad . \quad (1)$$

when P_y = hoop stress,
w = specific weight of material per unit volume,
ω = speed of rotation in radians per sec.,
m = Poisson's coefficient for the material,
R_1 and R_2 = outside and inside radii of disc.

In the limit where $R_1 = R_2$ we have

$$P_{y1} = \frac{w}{g}\omega^2 R_1^2 = \frac{wv^2}{g12}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where w = lbs. per cubic inch, v = peripheral speed in feet per second and g = acceleration due to gravity in feet per second per second.

Where, however, R_2 is so small as to approach zero we obtain

$$P_{y2} = \frac{w}{g}\omega^2 R_1^2\left(\frac{3m+1}{4m}\right), \quad . \quad . \quad . \quad . \quad (3)$$

which, for mild steel, where $m=4$,

$$P_{y2} = \frac{13}{16}\frac{wv^2}{g12}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Where the ratio R_2/R_1 has any value less than unity the maximum hoop stress may be given by the formula

$$P_y = \frac{wv^2}{g12}K, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

which for steel becomes

$$P_y = K \times 0{\cdot}105\, v^2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Values for K are given by the curve in Fig. 1. If, however, the disc has no central hole,

$$P_y = \frac{13}{32}\frac{wv^2}{g12} = 0{\cdot}0425\, v^2 \quad . \quad . \quad . \quad . \quad . \quad (7)$$

The stresses in the core body due to tooth forces may be calculated by assuming that the tooth load is evenly distributed around the periphery, that a very thin plate only is considered, and that, therefore, there exist no stresses normal to the plane of disc. The radial tensile stress intensity at the outer periphery is the tooth root stress multiplied by the ratio of tooth width to tooth pitch. This average stress we will call "P."

In Fig. 2, R_1 and R_2 are the internal and external radii respectively, P_x and P_y are the radial and tangential stress intensities at radius x, and t is the disc thickness. The forces acting upon the small element t, δx, $x\delta\theta$, are in equilibrium, so that

$$t\left\{P_y\delta x\, 2\sin\frac{\delta\theta}{2}+(P_x-\delta P_x)2\,x\sin\frac{\delta\theta}{2}\right\}$$
$$= tP_x 2(x+\delta x)\sin\frac{\delta\theta}{2} \quad . \quad . \quad . \quad . \quad . \quad (8)$$

$$2P_y\delta x\sin\frac{\delta\theta}{2} = 2P_x\delta x\sin\frac{\delta\theta}{2}+2x\delta P_x\sin\frac{\delta\theta}{2}$$

$$P_y\delta x = P_x\delta x + x\delta P_x$$

$$P_y = P_x + \frac{x\,dP_x}{dx} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

$$= d\left(\frac{xP_x}{dx}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

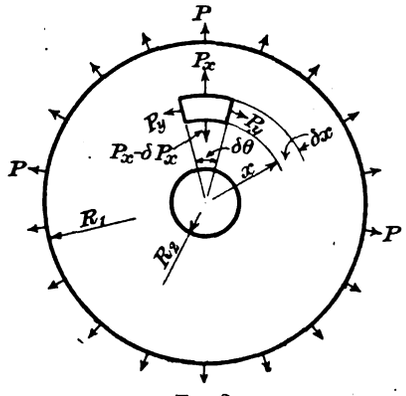


FIG. 2.

Considering the strains, if (since strains are purely radial from our assumptions) the radius x is increased to $x+u$, the circumferential strain is

$$\frac{2\pi(x+u)-2\pi x}{2\pi x} = \frac{u}{x}; \quad . \quad . \quad . \quad . \quad (11)$$

and the radial width of this element is, after straining,

$$x+\delta x+u+\delta u-(x+u) = \delta x+\delta u \quad . \quad . \quad (12)$$

And the radial strain, necessarily positive, is the limiting value of

$$\frac{\delta x+\delta u-\delta x}{dx} = \frac{du}{dx}. \quad . \quad . \quad . \quad . \quad (13)$$

From the law of strains due to two principal stresses (radial and tangential) we know that in a circumferential direction

$$\frac{u}{x} = \frac{1}{E}\left(P_y-\frac{P_x}{m}\right), \quad . \quad . \quad . \quad . \quad . \quad (14)$$

Digitized by Google

and that in a radial direction

$$\frac{du}{dx}=\frac{1}{E}\left(P_x-\frac{P_y}{m}\right). \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

Solving these equations (14) and (15), we obtain

$$P_y=\frac{Em}{m^2-1}\left(m\frac{u}{x}+\frac{du}{dx}\right) \quad . \quad . \quad . \quad . \quad . \quad (16)$$

$$P_x=\frac{Em}{m^2-1}\left(\frac{u}{x}+m\frac{du}{dx}\right), \quad . \quad . \quad . \quad . \quad (17)$$

$$xP_x=\frac{Em}{m^2-1}\left(u+mx\frac{du}{dx}\right),$$

$$\frac{dxP_x}{dx}=\frac{Em}{m^2-1}\left(\frac{du}{dx}+m\frac{du}{dx}+mx\frac{d^2u}{dx^2}\right),$$

and from equation (10)

$$\frac{dxP_x}{dx}=P_y,$$

so that

$$\frac{Em}{m^2-1}\left(m\frac{u}{x}+\frac{du}{dx}\right)=\frac{Em}{m^2-1}\left(\frac{du}{dx}+\frac{mdu}{dx}+mx\frac{d^2u}{dx^2}\right) \quad . \quad (18)$$

whence we obtain $\frac{d^2u}{dx^2}+\frac{1}{x}\frac{du}{dx}-\frac{u}{x^2}=0,$

that is $$\frac{d^2u}{dx^2}+\frac{d}{dx}\left(\frac{u}{x}\right)=0. \quad . \quad . \quad . \quad . \quad . \quad (19)$$

Integrating, we have

$$\frac{du}{dx}+\frac{u}{x}=2\text{A(a constant)}, \quad . \quad . \quad . \quad . \quad (20)$$

or $$\frac{xdu}{dx}+u=2\text{A}x. \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

Integrating again, we have

$$ux=Ax^2+B,$$

whence $$\frac{u}{x}=A+\frac{B}{x^2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

and from (20) $$\frac{du}{dx}=A-\frac{B}{x^2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

Then equation (17) becomes, when we substitute values for

$$\frac{u}{x}\text{ and }\frac{du}{dx},$$

$$P_x=\frac{Em}{m^2-1}\left\{A+\frac{B}{x^2}+m\left(A-\frac{B}{x^2}\right)\right\} \quad . \quad . \quad . \quad (24)$$

When $x=R_2$ then $P_x=P$; and when $x=R_2$ then $P_x=0$.

$$\therefore \quad P=\frac{Em}{m^2-1}\left\{A(1+m)+\frac{B}{R_1^2}(1-m)\right\} \quad . \quad . \quad . \quad (25)$$

and $$0=\frac{Em}{m^2-1}\left\{A(1+m)+\frac{B}{R_2^2}(1-m)\right\} \quad . \quad . \quad . \quad (26)$$

solving equations (25) and (26) we obtain

$$A=\frac{PR_1^2(m-1)}{Em(R_1^2-R_2^2)}. \quad . \quad . \quad . \quad . \quad . \quad (27)$$

$$B=\frac{PR_1^2R_2^2(m+1)}{Em(R_1^2-R_2^2)}. \quad . \quad . \quad . \quad . \quad . \quad (28)$$

By substituting the values of these constants in the equations for

$$\frac{u}{x}\text{ and }\frac{du}{dx},$$

and by further substitutions in equations (16) and (17) we obtain

$$P_y=P\left\{\frac{R_1^2}{R_1^2-R_2^2}+\frac{R_1^2R_2^2}{x^2(R_1^2-R_2^2)}\right\} \quad . \quad . \quad . \quad (29)$$

$$P_x=P\left\{\frac{R_1^2}{R_1^2-R_2^2}-\frac{R_1^2R_2^2}{x^2(R_1^2-R_2^2)}\right\}. \quad . \quad . \quad . \quad (30)$$

Whence it is easily seen that P_x has its maximum value when $x=R_1$, *i.e.*, when $P_x=P$.

Further, that P_y attains a maximum when $x=R_2$ when

$$P_{y\,\text{max.}}=\frac{2PR_1^2}{R_1^2-R_2^2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (31)$$

and when $x=R_1$

$$P_{y\,\text{min.}}=P\left(\frac{R_1^2+R_2^2}{R_1^2-R_2^2}\right). \quad . \quad . \quad . \quad . \quad . \quad (32)$$

And when R_2 is so small as to be almost zero the tangential hoop stress at the outer periphery equals P and at the inner periphery equals $2P$. From the curve in Fig. 3 may be found the maximum values for P_y in terms of P for varying ratios of R_2/R_1.

This concludes the case of a disc with a central hole. However, where there is no central hole the result is somewhat altered. From equation (22) we have

$$u=Ax+B/x,$$

When however, $x=0$ the strain u must also be zero, *i.e.*, $B=0$, otherwise $B/x=\alpha=$ infinity.

$$\therefore \quad u=Ax,$$

so that $$u/x=A \quad . \quad . \quad . \quad . \quad . \quad . \quad (33)$$

and $$du/dx=A \quad . \quad . \quad . \quad . \quad . \quad . \quad (34)$$

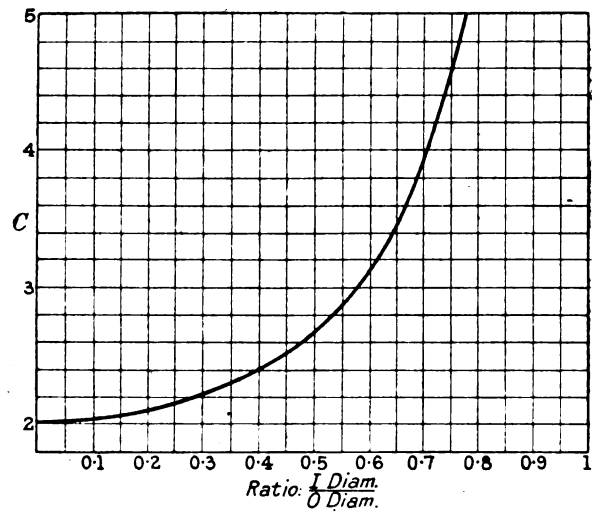


FIG. 3.

From equation (17) by substitution of values for u and u/x in (33) and (34) we have

$$P_x=\frac{Em}{m^2-1}\{A(m+1)\}$$

$$=\frac{EmA}{(m-1)}$$

$$=P \text{ which is a constant.}$$

Similarly $P_y=\frac{EmA}{(m-1)}$

$$=P \text{ which is also a constant.}$$

In the case therefore, of a disc without central hole, and loaded on the periphery, the tangential stress equals the radial stress throughout the disc.

The maximum stress in a rotor disc may be easily and simply computed by the use of the curves in Figs. 1 and 3. As an example, let us investigate the following :—

A turbo-rotor core 44 in. outer diameter and 15 in. inner diameter, slotted with slots 64 to the circle, 6 in deep. The tooth root is 0·54 in. thick, and the tooth root stress is 7,200 lb. per square inch when $P=2,480$ lb. per square inch.

Ratio $R_2/R_1=0{\cdot}47$ $\quad V=210$ft. per sec.

Stress at inner periphery for plate portion becomes equation (6)

$$P_y=K\times 0{\cdot}105V^2.$$

From the curve in Fig. 1 $K=0{\cdot}853$, so that

$$P_y=3,950$$

From the curve in Fig. 3 we find the stress at the inner periphery due to tooth forces to be

$$2,480\times 2{\cdot}58=6\,400 \text{ lbs. per sq. in.}$$

Total max. stress $=6,400+3,350=10,350$ lbs per sq. in.

Digitized by Google

ELECTRICITY IN THE PULP AND PAPER INDUSTRY.*

BY W. W. CRONKHITE.

Summary.—The advantages of electric drive for pulp and paper machinery have been so thoroughly demonstrated and are so well appreciated by the industry that it is unnecessary to discuss this matter at length. In this article the various machines are considered separately, and especially with respect to the approved method of driving and the power requirements. The illustrations will indicate the adaptability of the electric motor to this service, and the large extent to which it is employed in the industry.

The paper and pulp industry was one of the pioneers among large manufactures to realise the benefits of electric drive. At the present time motors installed in these mills in the United States number 300,000 H.P. Electricity allows the centralisation of the power generating apparatus in one efficient station, affords the necessary flexibility of distribution and is also a convenient agent for distributing power.

In what follows a brief account of some of the chief applications of electric drive in the pulp and paper industry is given :—

Wood Conveyors.—Wood conveyors take 1½ H.P. per 100 ft. of length when running at 100 ft. per min. Some paper and pulp companies, however, make a practice of running their conveyors up to nearly 200 ft. per minute and allow 5 H.P. per 100 ft. of length. This may result in a motor that is a little larger than necessary, but it is an insurance against trouble due to high peak loads that may be encountered if the wood jams in the trough ; it also insures ample starting torque if the conveyor is started with the trough full of wood.

Barkers.—Individual drive is an ideal method for driving barkers. The power consumption varies somewhat with the material and speed. Tests which have been taken on a 5-ft. barker driven by a 15-H.P., 720-revs. per min., direct-connected motor show a maximum requirement of 12 H.P. and a minimum of 7 H.P. Squirrel-cage motors are to be recommended, but inasmuch as starting conditions are severe, due to heavy loads to be accelerated, it is important that an indestructible type of rotor construction be used. There may be conditions when group drive would be best.

Grinders.—Motor-driven grinders are finding an increasing field when it is desired to locate the pulp mill at a distance from the water power, or where power is purchased. Also, motor-driven stones can be used to supplement the work of the water-wheel driven stones at time of low water. Motors may be direct-connected to two four-pocket grinders, one on each end. This same arrangement with two stones on each end of the motor has been adopted in some mills. The reason for placing half of the stones on one end and half on the other is that in case of accident to a stone the coupling can be opened at that end of the motor and the stone or stones on the other end operated. Many installations are being made with all the stones on one end of the motor. This latter arrangement allows the motor and controlling apparatus to be placed in a separate room, free from dirt and slush, and also permits of easier handling of the wood. The power required to drive grinders varies considerably with the pressure. Tests taken on a 1,200 H.P. motor, driving four three-pocket grinders with 54-in. diameter by 27-in. stones at 255 revolutions full-load speed, and with a water pressure of about 55 lb. per square inch in 18-in. diameter cylinders, showed that 104 H.P. was required to drive the four stones light with no wood in the pockets ; and, as each pocket was filled with wood and the pressure applied, the power was increased by an average of 105 H.P. per pocket. On this basis, allowing 26 H.P. for windage and bearing friction, a three-pocket grinder should require 341 H.P. The power consumption would increase or decrease proportionately as the speed and pressure increased or decreased. It is seldom that all the pockets are full at one time ; in the test referred to it was found that it took 40 to 50 seconds for the attendant to fill a pocket with wood, and that the time between successive fillings was sometimes as low as four or five minutes. During this period the power consumption drops off. Therefore, instead of 1,364 H.P. being required to drive four three-pocket stones, the average load actually would not exceed 1,250 H.P. because there would be an average of more than one pocket empty all the time.

There seems to be some uncertainty, even among the manufacturers, about the best speed for grinders. We have motors on this work, ranging in speed from 214 revs. per min. to 257 revs. per min. Some paper mill engineers believe that 257 revs. per min. is too high, and a few even advocate speeds as low as 210 revs. per min. Others believe that 257 is not only satisfactory but gives increased production.

Both slip-ring type induction and synchronous motors are operating successfully on grinders. In certain sizes the synchronous motor will work out a little lower in cost and better in power factor than the induction motor.

Screens.—Screens require such small amounts of power that we will not dwell long on them. The flat bed screen, by test on a group of three eight-plate screens, showed a power consumption of about 6 H.P., or ¾ H.P. per plate.

Group drive is the proper thing for flats. Rotary and centrifugal screens consume more power. Requirements vary from 12 H.P. to 20 H.P. : for one centrifugal, which was somewhat larger than the others, 30 H.P. was required. Centrifugals may be belt driven, using a quarter turn belt, or a vertical motor may be direct-connected to the screen shaft at the top.

Chippers.—Fig. 1 shows test results on a 5-ft. chipper working on spruce in 2 ft. lengths. The average load was 56 H.P. Evidently a 75 H.P. motor would be ample to drive a chipper of this size. The load fluctuates and the motor is subject to high peaks due to irregularities in the size of the wood fed into it. Tests on an 87 in. chipper show a maximum peak of 115 H.P. and an average of 75 H.P. Chippers should never be direct-connected to motors.

Beaters.—These machines may be driven in groups, in pairs, or singly. The motor may be mounted between the two beaters, but this arrangement is not always practical, as the distance between beaters may be insufficient.

The power consumption of beaters varies considerably. Fig. 2 is from tests on a 1,500-lb. beater having a roll with 54-in. face and 65-in. diameter.

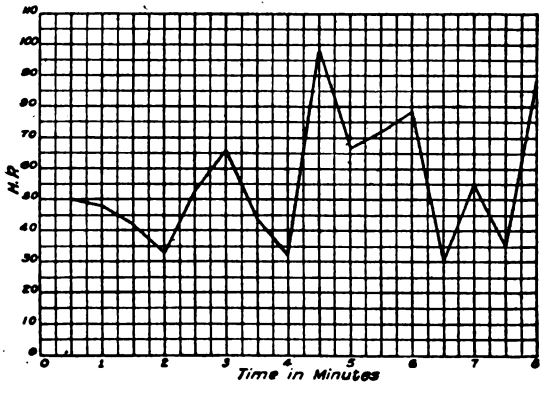


Fig. 1.—Test on 5-ft. Chipper Working on Spruce—2-ft. Lengths.

Curve A is for beating rope stock at 106 revs. per min. The first period is "feeding," and the maximum horse-power is about 48 ; the second period is "washing," and the power consumption gradually goes down ; the third period is beating, and the load goes up to approximately 75 H.P. The peaks occur when rolls are turned down. This test is over a complete cycle.

Curve B is similar to curve A, except that it shows the difference in power consumption due to the lower speed. In both cases the beater was working on rope stock.

Curve C is a similar test except that old paper stock is used and the beater is operated at 105 revs. per min. ; naturally the power is less—a trifle over 50 H.P.

Some mill engineers recommend 1 H.P. per inch width face of beater-roll in estimating power required, but on very tough material and high peripheral speed the requirements go higher than this. For work on light stock such as ground wood, sulphite, old papers, &c., with peripheral speeds not exceeding 1,700 ft., ¾ H.P. per inch width face is probably ample.

Jordans.—The advantage of the direct-connected motor for driving jordans and similar refining engines is its compactness, freedom from belts, and long life of bearings and linings. Sometimes three-150 H.P. induction motors are arranged with sliding base arranged to take up the movement of the jordan plug. This movement can also be taken care of by the use of a telescopic coupling, as shown in Fig. 3.

Synchronous motors are also used for driving jordans. Some mills prefer to use a motor having internal resistance.

Jordans do not require high starting torque unless the machine is shut down and allowed to stand with the stock in it and with the

* Abstract of an article in the "General Electric Review" (U.S.A.).

Digitized by Google

pressure of the plug not relieved. This practice is not customary, of course, as the jordan is generally allowed to clear itself before shutting down, and the pressure of the plug is relieved upon starting up.

There are so many conditions that enter into the operation of jordans to affect the power consumption that it is hard to do other than fix the extreme limits. Each case should be considered separately before making recommendations for size of motor.

Paper Machines.—Electric drive for paper machines has engaged the attention of engineers for years, and eliminates mechanical speed changing devices and variable speed engines. It confines the power generating apparatus to one central plant, and in cases where power is purchased, it does away with the high operating cost and trouble incident to maintaining a few small engines on the machines alone. There are, however, many cases where it is not economy to employ

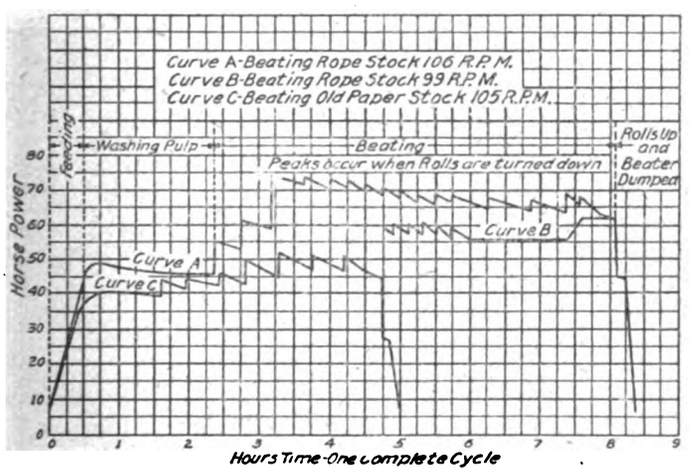


FIG. 2.—POWER REQUIRED BY 1,500 LB. BEATER.

Roll 54-in. face by 65-in. diameter. Capacity of Beater about 1,200 lb. Rope Stock, 1,300 lb. Sulphite.

motor drive on paper machines, for instance, steam engines exhausting into the driers may give an overall fuel economy higher than can be obtained by using motors supplied with central station power and using live steam for drying. In new mills this can be taken care of by using steam turbines in the power station and extracting the low pressure steam for drying. This problem, above all others, should be thoroughly studied, since the steam demands of paper mills vary greatly with the class of product. A scheme that would be economical for one mill might fail utterly for another.

On account of the fairly wide range of operating speeds of paper machines, direct current motors should be used. Consequently, when the power supply is alternating current, a motor-generator set must be used to convert the power to direct current for the paper machine motors.

In some cases the motor may be coupled in the middle of the line or at one end. With this method a very wide speed range, 8 or 10 to 1, can be secured. Push-button stations can be placed at convenient points around the machine.

Another method that has worked out satisfactorily in some cases and that is well adapted for large machines requiring a wide speed range, is to drive the constant speed line shaft direct from an engine which is also connected to a generator of sufficient capacity to furnish power for the variable speed section, the latter being driven by a motor coupled to the back line and controlled from the machine room. This method gives an easily controlled and reliable method of obtaining a wide speed range, and leaves the engine exhaust for drying.

An analysis of tests made shows that in Fourdrinier and single cylinder machines the power required to operate the entire machine (including both constant and variable speed ends) can be arrived at by this formula :—

Horse-power = 0·004 to 0·0045 × width in inches × speed in feet per minute.

The power for the variable speed end alone runs from about 0·0023 H.P. to 0·003 H.P. per inch width per foot per minute speed.

For multi-cylinder board machines, the power is very much higher, ranging from 0·012 H.P. to 0·015 H.P. per inch per foot per minute for the entire machine, and from 0·0069 H.P. to 0·0088 H.P. per inch per foot per minute for the variable speed end alone.

These figures are in actual brake horse-power and should be increased 10 per cent. when comparing with tests of indicated horse-power.

Super Calenders.—Several arrangements of motors for driving super-calenders have been installed. The one motor drive, depending upon resistance in the secondary circuit for threading, gives an unstable threading speed and also consumes considerable power. Super-calenders work from 20 to 30 per cent. of the time at the low speed. It is, therefore, apparent that a motor large enough to drive the calender at calendering speed, if operated at one-tenth speed for threading 30 per cent. of the time, is a very inefficient equipment.

With single motor drive the threading speed is obtained by inserting resistance in the rotor circuit. After the paper is threaded through the stack the motor is gradually brought up to the desired speed by cutting out resistance by means of the dial controller. From an engineering view-point this method is open to serious objection, as the low speed requires a speed reduction of about 90 per cent. below normal. This makes the threading speed very unstable and requires care on the part of the operator while threading. In fact, single motor alternating current drives have proven unsuccessful in some plants.

With direct current motors the threading speed can be made somewhat more stable, as a certain amount of field control can be used and a shunt resistance connected around the armature to hold the speed down during threading. Even this method is not entirely satisfactory unless the load is uniform during threading, and this condition seldom exists. Further, the power consumption on a one motor drive (either alternating-current or direct-current) is excessive at low speeds.

We will now consider the two-motor alternating-current equipment. In the first place, most mills have alternating-current available. Next, we know that super-calenders are constant torque propositions and the power goes down with the speed. The two-motor drive is therefore to be recommended. It has been developed and installed with a number of modifications to meet varying conditions. The small or threading motor which gives one-tenth speed, is controlled by push buttons placed at convenient points on the calenders, so this motor can be started and stopped by the men handling the paper. When the paper is threaded through the calenders the large motor is thrown in and brought up to speed by a drum controller.

This motor is fitted with a magnetic switch for connecting its primary to the line, so that it can be stopped from any of the push-button stations. In some installations the large motor is brought up to speed automatically instead of by hand controller.

Each push-button station, of which there can be as many as desired, contains three buttons, one marked "slow," one "fast" and one "stop." Pushing the "slow" button in any station starts the small motor and drives the calender at threading speed. Pushing the "fast" button starts the large motor and automatically brings it up to whatever speed the controller is set for, and at the same time shuts down the small motor. Pushing any of the "stop" buttons shuts down either motor that may be driving the stack, and electrically brakes so that the calender will come to rest instantly. This particular arrangement allows a range of calendering speed from 300 ft. to 600 ft. per minute and permits slowing down for bad spots in the paper. This equipment is absolutely fool-proof and completely automatic with push button control.

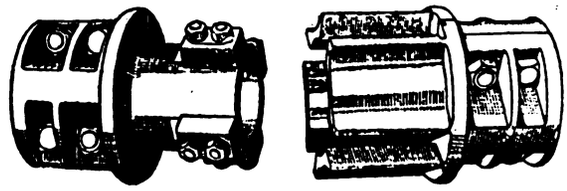


FIG. 3.—FLEXIBLE TELESCOPIC COUPLING FOR USE WITH MOTOR-DRIVEN JORDAN ENGINES.

Platers.—In plater equipments direct-connected motors are built to stand the jar of frequent reversals. In one case mentioned the plater is a Norwood, with 42 in. face and 18 in. diameter rolls revolving at about 17 revs. per min. when the motor is running at full speed. The ordinary reversals are about 10, or 5 complete trips of the book, but when working on a corner of the book the reversals are as high as 30 a minute. The controller is mounted on a bracket attached to the plater table convenient to the operator. An enclosed contactor panel is mounted near the plater, containing switches for reversing the motor. These are controlled by the drum controller previously mentioned.

Digitized by Google

Steam Turbines.—Electricity has been responsible for the modern steam turbine. Paper manufacturers are interested, as their power and heating problems are closely related, and the steam turbine gives ideal flexibility with respect to steam utilisation.

The author describes a 600 kw. mixed pressure unit. This machine is designed for mills whose supply of exhaust steam from existing engines considerably exceeds the drying and heating requirements, and where the engines are consequently operating condensing, or if non-condensing, are exhausting into the air. This turbine takes this exhaust steam at slightly above atmospheric pressure and expands it down to 28 in. vacuum, producing practically as much additional power as given by the engines themselves. The engines will take somewhat more steam than if they were operating condensing, but the increase is far less than the gain in power, and no change in the boiler-room or boiler-room force has been necessitated by the addition of this turbine.

Another demand may be made on the turbine by the paper mill that operates under a different condition. For instance, when the need for low-pressure steam for manufacturing purposes is moderate compared with that required for power, an extraction turbine can be used to advantage. This type is designed to operate condensing and uses high-pressure steam, but low-pressure steam can be extracted from one of the stages. The extracted steam is automatically regulated so as to remain constant under variable load and steam flow conditions. Paper mills differ widely in their steam requirements and it is better that each proposition be carefully studied.

A recent use of the steam turbine is its application to the Winestock de-fibering and de-inking machine; the turbine not only drives the machine but furnishes steam to heat the stock for the next charge.

THE DETERMINATION OF THE SEQUENCE OF PHASES FROM WATTMETER READINGS.*

BY DR. GISBERT KAPP.

The so-called "two wattmeter method" of measuring the power flowing through a three-phase line may be used to determine the power factor according to the well-known formula

$$\cos\varphi = \frac{1}{2}\frac{1+r}{\sqrt{(1-r+r^2)}},$$

where r is the ratio between the two readings. This ratio has to be determined by dividing the smaller reading by the larger, and the power factor may then be read off from a chart such as is used in every test room. The same chart may be used if the two readings are obtained by the well-known modification of the "two wattmeter method" where both readings are taken on the same wattmeter by

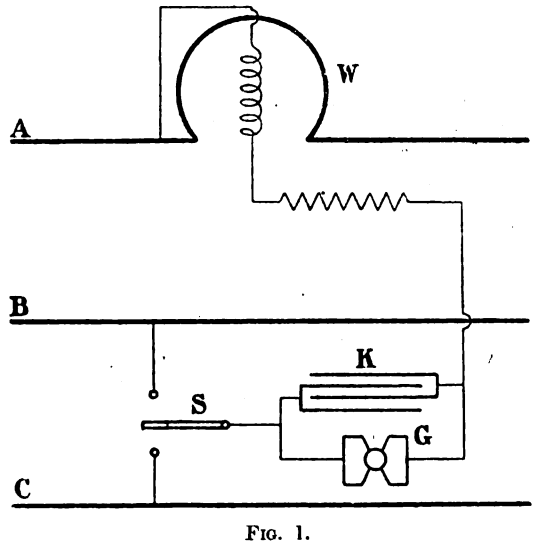


Fig. 1.

using a change-over switch for the pressure circuit of the wattmeter.

The chart tells us what the power factor is, but nothing more. It does not tell us whether the current is leading or lagging nor the sequence of phases. This can only be found if we know, not only the ratio of the two readings, but also their signs as determined by the sequence of phases. Before we can tell whether any particular power factor read off on the chart means a lagging or a leading current we must know the sequence in which the phases follow each other. When the generator is close at hand it is possible—though it may not be very convenient—to trace back the circuit to the generator, and, by observing the direction in which the generator is driven to establish the sequence of phases. Let us label the three terminals A, B and C, then the current (or the E.M.F.) in each will attain its positive crest value 120 time degrees after the other. Thus, B may attain its positive crest value (or any particular phase condition) 120 deg. after A or C has attained the same condition. In the former case we have the sequence A-B-C, and in the latter the sequence C-B-A.

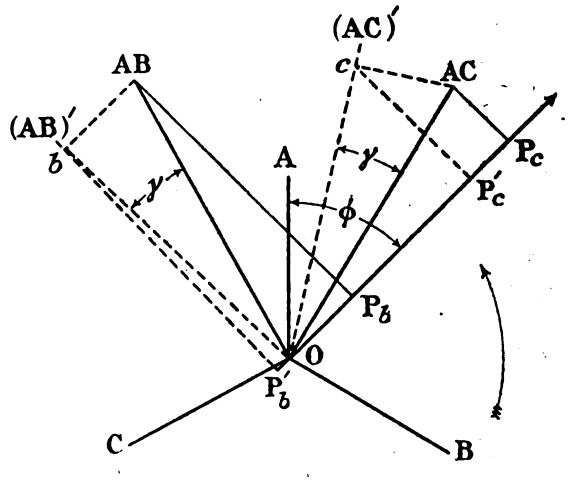


Fig. 2.

By tracing back the circuit to the generator it is, therefore, possible to interpret the chart reading as regards the sign of the phase angle: positive for a lagging and negative for a leading current. But it is not always convenient, and is frequently impossible, to trace the circuit back from the point where the power measurement is made to the generator. There may be a distance of miles between the two points and there may be various transformations within that distance. In such cases some other method purely local must be employed.

One obvious method is to insert a little inductance into the main lines and repeat the power measurement. If the power factor is then smaller than without the artificial inductances, the current is normally lagging; if greater, it is normally leading. Such a device is, however, costly, because the inductances must carry the main current, and must be rather heavy pieces of apparatus. Their insertion means at least a temporary interruption of the supply, and, even after they have been inserted, some alteration and disturbance in the regular condition of the supply of power to the load. For these reasons we may dismiss this expedient as clumsy and often impracticable.

The following method is, however, quite practicable; it does not interfere with the power supply to the load, and the additional cost is confined to the provision of a paper condenser of a few microfarads capacity. The arrangement of apparatus is shown in Fig. 1. W is the wattmeter as ordinarily used, S is the change-over switch, also as ordinarily used, and K is a condenser which can be short-circuited by inserting the plug G. When the plug is inserted the sum of the wattmeter readings gives in the usual way the total power. If the plug is withdrawn, the condenser is in series with the pressure coil of the wattmeter, and the current through this coil is slightly advanced as compared with the usual test. The two readings will, therefore, be different from those obtained with the condenser short-circuited, and by analysing the two sets of readings it is possible to determine whether the sequence of phases is A-B-C or C-B-A, and also whether the current supplied to the load is lagging or leading.

Fig. 2 shows the vector diagram for sequence A-B-C and a lagging current. AC and AB are the E.M.F. vectors of the pressure coil if the switch is connected to C and B respectively. The wattmeter readings are respectively P_c and P_b and are proportional to the projections of the two E.M.F. vectors on the current vector. If now the plug is withdrawn the E.M.F. vectors assume the positions $O(AC)'$ and $O(AB)'$, since by the action of the condenser they are both advanced by the angle γ, where

$$\tan\gamma = \frac{10^6}{\omega K R}.$$

* Paper published in the "Journal" of the Institution of Electrical Engineers.

Digitized by Google

In this equation $\omega=2\pi f$, K is the capacity in microfarads, and R is the resistance of the pressure circuit of the wattmeter in ohms. The precise value to be given to γ need not be known, but for greatest accuracy it should be about one-half the angle which $O(AC)$ makes with OA, or say 15 deg. This gives with the usual frequency of 50

$$K=12{,}000/R \text{ microfarads.}$$

The new readings will now be reduced, first because of the greater angle between the current and pressure vectors, and secondly because the current in the pressure coil has been reduced in the ratio of 1 to cos γ. The power is proportional to the projection of Oc and Ob on the current vector. The corresponding points are P'_c and P'_b. For a very small lag, φ, P'_c may not be smaller than P_c; but for all values of lag from 0 to 90 deg. P'_b is smaller than P_b, and this is a criterion for the conditions to which the diagram refers—namely, sequences A-B-C and lagging current.

In the same way we can analyse the three other possible conditions, namely, sequence A-B-C and leading current; sequence C-B-A and lagging current; and finally sequence C-B-A and leading current. It is unnecessary to demonstrate these different conditions in detail, as it would merely be a repetition of the above reasoning. It will suffice to give the result in tabular form.

Readings taken in the usual way give	$P_c > P_b$		$P_b > P_c$	
If readings taken with condenser give	$P_b > P'_b$	$P'_b > P_b$	$P'_c > P_c$	$P_c > P'_c$
Then sequence is	A-B-C	C-B-A	A-B-C	C-B-A
And current	lags	leads	leads	lags

In using this table, care must be taken to insert the powers with their proper sign; thus, if P_b is numerically smaller than P'_b, but the latter is negative whilst P_b is positive, then P'_b must be considered to be smaller than P_b.

The same table may be used if the measurement is made by two wattmeters in the usual way. In this case the free terminals of the pressure coils must be connected through condenser and plug to the phase line labelled A, and the wattmeter must be inserted into the phase lines labelled B and C.

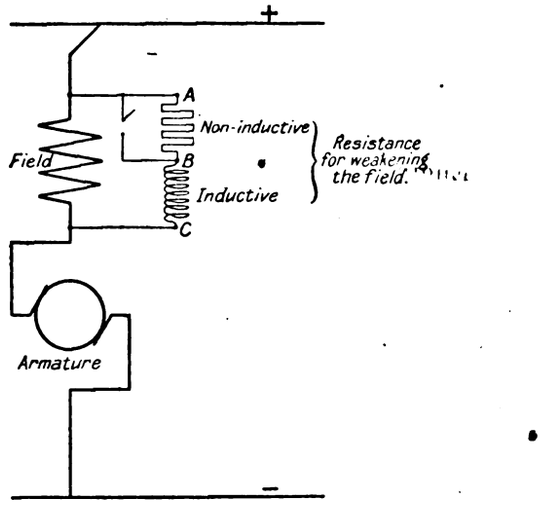
INDUCTIVE RESISTANCES FOR WEAKENING THE FIELD OF TRAMWAY MOTORS.*

BY DR. L. ADLER.

Methods for weakening the field were recognised as useful as soon as electric traction started. There were in those days no commutating poles consequently there were troubles with the commutator and flashing-over between the brushes. Thus about 20 years ago this plan fell into disrepute. Traction motors were, however improved and commutating poles were introduced; the plan was therefore tried again. Normally the motors ran quite sparklessly but if the current was interrupted or if there were short-circuits on the network there was always sparking at the brushes and burning of the commutator. The cause was the employment of non-inductive resistances to weaken the field and the sluggishness of the magnets. One plan to avoid these difficulties was to prevent the vibration of the overhead collector. Its springing was improved and two were used instead of one. In this way the complete interruption of the current could be almost entirely avoided or at any rate it could be reduced to a small fraction of a second. Tests have shown that the length of the period of interruption has a great effect on the character of the sparking at the brushes. An interruption of 1 or 1½ seconds at full speed and with a weakening of the field by 50 per cent. may cause flashing-over between the brushes. If these interruptions can be reduced to one-third of a second no harmful effects are observed. Naturally then things depend on the extent to which the field is weakened. If the field is not weakened below 85 per cent. of its normal value then a non-inductive resistance in parallel with the field exercises no injurious effect. An increase in the number of collectors would seriously add to the cost of the equipment in the case of urban lines though it would matter little on country lines; but this would not avoid the effects of short-circuits on the network.

Various plans have been tried for obviating these defects. Electromagnetic relays have been used which disconnect the resistances for weakening the field if the supply of current is interrupted. Thus, when the supply starts again the motors have no weakening of the field; in consequence of the sluggishness of the action of the relay the resistances are inserted somewhat later. But this does not avert the effects due to a short-circuit; moreover, it introduces an extra piece of apparatus that may conceivably give trouble by getting out of order. Another method is to weaken the field by subdividing the field coils. This means an increase in the number of the connections on the motor, perhaps also an increase in the size of the coils which is not possible without increasing the size of the case. Moreover this standardises things once and for all and it is not possible later on to alter the extent to which the field can be weakened. It is very important that tramway motors should be simply constructed and the complexity of this plan seems to make it generally undesirable. The field can also be weakened by cutting out certain pairs of poles; but, electrically speaking it is not a good plan and it is only very occasionally employed.

Present experience seems to show that the best plan is to weaken the field by using inductive resistances. Such inductive resistances consist essentially of coils imbedded in an iron core; its self-induction should preferably be rather greater than that of the field coils, the effect of which is to be weakened. If the field is to be weakened to less than 60 per cent. of its normal value, it is well to do it in two stages, in order to avoid heavy rushes of current in the armature.



CONNECTIONS FOR INDUCTIVE AND NON-INDUCTIVE RESISTANCES IN PARALLEL WITH THE FIELD OF A TRACTION MOTOR.

In this case the arrangement might be as follows: The resistance would then consist of the aforementioned coil in series with an ordinary inductionless resistance (*see* diagram). In the first stage the whole resistance is inserted in parallel with the field while in the last stage only the inductive resistance is inserted. By the use of this method it is possible without any ill effect to keep the coil much smaller. Thus the whole resistance will be much smaller and cheaper than if it were constructed throughout on the inductive principle. Photographic illustrations are given showing the general appearance of these resistances as constructed by the A.E.G. One illustration shows a somewhat cylindrical form of construction which is said to be suitable for small motors up to 45 kw. capacity, while the other, which is cylindrical in shape, would be used for larger motors. Each car, carrying two motors, would require two resistances, which can be put either beneath the car or below the seats, or even in the box containing the switches. The space which they require is probably rather less than that taken by the resistance hitherto ordinarily in use, and they weigh very little more. Resistances of this kind have been tested in use on a great number of lines, and have been found quite successful. These inductive or semi-inductive resistances are likely to dispel any doubt that has hitherto existed with regard to the principles involved in this system of regulation.

The Cement Industry in Japan.—According to the "Journal" of the Royal Society of Arts, the cement industry in Japan has made rapid strides since the beginning of the war. The production has risen from 3,741,000 barrels in 1913 to 3,943,000 barrels in 1915, and the output during 1916 is understood to have been still greater. Five years ago there were practically no exports, but in 1915 upwards of 600,000 barrels were exported and a considerable trade is being built up in India and in the South Seas.

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 48, 1916.

Digitized by Google

The Electrician.
FRIDAY, AUGUST 31st, 1917.
Editorial and Publishing Offices:—
8, BOUVERIE STREET, LONDON, E.C. 4.
Telephone: City 9853 (4 lines). Telegrams: "Benbrotric Fleet London."

THE STREET LIGHTING SPECIFICATION.

The publication of the Standard Clauses for Street Lighting Specifications in the current number of the "Journal" of the Institution of Electrical Engineers revives an old controversy. It was in 1913 that the draft Standard Specification was first brought forward, and it was then subjected to very considerable criticism.

It was hoped that the clauses suggested would prove acceptable, the more so as the Committee had been formed upon a very representative basis, representing, in fact, the Institution of Electrical Engineers, the Institution of Municipal and County Engineers, the Institution of Gas Engineers and the Illuminating Engineering Society. As the result of the discussion in 1913 the Specification was further considered, but it was found that it contained certain points upon which irreconcilable views were held. Doubtless, if it had not been for the war the whole matter would have been made public long before; but it is difficult under present conditions to discuss matters which are not of the first urgency at the moment, however important they may be at some later date. Later on, no doubt, the matter will be considered still further; but meanwhile it has been thought desirable to publish the Specification as a majority report along with a minority statement.

The standard clauses as now issued do not differ materially from those already published, and therefore the most interesting point is the minority statement. This is to the effect that the appraisement of street lighting in terms of the minimum horizontal illumination obtained is not a correct means of measuring the illumination given by street lamps, as this is affected by the light given from other sources, of varying intensity in different places and at different times. Leaving over for the moment other contentions in the minority statement, we may say that illumination tests would presumably be made when any serious illumination from other sources, such as shop windows, would be absent. Reflection from the walls of buildings can scarcely be taken as a serious objection, as such reflection would merely be to the advantage of the lamps supplying the illumination, and would render it more easy to comply with the required minimum. We cannot, therefore, consider that this particular objection is one that can be well supported.

A further objection is concerned with the variation of illumination—that is, with the ratio of the maximum to the minimum illumination, or what may be termed the "variation factor." This question was considered by a sub-committee, and the statement is made that an amendment in this direction would have considerably modified and lessened the objection to the Specification as previously drafted. Unfortunately, the sub-committee were unable to find a suitable form of words to bring forward, and, consequently, no such amendment was included. We confess to considerable sympathy with the view that limits for the variation factor should be included, and we fail to see why such keen opposition was raised against it, more particularly if the inclusion of this quantity would have enabled the Specification to be adopted by the Committee as a whole.

Lastly, the Council of the Institution of Gas Engineers express the view that the correct method of measurement is one based on the average candle-power of light sources ascertained at two or three defined angles. With this view we disagree, for the simple reason that what is required is not candle-power, but illumination. We cannot help thinking that if the gas engineers were able to vary the distribution of light from their lamps rather more easily they would not raise this objection.

In looking over the standard clauses we notice what appears to be an inconsistency in the method of measurement allowed. The illumination may be measured (*a*) by any suitable illumination photometer, or (*b*) by any suitable photometer measuring candle-power, from which the illumination may then be calculated. If the illumination is measured by the second method it is clear that any illumination contributed by other sources is eliminated, and the first objection raised by the minority no longer holds.

We think that one of the causes underlying the opposition to these standard clauses is that they may be regarded as a basis for penalties. Obviously, if penalties are to be exacted, the accuracy of measurement must be not only sufficient to act as a guide, but sufficient to ensure that no injustice is done. We should like to hear something more upon this side of the subject. It will be generally felt that the accuracy of illumination measurements does not compare with the accuracy of efficiency tests in electrical work, and, therefore, contractors may object to such measurements for the purpose of exacting penalties. On the other hand, unless penalties can be based upon specified measurements it is difficult to see how the Specification can be regarded as one that is standard and one which carries with it various legal obligations.

REVIEWS.

Functions of a Complex Variable. By T. M. MACROBERT, M.A., B.Sc. (London: Macmillan & Co., Ltd.) Pp. xiv.+298. 12s. net

Those of us who have not attended a mathematical lecture, at least in the *role* of a listener, for some 30 years cannot help feeling a little jealous of the coming race of mathematicians. It seems to us that the path to higher knowledge is now made so smooth that the modern student can learn in a week what it took us months to learn in the old days. Mr. Hardy's "Course of Pure Mathematics" and Dr. Bromwich's "Theory of Infinite Series" have made easy the theory of convergence. Now we have Mr. Macrobert's "Functions of a Complex Variable" providing a short path to a summit from which we can survey some of the marvellous explorations made during the last century in this very abstruse subject.

Formerly we used to regard Stirling's theorem as showing the "wonderful stretch of human brain," more particularly the investigation as to its convergence. We thought at first that this theorem was not given in this book, but further investigation showed that it is no longer called Stirling's theorem, the reason being that it is made rigorous, and that the remainder term we used to puzzle over is simply a Bessel's function of order n.

The book is divided into 15 chapters. The first seven form a clear introduction to the whole subject quite within the comprehension of any one who has a thorough knowledge of the Calculus and of the higher parts of trigonometry. Chapter VIII., on the gamma function, is excellent. Perhaps it is too condensed. The whole theory of the function $\Psi(x)$ is given in five lines. As a knowledge of this function is necessary before we can compute the attractions of electrified spheres, for instance, we think that a little more space should have been given to it. As this function is left innominate, we could not find it in the index. Whitaker has suggested that it should be

Digitized by Google

called the "logarithmic derivate of the gamma function." Although this sounds a little pompous, it is better than nothing. We notice that Mr. Macrobert uses "derivative," and will have nothing to do with the new-fangled "derivate."

In subsequent chapters Weierstrassian and Jacobian elliptic functions are discussed. Nagaoka has recently shown how easily the coefficients of self and mutual induction of circular and cylindrical coils can be calculated by means of the Weierstrassian elliptic function. The reviewer thinks that in the future the standard method of calculating these coefficients and the attractions between circular currents will be by means of these functions.

We particularly like the proof the author gives of Legendre's relations between the elliptic functions. The numerous examples are all excellently chosen, and the author's hints as to the methods of solving the difficult ones most helpful. The book could be improved by adding a table of the symbols used. The author should not use K and K' as constants (p. 147), seeing that he uses them as symbols for the complete elliptic integrals.

The absence of numerical values shows how little the modern mathematician cares about numbers. Only the values of the first three of Bernoulli's numbers are given. The author, however, expresses the nth in the form of an integral. This method of procedure is not unusual nowadays, but it should not be encouraged. In conclusion, we can recommend this book to the physical mathematician as a very clear introduction to a most difficult subject. The great care which has been exercised in proof reading is highly commendable. A. RUSSELL.

Underground Transmission and Distribution for Electric Light and Power. By E. B. MEYER. (London: Hill Publishing Co.) Pp. viii.+312. 12s. 6d. net.

This is a book that should prove of great value to all those interested in the distribution of electricity. It shows that our American cousins are well ahead in this branch of our profession. It is more necessary than ever that we should strive after efficiency, and the mains engineer will be an exceptional man that will not find some good hints as to how to do his work better by reading this book. There has been a great difference between British and American cable practice in the past, but this seems to be disappearing. Overhead wires at one time boomed in the States, and became so numerous, ugly and dangerous as to cause them to be largely dispensed with. The author gives some striking illustrations in favour of underground work.

The first chapter is historical, and deals with the principal systems in use throughout the world. It is interesting to note that in Paris the sewers are specially constructed to accommodate electric cables, and no street openings or manholes are necessary. This practice might be adopted in our larger cities, especially as it states that the air in the sewers is odourless.

The author wisely devotes some space to the planning out of the route along which a cable should be laid. He states with regard to street openings that in some cities representatives from the water, gas and electricity departments form a municipal board, who control this work and prepare plans showing the whereabouts of all pipes and cables. Conduit and manhole construction are next dealt with and plenty of practical advice is given. The paragraph on the sealing of ducts to prevent damage from inflammable gases to private property and manholes is good. So is the one dealing with special cable work required when passing under rivers.

In Chapter IV. economical methods of arranging services are described and illustrated. The back-yard method should be suitable for large towns. The next chapter deals with cables, and gives some valuable information about copper, rubber, paper and other materials used in cable manufacture; in this connection the mains engineer often finds a slight knowledge of chemistry an advantage. Methods of cable manufacture are described fully enough for the user, but not for the maker. The ordinary tables are given, and also some of special interest. Submarine cables for the transmission of power and the methods and precautions to be adopted in laying them are described.

Chapter VI., on the installation of cables, is the most important in the book. America is famed for its labour saving machinery, and they have applied this principle to the work connected with cables. Twelve large companies use electrically-driven trucks which haul the cable drums to the jobs, pull in the cable, deliver material and come in useful for emergency work. The author goes fully into the details of the practical work, rodding ducts, devices to protect cables from injury, grips for cable ends, and precautions to adopt in laying cables. He then deals with joints and gives some excellent illustrations showing the whole process for each type of cable. His description of tests made on sleeve filling compound are interesting. The production of ozone inside a cable and its effect on the insulating materials used may explain the origin of some mysterious faults. The question of the protection of cables in manholes is thoroughly discussed, and is one that should receive more general attention in this country. Undoubtedly most faults occur in manholes, and some of them at least are preventible. Another question the author discusses is the current carrying capacity of cables and duct temperatures. Some interesting tables are given, and various methods of artificially cooling ducts are described. The Geissler tube method of testing for live cables is illustrated.

The chapter dealing with the testing and localisation of faults is not so good. Some of the terms used are possibly American—"factor of assurance" and "capacitance" are specimens. The author's conclusions on the periodic high-potential testing of transmission cables may be disputed by some engineers. He finds that from the experience of a number of supply companies these tests increase the liability to subsequent breakdowns and often do not disclose existing points of weakness. The next chapter on distribution systems and auxiliary equipment is much more satisfactory. Diagrams of alternating-current networks are given and also all kinds of transformer connections. The descriptions and illustrations of cutouts, meters and their connections to the consumer's wiring show how improvements can be carried out in many places in this country. The chapter on electrolysis shows the difference between American practice and British. In America they have not our stringent rules regarding voltage drop in the rails of tramway and railway systems and have experienced much trouble in consequence. A short final chapter deals with mains records and the ordinary routine work that is necessary to keep a cable network in good order.

The author is to be commended for the good illustrations, forms of agreement and specifications with which the book abounds. W. A. TOPPIN.

The Public School System in Relation to the Coming Conflict for National Supremacy. By V. SEYMOUR BRYANT, M.A. (London: Longmans, Green & Co.) Pp. xviii.+78. 1s. 6d. net.

This brochure, to which Lord Rayleigh contributes a preface, deals with the evils of classical education as pursued by our public schools. Lord Rayleigh, while doubting whether an exclusively scientific training would be satisfactory, points out that the majority of boys, notwithstanding the time spent on classics, attain neither to a knowledge of the languages nor to an appreciation of the writings of the ancient authors. The author deals with education in both preparatory and public schools, with the advantages and defects of the public school system, and the policy that should be followed. That it is hopeless to expect much from a Head Masters' conference when over 80 per cent. of the head masters are classical men is obvious, and this view is emphasised by the curriculum proposed by the Conference in 1908. In this curriculum the study of the dead languages occupied over 40 per cent. of the school hours after the age when Greek became a subject. Parents would do well to study the figures here given, and ask themselves if such curricula, in which English as well as science is neglected, are not contrary to all common sense, and do not necessarily lead to no education instead of one that is "liberal." The author expresses the view that the public school system is so bad that it cannot be patched.

Digitized by Google

THE JUSTIFICATION OF THE DIFFERENTIAL.

BY C. G. CONRADI, M.I.MECH.E.

Considerable time and thought have at various times been bestowed upon the differential, with a view to simplifying its design or eliminating it entirely from the motor vehicle, whilst recently vehicles have been put on the market in the design of which no differential is embodied.

The differential is not absolutely essential towards the propulsion of the machine, and has always been looked upon more or less as a necessary evil. It is not to be wondered at, therefore, that efforts should have been made to dispense with it, especially when its use is attended by certain disabilities, as, for instance, when operating in soft ground or on greasy roads. Various arrangements of the ratchet drive have been tried, but without much success, on account of the difficulty of arranging for the reverse motion. Spring drives giving a certain amount of flexibility between the two coupled road wheels have also been tried with a fair measure of success, the best, perhaps, being that of Messrs. Schiedmann, who built a number of passenger 'buses on this system in Belgium. It has been claimed in some quarters that when no differential is used the tyre wear is less, but the writer is not aware that this has been substantiated by any actual results.

The desirability of eliminating the differential altogether, and so allowing of the adoption of a much simpler and cheaper design, prompted the making of a series of tests which might give a figure showing the value of the differential.

The ease and accuracy with which energy in the electrical form can be measured pointed to the use of an electrical vehicle for the tests, which were accordingly carried out on a 15 cwt. covered van built by Messrs. Electromobile (Ltd.), of Leeds. The vehicle was designed for a speed of 15 miles per hour, and weighed complete with battery, but without load, 30 cwt. The electrical equipment consisted of a 60-cell A4 Edison battery, supplying current to a double commutator motor with a modified series-parallel arrangement of control. The chassis is arranged with an all-gear drive, the motor driving the live axle through double reduction double helical gear, whilst a bevel geared differential of normal type is fitted. Both the gear box and the road wheels were fitted with ball bearings, the wheels being equipped with solid tyres, 810 mm. by 75 mm. and 810 mm. by 90 mm. on front and rear respectively.

The differential was securely locked when required by the insertion of brass blocks between the pinions and meshing with the teeth of the same, no movement being then possible.

The current consumed was measured by a Sangamo ampere-hour meter, the readings shown in the following table of results being current as charged to the battery and not output, as is frequently the case Great care was taken in making the tests to ensure as far as possible that the conditions of road and weather were identical, whilst differences in driving were eliminated by having the same driver on each occasion.

The runs were made over the same course with the battery in the same state of charge, the route chosen being an undulating one, and on the whole fairly level with stretches of good macadam and Tarmac. It formed a loop, and, therefore, the effect of the slight wind prevailing would cancel out, the accelerating effect on the outward journey equalling the retarding effect on the homeward run.

Condition of differential.	Load.	Miles.	Amp.-hours.	Amp.-hours. per mile.	Saving.
Free.....	Light.	18·1	93	5·13	7 p.c.
Locked	Light.	18·1	100	5·52	...
Free.....	11 cwt.	18·1	110	6·08	12 p.c.
Locked	11 cwt.	18·1	125	6·90	...

It will be observed from the tabulated results that, both light and loaded, the consumption of current is greater when the differential is out of action, the percentage difference increasing with increase of load. This is to be expected, as with increased load the tyres will grip the road better and more power be required to cause one wheel to slide when travelling on a curve.

As the machine runs entirely on ball bearings the whole of the additional power is apparently absorbed by extra wear on the tyres, the face of the tyres, even after only a small mileage had been run, presenting a totally different appearance from that of a tyre running under ordinary circumstances.

DIRECT-CURRENT WATT-HOUR METERS.*

BY R. ZIEGENBERG.

A watt-hour meter of the direct-current type suffers from serious notable defects. In the first place it is liable to be disturbed by external magnetic fields. Electric cables, laid too near the meter, may affect the readings, as also the presence of powerful magnetic fields; and consumers have been known to place permanent magnets near the meter with a view to affecting the readings. The weakness of the earth's magnetic field is sufficient to cause errors on low loads. For instance, on 5 per cent. of full load, the error may amount to 4 or 6 per cent. In the United States, it is the custom to make the final adjustments *in situ* so as to allow for the various local external influences. In large towns there are heavy currents in the cables and in tramlines, and the demand for a meter unaffected by external influences is very great. For heavy currents and switchboards a sort of astatic type, consisting of a kind of double meter, has to be used. Here two armatures are employed, which are exposed to fields of opposite polarity, but this increases the weight of the moving parts, and is also expensive. However, even this arrangement is not insensible to the near approach of a magnet. A further trouble arises at low loads from the effects of friction, and this increases as time goes on. With metal lamps and their low currents, this is serious; small consumers, too, cease to be profitable. It is, therefore, very necessary that the meter should read correctly between 3 and 10 per cent. of its full load. Moreover, when compared with meters of other types, its construction is too complex; it is too big, too heavy and too dear. The armature, too, is not very accessible; it is usually necessary to remove one of the field coils, and this generally upsets the calibration.

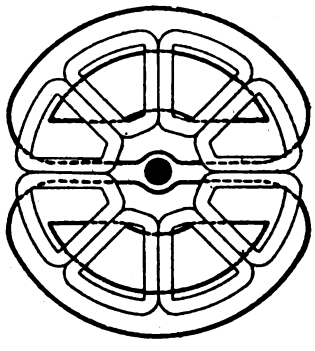


Fig. 1.—Disc Armature for a Meter.

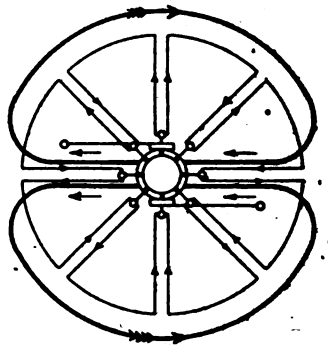


Fig. 2.—Disc Armature with Eight Coils

For some time a type has been known which is free from most of the serious defects attaching to the old drum armature. It has flat coils and a disc armature and its typical construction is shown in Fig. 1. The armature is compounded of sector-shaped coils, and moves in the magnetic field of two semi-circular current coils; thus one-half of the armature is exposed to a field of opposite polarity to the other. This is an astatic arrangement. Moreover, if the armature is placed above the field coils, it is easily accessible. It is, therefore, remarkable that the flat-coil armature should be so little used in watt-hour meters. The American designer Duncan used it towards the end of last century, and others have also made the attempt. But the fact remains that they did not succeed, and this was due to the very small torque of such an instrument. Still a properly constructed flat-coil meter can be made to have a normal torque. The fact was that, if the armature was divided into too many sections, the various coils tend, as far as torque is concerned, to counterbalance one another. Take, as shown in Fig. 2, an armature with eight coils and a corresponding number of commutator segments. Several coils are always exposed to the action of one field winding. The conductors of two neighbouring coils have currents in them as shown by the arrows and, as will be seen, the forces largely counter-balance one another. Only those coils which are

* Abstract of an article in the "Elektrotechnische Zeitschrift." Paper read before the Elektrotechnische Verein.

Digitized by Google

connected to the segments of the commutator that are actually at the moment under the brushes contribute to the effective torque; the rest only add unnecessary resistance and weight. It is much better to construct the armature with a limited number of coils; at the outside they ought not to be more than double the number of fields. In this case either each coil has its two radial conductors in fields of opposite polarity, in which case we have two torques of like sign; or at worst one radial conductor may be in a neutral zone, and, therefore, does not disturb the effective torque of the other. A flat-coil meter ought, therefore, to have only a limited number of sectors. A two-pole meter would therefore have two or at the outside, four coils. In this way we should get a normal torque as with the drum armature. Fig. 3 gives a diagrammatic sketch of a flat-coil meter with an armature having three sectors, which moves between two pairs of field coils, nearly semi-circular in form. Here there is practically no counterbalancing of torques. The moving parts can be made quite short; there is no difficulty in construction. We can get a torque of 6·5 to 7 gramme-cm., the weight of the moving parts is 75 grammes, and the shunt takes 0·015 ampere. The author gives a diagram, showing how much more compact this form of construction is than that having a drum armature. One can choose whether to place the field coils on one side only of the armature, making the latter very accessible, but sacrificing something in torque; or, as shown in Fig. 3, to place field coils on both sides, in which case we have an increase of torque amounting to 35 or 40 per cent.

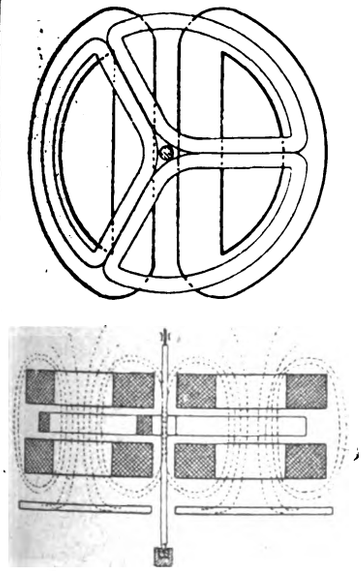


FIG. 3.—FLAT-COIL METER WITH AN ARMATURE HAVING THREE SECTORS.

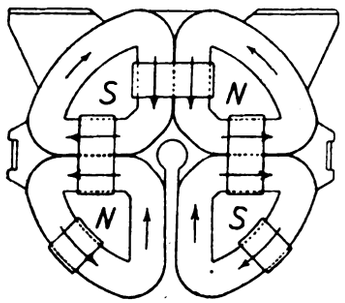


FIG. 4.—FOUR-POLE MAGNET.

Even so, there remains the serious objection that only the radial portions of the armature sectors are effective in producing torque; the circumferential portions add weight and resistance without contributing to the torque. The inactive portion of the copper is thus a serious fraction of the whole. But questions similar to these have led designers to prefer a multipole type of direct-current generator to the two-pole type. In this case, if we decrease the angular width of the sector, and so diminish the circumferential proportion of copper, we get led to a multipole type. Admittedly this complicates the construction; a reasonable mean between conflicting requirements probably leads us to adopt a four-pole construction. Fig. 4 shows such a construction. There is seen to be a small gap between two of the field coils through which the armature can be removed, if necessary. This four-pole construction has the advantage that the arrangement is doubly astatic, and an analysis will show that this type is practically independent of the effects of any external influence. This type also allows us to produce a powerful magnetic field with a relatively small amount of copper. The connections in the armature are similar to those in a four-pole direct-current generator. Two opposite armature coils are connected in series, and so form one unit. The three armature units are then connected to three neighbouring segments of a commutator having six segments in all. The commutator itself is so arranged that opposite segments are connected together. A simple method of construction is shown in Fig. 5. The commutator is built up of straight silver strips, of the shape shown. These are bent somewhat into the shape of a staple, which thus forms two opposite segments with the connecting piece. The central hole fits on the armature spindle, insulating pieces are needed to separate the various segments, and three such staples will complete the commutator with its six segments and three connecting pieces.

The number of revolutions is usually counted by transmitting from the armature spindle through a worm and worm-wheel to the counting mechanism. The friction of this movement is very serious; and the matter has of late become still more troublesome owing to the extensive use of roller wheels in series on which the figures are placed. The resistance is very great when the counting mechanism passes from 19 to 20 or from 99 to 100. On a light load many a

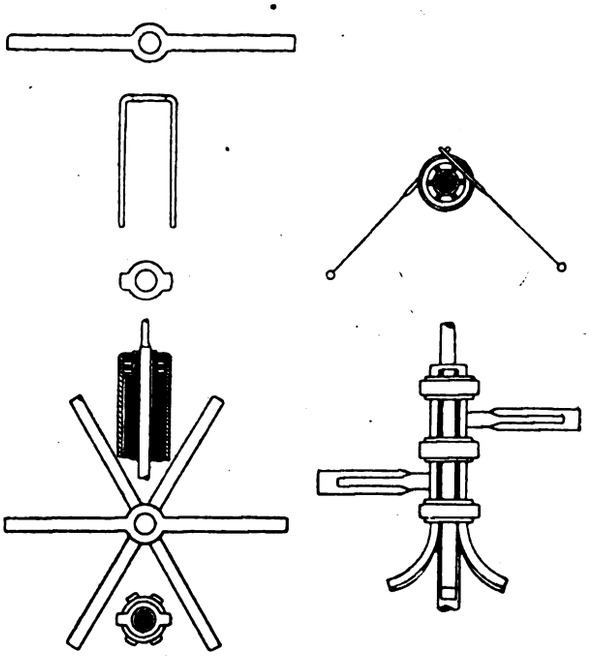


FIG. 5.—CONSTRUCTION OF THE COMMUTATOR.

meter will stop altogether at this point until a heavier load enables it to overcome the frictional resistance. Dr. Schmiedel, of the Reichsanstalt, has examined a number of new meters with regard to this point. He examined seven commutator meters and found that the friction of the counting mechanism varied according to the workmanship and method of gearing from 7 to 28 per cent. of the total friction of the meter. In one case this figure actually rose to 54 per

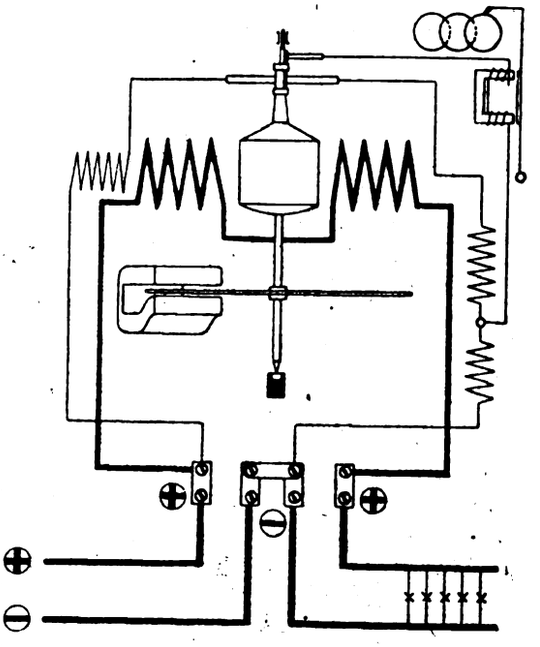


FIG. 6.—ELECTROMAGNETIC DRIVE OF THE COUNTING MECHANISM.

cent. These figures were found on new meters, and might be expected to get worse after the meters have been in use for some time. Anyhow it is plain that this friction cannot be neglected. Electromagnetically-driven counting mechanisms have often been used. They are excited by the shunt of the meter, and actuated through a contact which is closed by the revolution of the armature of the

Digitized by Google

meter. Evershed has proposed a construction of this sort, and there is also the oscillating watt-hour meter of the A.E.G. In the latter case a method is proposed by which there is a fairly high voltage at the moment when the contact is closed, but at the moment when the circuit is broken, there is only a pressure of a few volts; in this way, the satisfactory working of the device is assured, and the contacts have a sufficiently long life. The author's method is decribed diagrammatically in Fig. 6, and the sketch explains itself. But this extra contact is a possible source of trouble, and the suggestion has been made to utilise the natural and inevitable variation of current that takes place in the armature of the meter. Evershed's very interesting suggestion has this object in view; he inserts in an

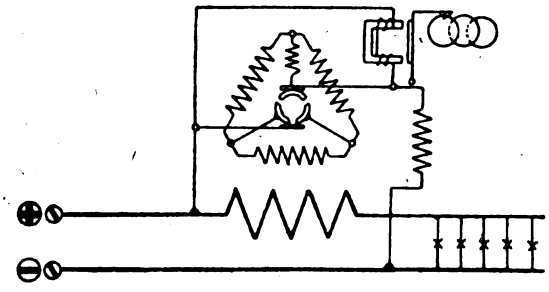


Fig. 7.—Connections for Driving Counting Mechanism.

armature coil a small coil surrounding the spindle, in which there is periodically a reversal of the current. Evershed embraces this small coil either by another larger coil or by a permanent magnet. Thus, he obtains a periodic movement which can be transferred through a pawl and ratchet to the counting mechanism. There are constructional difficulties about this plan; the main one is that the counting mechanism must be very close to the armature. But for the actuation of an electromagnet it is not necessary completely to break its exciting current; a periodic movement can be effected by a periodic variation in the excitation. We might use a current that varies synchronously with the revolution of the armature. A suggestion of this kind is illustrated in Fig. 7. Let us take a normal three-coil armature with closed windings, and insert an additional resistance of given amount between the winding and one of the commutator segments. Then, as soon as the brush touches this segment, the voltage between the brushes will fall by an amount equal to that due to the passage of the armature current through this resistance. Let us now join to the brushes an electromagnet with many turns of very fine wire, which actuates the counting mechanism. Then we can give a proper value to the additional accessory resistance in the armature, and this value must be such that the variation in voltage is sufficient with certainty to actuate the relay. The magnet, actuating the counting mechanism, will on this plan always carry a very small fraction of the armature current, which is of itself insufficient to excite the magnet. Excitation is only effected by the higher voltage of the brushes.

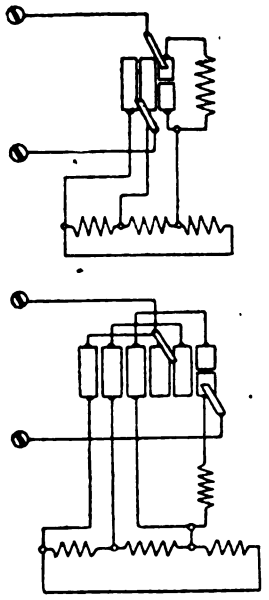


Fig. 8.—Method Employing Divided Commutator Segment.

Now, with a two-pole meter this rise of brush voltage takes place twice in each revolution; with a four-pole meter it takes place four times. But with an overload of 25 to 50 per cent. the relay may work too fast. We can, however, attain our object if the segment, to which the accessory resistance is connected, is divided, and the resistance is connected between the two halves of the segment; the brushes are so displaced that the upper brush only makes one contact with the upper half-segment during each revolution, while the lower equally makes only one contact with the lower half-segment, as s own in Fig. 8. Then the necessary rise in the brush-voltage only occurs once in each revolution at the instant when the upper half-segment touches the upper brush. This plan can be adapted to a multipole armature. In the lower part of Fig. 8 there is shown a four-pole armature with three armature sections and a commutator having six segments. Here again the voltage-rise for working the counting mechanism only takes place once in each revolution. This electromagnetic drive can be applied to any construction of armature. The commutator must, however, be somewhat modified. As shown in Fig. 5, it is made in two parts, somewhat longer than usual; there is an insulating ring in the middle, which maintains the parts in position. This form of construction also has the advantage of preventing the brushes making accidental contact with one another, which is quite a possible mishap with a four-pole construction where the brushes are separated by 90 deg. The counting mechanism is driven by an electromagnet or relay of the simplest form, the armature of which is directly connected to the pawl. A current of 0·0012 ampere flows continuously through it without causing the relay to work while a current of 0·0025 or 0·003 ampere is sufficient to lift the pawl. There are many advantages resulting from this method of construction. The error is very small in consequence of the disappearance of the friction of the counting mechanism, and the meter can be made more compact and less heavy. There are also other advantages to which the author calls attention, such as the possibility of installing the counting mechanism at a distance from the meter, and it is therefore specially suitable for use on a switchboard.

THE LUBRICATION OF RESISTANCE BOX PLUGS.*

BY J. J. MANLEY.

During March, 1914, as a preliminary step in some work with platinum thermometers, it was neccsary to standardise some resistance-coils. It appeared that for highly accurate work advantage would be gained if the plug-resistances of these sets of coils could be made practically invariable. Initially it was sought to secure this object by frequently re-polishing the plugs and their seats with emery-dust paper; and as a further aid to constancy each plug was used only for that seat in which it was found when the coils arrived from the makers.

When a plug is seated by the usual screw-like movement, the engaging surfaces tend to plough each other, and as a result burrs and grooves appear upon both; the existence of such grooves is readily verified with the aid of a lens. These burrs and grooves, which change in size, number and form as the coils are used, appear to be entirely responsible for the variations observable in plug-resistance.

A too frequent re-polishing of the plugs, besides being highly inconvenient, is prejudicial to accuracy; the authors were, therefore, led to try the effect of several lubricants, and the plan was immediately successful.

Dr. Glazebrook states that this method is not new, that Mr. Price some 12 or 14 years ago showed that contact resistance is reduced by the application of petroleum either in the form of a film or bath, and that for some years past it has been the custom at the National Physical Laboratory to lubricate box plugs and switches with paraffin. Seeing that no special description of the method has been published, an account of some quantitative experiments recently carried out with the aid of five boxes of coils may be helpful to other observers.

To begin with, the plugs and seats of box No. 1 were polished and wiped with a clean cloth. Next, strips of stout writing-paper were, with the aid of resin cerate, fixed to the vertical faces of the row of brass blocks. As the upper edges of the paper were somewhat higher than the top of the blocks, a trough was thus formed, and this was filled with oil of the kind used in a Geryk pump. All the plugs having been normally seated, their joint resistance was measured by Carey Foster's method; the plugs were then loosened, re-seated and their resistance again determined. These several operations were performed 10 times, and from the 10 independent values a final mean value was calculated.

Secondly, the strips of paper were removed and the oil allowed to drain away; but the plugs and their seats were not wiped. A new series of measurements was then effected, and from the results obtained another final mean value was calculated.

Thirdly, the oil was entirely removed, the plugs lubricated with medicinal paraffin oil, and a further series of observations proceeded with. For a fourth series the lubricant was "pure" vaseline.

Finally, the plugs, their seats and the ebonite top of the resistance box were, with the aid of purified benzene, thoroughly free from the lubricant and a last series of determinations of the total plug-resistance carried out.

* Abstract of a Paper in the "Philosophical Magazine."

Digitized by Google

Table A.—*Box No. 1. Fitted with Nine Plugs.*

Exper.	Resistance.				
	Plugs in bath of Geryk pump oil.	Plugs smeared with Geryk pump oil.	Plugs smeared with medicinal paraffin oil.	Plugs smeared with vaseline.	Plugs unlubricated.
	(1) Ohm.	(2) Ohm.	(3) Ohm.	(4) Ohm.	(5) Ohm.
Means	0·00135	0·00118	0·00124	0·00116	0·00119
Max. value	0·00170	0·00137	0·00142	0·00129	0·00194
Min. value	0·00116	0·00095	0·00094	0·00109	0·00023
Variation = ...	±0·00027	±0·00022	±0·00024	±0·00010	±0·00086
Variation = ...	±20%	±18·6%	±19·3%	± 8·6%	±72·2%

The data obtained show that in every instance a distinct advantage is gained by lubricating the plugs. For two series, (1) and (3), the mean resistance of the oiled plugs is greater than the normal value (series (5)). In accurate work this is of no consequence, as the plug-resistance must in any case be measured; but when this has been done it is highly desirable that the resistance should remain invariable, and this end, is, it appears, best attained by the use of vaseline. Confirmatory evidence of the value of vaseline-lubrication is afforded by tests on two other boxes, particulars of which are given in the original paper. In general, on bringing newly lubricated plugs or switches into use, their joint resistance diminishes for a short period, and then becomes for all practical purposes constant.

THE PRESCOT TWIN HOUSE WIRING SYSTEM.

A booklet issued by British Insulated & Helsby Cables (Ltd.) describes the Prescot wiring system, and illustrates various accessories, such as joint boxes, bases and distribution boxes, some of which are shown in Figs. 1 to 4.

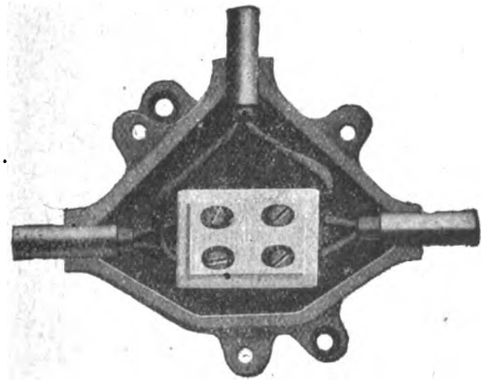


FIG. 1.—TEE SINGLE WAY.

In this system the house wire is made up of two copper conductors insulated with impregnated paper and covered with a lead sheath. As the paper is hygroscopic it is necessary, when the cable is likely to be exposed to moisture, to seal thoroughly all points where the lead is removed, and special provision for this is made in the fittings provided. Originally the conductors were soldered together at joints, which after insulation were covered with sheet lead. But a series of fittings has now been introduced which greatly reduces the labour of jointing and obviates the use of a soldering iron, at the same time ensuring electrical continuity of the lead sheath. The joint boxes and bases are of cast metal, and, where necessary, contain brass contact pieces enclosed in porcelain or provided with micanite separators. The glands are drilled to fit the various sizes of cable in such a way that when the two halves are screwed tight the lead sheath is tightly gripped, thus securing the desired continuity.

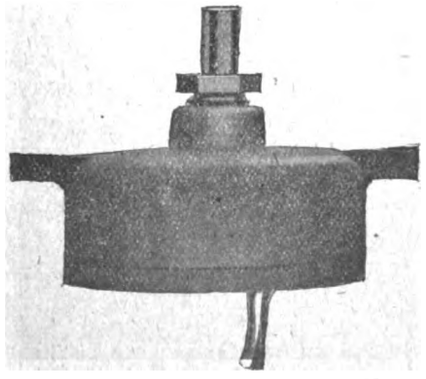


FIG. 2.—STANDARD UNIVERSAL SEALING BASE (NOZZLE TYPE).

In Fig. 1 a typical tee single-way joint box is shown, while Figs. 2 and 3 show the nature of the universal sealing bases. Here there are two distinct types, the split type, in which continuity of the joint is attained in the same way as in the joint boxes, and the nozzle type in which a small nozzle is screwed into the gland and grips the lead. A typical distribution box with double fuses and suitable for currents up to 10 amperes is shown in Fig 4.

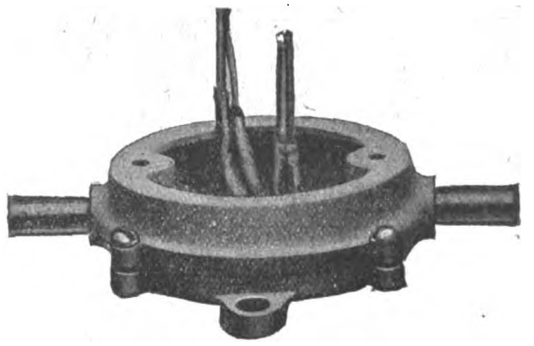


FIG. 3.—STANDARD UNIVERSAL SEALING BASE (SPLIT TYPE).

A feature of the system is its flexibility, which enables the laying of wires in positions where it would be difficult or impossible to erect casing or tubing. The cost of insulation is low, and the jointing connections enable joints to be made readily and easily. It is essential that the lead sheathing should be connected to earth, and the electrical continuity then ensured throughout the system renders it impossible for persons to receive shocks from leaky fittings, &c. Moreover, partial leaks are impossible in the event of a fault occurring owing to damage of the sheath of the cable. Any fault of this nature would necessarily result in the blowing of a fuse.

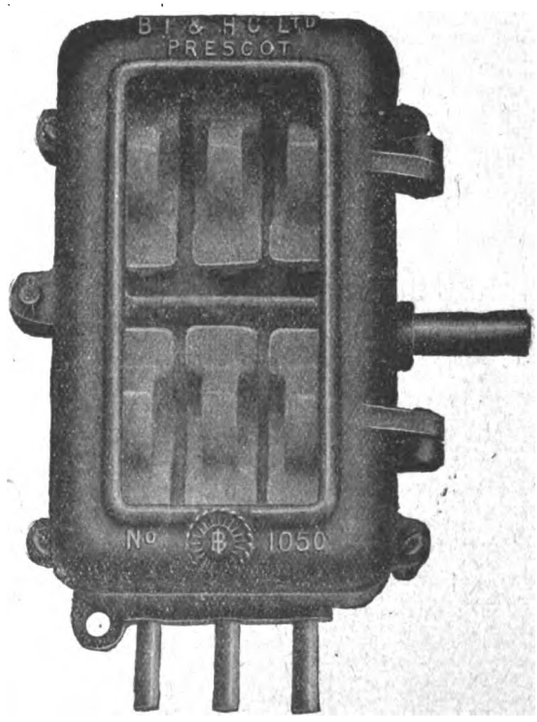


FIG. 4.—DISTRIBUTION BOX WITH DOUBLE-POLE FUSES (UP TO 10 AMPS.).

The system has been largely employed for important public buildings. It is stated that in one district it has been the principal method of wiring for over 18 years, and that of 1,500 houses connected up in this district during the last three years before the outbreak of war, 1,200 were wired on the Prescot twin house wire system.

Digitized by Google

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

5,842 B.T.-H. Co. & WHITAKER, F. P. Dynamo-electric machines. (20/4/16.) 107,993.
5,858 BERRY, A. F. Electric fuses. (20/4/16.) 107,994.
6,782 ANTONI, G., & ANTONI, U. Aeroplanes. (12/5/15.) 100,455.
10,023 BEAVER, C. J., & CLAREMONT, E. A. Electric joint-making washer. (17/7/16.) 108,015.
10,178 BENNITT, W. B. Controllers for electric motors. (19/7/16.) 108,030.
A controller for electric motors having a reversing drum provided with three sets of contacts and a shaft rotatable from the exterior of the controller casing, by which the reversing drum may be turned without moving the cam plate which actuates the usual interlock between the reversing and main drums to any one of three positions from which when the shaft is further rotated by the reversing handle to either forward oe reverse position, the reverse drum will be moved so that a determined pair of said sets of contacts will be caused to engage the co-operating stationary conracts.
11,360 BENHAM & SONS & ALLENSBY, C. R. Electric heaters for water and other liquids. (11/8/16.) 108,045.
11,371 B.T.-H. Co. (G.E. Co.) System of ship propulsion. (11/8/16.) 108,047.
12,396 RENNERFELT, I. Electric furnace. (8/9/15.) 101,412.
12,561 HOLT, W., & BROOKS, B. Dynamo-electric machines for combined electric lighting and ignition in connection with motor-driven vehicles and the like. (5/9/15.) 108,062.
17,752 BERRY, H. H. Electric fire or radiator. (9/12/16.) 108,097.
18,504 MIDGLEY, A. H., & VANDERVELL & CO., C. A., Electric starters for internal-combustion engines.

1917 SPECIFICATIONS.

438 BETHENOD, J., & GIRARDEAU, E. High-frequency alternators. (10/9/15. Divided application on 10,576/16.) 103,657.
A high-frequency alternator, having the magnetic part of the rotor formed of segments of thin plates provided with teeth and held in place by means of tenons, the radii of the curved portions of the tenons being approximately equal to the height of the teeth forming the polar projections, and the number of tenons being either independent of or dependent on the number of the teet h.
2,332 BOOTHROYD, G. S., & CALLENDER'S CABLE & CONSTRUCTION CO. Sealing and bonding glands for electrical junction boxes. (16/2/17.) 108,125.
3,091 RUTHERFORD, A. P. Carrier or means for supporting electric lamp or other shades, reflectors and the like. (2/3/17.) 108,129.
6,196 CABLE ACCESSORIES CO., REEVES, F. H., & DAVIS, P. W. Electric irons and the like. (2/5/17.) 108,139.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

June 15, 1917.

8,628 ISENTHAL. Variable electric resistances.
8,631 WESTON. Magnetic belting. (8/1/17, Australia.)
8,634 CREEDY. Phase transformers or converters.
8,638 EDISON ACCUMULATORS (LTD.), MONNOT & LEWIS. Electric controllers.

June 16, 1917.

8,659 ELECTRIC & ORDNANCE ACCESSORIES CO. & LANGRISH. Controlling and regulating devices for electric motors.
8,682 FAWCETT & HOYLE. Holders or fittings for electrodes of electric furnaces.
8,690 TAYLOR & WILLIS. Reflectors for electric lamps. (11/8/16, Australia.)
8,692 BERRY & QUAIN. Electric heating.

June 18, 1917.

8,713 ST. HELENS CABLE & RUBBER CO. & WHITE. Locking devices for electric fittings
8,721 BRITISH INSULATED & HELSBY CABLES, BUCHER & ROBINSON. Electric welding machine, &c., switches.
8,722 BRITISH INSULATED & HELSBY CABLES & BLADES. Removable electric fuse carriers or connecting devices.
8,724 MCDONALD. Electric motors.
8,726 JOHN. Device applicable to spring-controlled switches of telephone receivers.
8,738 HARLOW. X-ray apparatus.
8,740 WINTERBOTHAM. Electrically-heated cooking stoves.
8,748 ROLLS-ROYCE (LTD.). Electric contact breakers.
8,759 GREVILLE. X-ray tube stand and table.

June 19, 1917.

8,791 COOPER & TODMAN. Automatic voltage regulation.
8,792 VIOLET. Ignition device.
8,814 ETLINGER. Adjusting electric and gas lamps.
8,817 BRUSH ELECTRIC ENGINEERING CO. & CHILTON. Double rotation turbines.

June 20, 1917.

8,826 LAVENDER & PANNELL. Portable electric drier for drawings, &c.
8,836 ROGERSON. Electric welding machines.
8,854 B. T.-H. Co. (G. E. Co.) Electric locomotives.

June 21, 1917.

8,894 VON KRAMER. Wireless telegraphy, &c.
8,908 HOUGH. Electric regulating resistances.
8,926 BRADLEY. Electric treatment of gases. (21/6/16, U.S.)
8,933 and 8,934 B. T.-H. Co. & POLLOCK. Dynamo-electric machines.
8,937 LA ROCHE. Electrically-driven road vehicles.
8,940 CHEETHAM. Indicating electric instruments.
8,945 CRYPTO ELECTRICAL CO., SHARP & SHAW. Rotary transformers or converters.

June 22, 1917.

8,964 SEYMOUR. Electric cables or conductors.
8,992 BRITISH INSULATED & HELSBY CABLES & BAYLES. Rubber insulated electric cables or conductors.
8,995 MURRAY. Testing electric ignition.
9,008 FLETCHER. Apparatus for obtaining parallel beam of light.
9,014 BIRBY. Transformers for electric furnaces, &c.
9,017 GUINNESS. Sparking plugs.

June 23, 1917.

9,024 CONNER & PUCKETTE. Interrupters of magneto-electric machines.
9,025 PATTISON. Electro-magnetic submarine mine with switchboard control.
9,039 WRISTON. Non-carbonising ignition plug.
9,047 THOMSON. Electric temperature regulator.
9,061 B. T.-H. Co. (G. E. Co.) Braking systems for electric vehicles.

June 25, 1917.

9,073 BAKER. Potentiometers, variable resistances and rheostats.
9,086 ST. HELENS CABLE & RUBBER CO. & WHITE. Terminal sockets for elec. conductors.
9,092 STANDARD MOTOR CO. & MAUDSLAY. Control mechanism for elec. fittings of motor vehicles.
9,108 ATHERTON. Elec. signalling devices.
9,111 KOWALSKI. Elec. condensers for h.t. and high-frequency currents. (24/6/16, Switzerland.)

June 26, 1917.

9,134 COWELL & COX. Elec. switches.
9,146 WOOD. Trolley heads of electric vehicles, &c.
9,153 KERMAN & MATHIAS. Device for fixing fuse wires to electrical installations.
9,165 TURNER. Electro-pneumatic brake system. (6/12/16, U.S.)
9,168 B.T.-H. Co. (G.E. Co.) Fluid pressure brakes.
9,182 DELAGE. Magneto controlling device for motors. (1/7/16, France.)

June 27, 1917.

9,208 SPHINX MFG. CO., CLARKE & LONGFORD. Ignition plugs.
9,232 & 9,233 HUTCHINS. Electrolytic cells for production of chlorine.
9,239 PICKETT & WEST. Elec. boat raising and lowering apparatus.
9,243 FAUCHON-VILLEPLEE. Elec. gun on apparatus for propelling projectiles.
9,245 SOC. ANON ITALIANA GAUSALDO & CO. Electric drive of submarines.
9,251 GILL & GRANT. Electric advertising device or sign.

June 28, 1917.

9,256 HUNTER. Trolley wheels for tramcars, &c.
9,267 CRABB. Elec. generators.
9,287 B.T.-H. Co. (G.E. Co.) Wireless signalling systems.
9,302 BAUCHELLE. Spark plug energiser.
9,305 MASON. Ignition dynamos.
9,308 KOWALSKI. Elec. condensers for h.t. and high-frequency currents. (13/4/16, Switzerland.)
9,312 WEST & BOSSOM. Electro-magnetic lock-out switch.
9,320 COOK & MONNOT. Mechanical and electrical horns.
9,321 GUINNESS. Sparking plugs.
9,335 BUCKELL. Telephone receivers, &c.

June 29, 1917.

9,339 BRIT. INSULATED & HELSBY CABLES & BLADES. Terminal box elec. cable or conductor insulators.
9,350 BURLEIGH. Dynamo-elec. machines.
9,371 MASTERS. Elec. telephones.
9,383 B.T.-H. Co. (G.E. Co.) Elec. motor control.
9,386 BAILEY. Electrical contact devices.
9,389 SCOTT. Applying radio-active substances to render objects luminous.
9,404 & 9,405 IMRAY. (Bosch.) Interrupting devices for ignition of internal combustion engines.
9,412 AUSTIN & TODD. Apparatus for starting elec. motors.

June 30, 1917.

9,450 KAULBACH. Dynamo-elec. machines.
9,470 VANDERVELL & MIDGLEY. Elec. switches.
9,477 PERRETT. Sparking plug connections.
9,480 PEARCE. Protective apparatus for alternating elec. current circuits.
9,482 JACOB. Insulated elec. conductors or cables.
9,488 SANKEY & STEVENS. Control of combined engines and elec. generators.
9,489 BERRY. Treatment of magnetic material for static transformers.

July 3, 1917.

9,501 HOWARTH. Sparking plugs.
9,521 PERRETT. Connecting h.t. leads to sparking plug.
9,552 HARROP. Electric accumulators.
9,553 LEITNER. Active material in accumulator plates.
9,554 LEITNER. Supports for accumulator plates.
9,558 ADAMSON. Elec. rivetting, stamping, &c., machines.
9,573 LEITNER. Separators or non-conducting supports for accumulator plates.
9,579 WHITE & BURGE. Elec. lanterns for hand-signalling.
9,584 CRITTALL MFG. CO. & PRIMROSE. Electric furnaces.
9,585 MARCONI'S WIRELESS TELEGRAPH CO. & PLATT. Interrupters.
9,587 SIMMS. Elec. condensers.
9,595 LATOUR. Electro-magnetic apparatus.

July 4, 1917.

9,631 BASTIAN METER CO. & SALISBURY. Electrolytic electricity meters.
9,675 VICKERS & BROWN. Dynamo-elec. machines.

July 5, 1917.

9,724 B.T.-H. Co. (G.E. Co.) Voltage regulators.
9,747 CONRADI & NEWITT. Electric fuses.
9,759 BEAVER & CLAREMONT. Machines for covering wires, &c.

July 6, 1917.

9,781 FITTON. Field telegraph, &c., apparatus.
9,784 PETITHORY. Telephones.
9,801 BERRY & MARKHAM. Elec. switches.
9,811 & 9,816 MELLERSH & JACKSON. (Bosch Magneto Co.) Multipolar magnetos for elec. ignition.
9,817 MERZ & MCLELLAN & MICHIE. Use of solid fuel for large scale power production.

July 7, 1917.

9,855 KOWALSKI. Spark dischargers producing impulse-excitation and h.f. sparks (25/7/16, Switzerland.)

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Lieut.-Colonel C. B. CLAY, V.D., Commanding.

Orders for the Week.

Officer for the Week.—Lieut. W. J. A Watkins.
Next for Duty.—Second-Lieut. P. Bowden.
Monday, Sept. 3.—Technical instruction (searchlight for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling Class, 6.30. Recruits' Drill, 6.30.
Tuesday, Sept. 4.—Physical Drill and Bayonet Fighting, 7.30.
Wednesday, Sept. 5.—Drill and Elementary Bridge Construction for No. 1 Company, Left Half Company.
Thursday, Sept. 6.—Drill and Elementary Bridge Construction for No. 2 Company, Left Half Company. Signalling Class, 6.30. Ambulance Class, 6.30.
Friday, Sept. 7.—Technical Instruction (Searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' Drill, 6.30.
Musketry.—All N.C.O.'s and men who have signed the "A" and "B" agreements are required to attend during this month to re-classify in order to enable the Corps to obtain the capitation grant. Preference will be given to these men in firing. This does not apply to those who hold the proficiency badge.
Armlets.—The new issue armlets can now be had at headquarters, and every enrolled man must obtain one without delay; at the same time all old red armlets (now obsolete) must be returned.
Note.—Unless otherwise indicated, all drills will take place at headquarters (Balderton-street, Oxford-street)

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

Consular Service Reform.

The "Manchester Guardian" announces that the new scheme for the reform of the Consular Service provides for the abolition of the present dual control by the Foreign Office and the Board of Trade and for placing it under an enlarged Commercial Intelligence Department. "A feature of the scheme is that there is to be a Parliamentary Secretary responsible jointly to the Foreign Office and the Board of Trade, who will be answerable for the whole of the commercial intelligence service in the House of Commons." This part of the scheme, which looks like an attempt to avoid the creation of a Ministry of Commerce, is certain to meet with criticism in the House; it is an entirely new departure in the Civil Service and has little to recommend it.

For our own part we are not enamoured with the proposed scheme, and our experience of the Commercial Intelligence Department does not justify us in anticipating good results from it. The scheme may be (as our contemporary puts it) "a step farther in the notable improvement that has taken place during the war in the intelligence service," but we have not ourselves noticed the notable improvement. We are of opinion that the consular service should be in the hands of a Ministry of Commerce which would be aided by a strong committee of commercial men. We feel sure that the commercial and trading interests of the country will not be satisfied with any scheme which does not give a voice in its control and management.

It is reported that there is to be a large increase in the commercial intelligence staff by the addition of men trained in commerce. The aim is to set up throughout the world an efficient service capable of dealing with the new and difficult conditions that will obtain after the war. The trade commissioners are to be increased from four to 16 immediately, covering not only the Dominions but India and other parts of the Empire. The hope is that the Government machinery both in the collection and dissemination of commercial information will be greatly improved and brought more closely into touch with traders.

* * * *

German Reconstruction Schemes.

In "The Times" of the 28th inst. particulars were given of the steps taken in German industrial circles to secure a supply of raw materials after the war and to resume and develop their foriegn trade. In a long resolution recently passed by the Association of German Chambers of Commerce, the question of the importation and distribution of raw materials is dealt with, and the following policy is recommended:—

The removal of restrictions on trade is of the greatest importance for Germany's international trade. Restrictions upon the importation of raw materials should be confined to measures which are necessary for economising the resources of German shipping and German railways, and for raising the value of the mark. Where restrictions are necessary they should be applied to any other goods rather than to important raw materials. The State should not attempt to control individual bargains by refusing means of payment, but should do everything possible to facilitate payments by means of foreign loans and credits and foreign money. During the period after the conclusion of peace, during which scarcity of raw materials continues it is necessary "for social reasons" to distribute raw materials as equally as possible, according to the capacity of particular concerns and the extent of their activities immediately before the war. The various industries should establish their own distribution centres, but these centres should not be given any monopoly of freight space and foreign money; they should "leave the importation of raw materials as much as possible to free trading"; care must be taken to guard the respective interests of industry and trade. It is insisted that the compulsory fusions of businesses which have been effected under the Auxiliary Service Law should be abandoned immediately after the end of the war.

The chambers of commerce are opposed to legislation which would compel employers to take back former employees on their return from the war. They express general approval of the Government proposals for demobilisation and say that in particular it is much better to retain men with the colours for a maximum period of four months, or until they have obtained definite employment than to attempt any ambitious scheme of support for the unemployed.

* * * *

Steel and Wrought Iron Scrap.

The Minister of Munitions has issued an Order that steel scrap of all classes and description is "war material" within the meaning of the Regulations, and cannot, therefore, be dealt in without a permit. He also issues a notice of the modification of the general permit in regard to dealing in wrought iron scrap.

Reserve Funds of Municipal Undertakings.

We notice that in some towns substantial sums are still being devoted out of the annual profits of municipal electricity supply works and electric tramways to the relief of rates. We suggest that this is an unwise course to adopt during the war, and it would be much better if strong reserve and depreciation funds were built up so as to be ready to carry out the extensions and improvements that will be necessary when peace comes, and thus be in a position to supply cheap electrical energy for industrial and other purposes. In many towns extensions of plant and mains have had to be postponed, while tramway track renewal work, overhauling of rolling stock, &c., has been suspended, and this very essential work will suffer unless the undertakings are in a sound financial position. We are glad to notice that some managers of municipal undertakings are adopting a more cautious policy as to the allocation of profits. For instance, the acting electrical engineer and manager at Grimsby (Mr. A. S. Channon) says in his annual report:—

"In considering the question of the disposal of the balance of £1,543. 14s. 10d., I would like to draw attention to the desirability of building up the reserve fund. The large extensions which will in all probability have to be made in the near future will tax very heavily the finances of the undertaking and the first year after the extensions have been made the revenue may not be sufficient to meet all requirements. A substantial reserve fund would in such circumstances prevent a call being made upon the rates and I strongly recommend that the balance now available should be placed to the credit of the reserve fund, as was done with the balance last year."

We think that the course suggested by Mr. Channon is very prudent under the circumstances and we are glad to note that it was adopted by the Council. We could wish that all authorities would take a similar course.

* * * *

Foreign Trade of the U.S.A.

The statistics of the foreign trade of the United States of America for the fiscal year ended June 30 show that the exports and the balance of exports over imports created records.

The value of the exports was $6,294,000, compared with $4,333,482,885 in 1915-16, and the excess of exports was $3,635,000,000, against $2,135,599,375. The commodities, the exportation of which showed a more or less important expansion, included electrical machinery, aluminium, zinc, agricultural implements, glass, mineral oils, &c. There was a decrease in the export of motor-cars. For the large increase in exports generally the demands of the Allied nations were mainly responsible, but there were notable gains in the country's trade with the South American Republics, the West Indies, China, Australia and Africa. High prices, however, played an important part in the expansion in the value of the exports, probably 75 per cent. of the increase is accounted for by the higher prices. The total value of the exports of pig iron, scrap iron and steel, steel billets and steel plates was $198,000,000 in 1916-17, compared with $62,093,000 in 1915-16 and $11,727,000 in 1914-15.

* * * *

The Importance of Cheap Power.

In certain parts of Canada, though there is a lack of coal fuel, there is an abundance of "white coal." The importance of this water-power is exemplified by the rapid industrial development of the districts in which hydro-electric power is available.

It is announced that at Fort William, Ontario, arrangements have been completed for the establishment of a large pulp and paper mill which will be supplied with 8,500 H.P. of electrical energy from the Kakabeka Falls on the Kaministiquia River. About 600 hands will be employed at the mill. Similarly, at Shawinigan Falls, in the Province of Quebec, new industries are being attracted to the district. A subsidiary company of an American abrasive manufacturing organisation is erecting a large plant at Shawinigan Falls, Quebec, for the purpose of manufacturing carborundum and other abrasives. A contract has been made with an electric power company to supply 20,000 H.P. to the new works.

* * * *

Machinery Imports.

A Royal Procalmation has been issued prohibiting the importation into the United Kingdom of all machinery driven by power and suitable for use in cutting, working or operating on wood, and all machines for grinding, planing or moulding irons, and electrical motors up to ½ H.P.

The prohibition does not apply to any such goods which are imported under licence given by or on behalf of the Board of Trade, and subject to the provisions and conditions of such licence.

Digitized by Google

ELECTRICITY SUPPLY.

GENERAL.

Belfast.—Some 38 men and boys employed by the tramways and electricity departments have come out on strike.

It appears that the overhead linesmen who had formerly been paid at the rates approved of by the Electrical Trades Union, were informed by Mr. Moffett (tramways manager) that in future their rate would be the same as that which obtained in other centres for men doing similar work. This meant that the men would receive 9d. an hour instead of slightly over 1s. 1d., and hence the strike.

Bethnal Green.—The Borough Council recently received sanction to a loan of £1,000 for house services, &c.

Crayford.—The Parish Council has been informed by the West Kent Electric Co. that they cannot supply electric current for lighting on the London road area, but further trunk feeders would shortly be laid in the direction of Crayford, which might help matters.

Dundee.—The Council has decided that all officials with salaries of £300 and under should be given a war bonus of 15 per cent., and that officials with salaries over £300 should be give a war bonus of 7½ per cent.

Forfar.—The question of the supply of electric power in Forfarshire was considered by the County Council last week.

The County Councils Association had requested the Council to supply answers to certain questions in regard to power supply, with the view of submitting evidence to the Board of Trade Committee on Electric Power Supply.

The chairman (Mr. WM. SMITH) said that so far as he could see the only source from which the county could obtain supplies would be from the burghs, and Col. MacHardy said Dundee might supply the whole of Forfarshire.

Mr. Alex. Lyell remarked that there was some idea of "harnessing" the water forces of the country with the view of producing electric power and there was a number of streams in the county which could be used for that purpose. Provost Ogilvy said he looked upon it as an endeavour to get a cheap supply of electricity for the country. Kirriemuir had considered the question of utilising the available water power in the district, but it was felt that nothing could be done, and, so far as that district was concerned, it was to Dundee that they must look for a supply. Eventually the Clerk was instructed to reply to the questions.

Glasgow.—At the meeting of the Corporation last week Mr. Denny objected to the minutes of the Electricity Committee containing the proposed scale of charges for the supply of electric energy during 1917–18. Mr. Denny moved an amendment that the proposed charges be disapproved, and that the increased revenue required for the current year be obtained by adding the necessary increased percentage, of an equal amount, to the accounts of all classes of consumers. He said he would like to see more encouragement given to the ordinary householder in regard to the use of electricity. In the new scale of charges there was a difference of 45 per cent. for lighting purposes, while upon the power consumer the extra cost was only about 33 per cent. That, he thought, was unfair. Last year they put 15 per cent. on all accounts, and he proposed that they should continue this method. On a division the minutes were carried.

Hammersmith (London).—On Monday the Electricity Committee reported that it was necessary to increase the price of electricity for lighting and power.

From 1905 up to the present the Borough Council has been enabled through a variety of causes to delay making any advance in the prices, but owing to the large increase in the price of fuel and in the cost of material, new plant, repairs, &c., brought about by the war, the committee now consider it necessary and prudent to advise an increase of 12½ per cent. in the charge to customers for current supplied, together with a minimum charge of 16s. per annum, both to be put into operation as from Sept. 29.

The report and recommendation have been adopted.

Radcliffe (Lancs).—Arrangements have been made for the wiring of the parish church.

Royton.—The Urban Council has concluded an agreement with Oldham Corporation for the supply of electricity in this district. The contribution to the cost of obtaining a provisional electric lighting order has been fixed at £200 up to a cost of £300, and one-half if over that amount.

Southampton.—The employés at the electricity works recently asked for an increase of 12s. a week in wages (with 6s. a week for boys), and arbitration proceedings in connection with the matter took place last week, when the arbitrator expressed the opinion that the claim should be conceded. The present bonus of 8s. a week will be included in the increase.

Wallasey.—The Council has decided to increase the salaries of the electrical engineer (Mr. J. A. Crowther) and the tramways manager (Mr. R. R. Greene) from £550 to £650 per annum, by annual increments of £25.

ELECTRIC TRACTION.

Belfast.—The city electrical engineer (Mr. T. W. Bloxam) has reported on the electrically-driven tower wagon, which was obtained in May, 1915, in place of a petrol-driven wagon, for the ordinary repair work of the overhead tramways equipment.

Mr. Bloxam states that this enabled the department to effect a very material saving in the cost of that particular work, where facilities for starting, stopping and manœuvring in traffic more than counterbalanced any lost time on the road, unless the journey was to a distant part of the city. He submitted comparison of the running cost per mile as compared with the petrol-driven vehicle, and the report was ordered to be entered upon the minutes for the information of the Council.

Brighton, Hove & District Railless Traction Act, 1911.—The Board of Trade has extended for one year from Aug. 7, 1917, the time limited by this Act (as extended by Brighton Corporation Act, 1913) for completion of overhead equipment for trolly cars.

Coventry.—It has been decided to discontinue the use of reduced fare return tickets on the tramways during the dinner hour. The employees of the tramways department have been granted a half-penny an hour increase in wages.

Dover.—The Board of Trade inquiry into the recent tramway accident was opened on Friday.

Witnesses stated that the driver did not stop at the top of the hill according to the regulations, and the driver admitted this, but stated that his hand-brake failed to act, and the car gathered speed so quickly that the other brakes also failed. He claimed that the control was shut off, but other persons who inspected the wrecked car gave evidence to the contrary.

Ipswich.—In order to save time and expense in the maintenance of the tramcars, and also in view of the frequent collisions between cars and other vehicles in the streets due to the absence of street lighting, the Corporation has decided that, for the remaining period of the war the fancy painting of the cars shall be abandoned, and that, in place thereof, the cars shall be painted two shades of grey with a limited amount of black lining.

Manchester.—The Traffic Congestion Special Committee has issued a report on the question of relieving the traffic congestion in the streets. Separate reports on the subject have already been issued by the Tramway and Watch Committees.

The special committee insist upon the necessity for new trunk routes and additional tramway terminals. In regard to the old infirmary site, Piccadilly, the committee think that a widening and lengthening of Parket-street would give all the room required for a terminal site. Six new tramway routes are recommended. The new terminals proposed by the Tramways Committee were as follows:—The old Infirmary site, Albert-square, St. Peter's-square, Marsden-square, Cannon-street (Corporation Street), and a rearrangement of the existing terminal in Stevenson-square. The Special Committee are of opinion that these terminals "are absolutely necessary, not only as a means of meeting the constantly growing demands of the tramway traffic, but also as a means of lessening the general traffic congestion in the central area of the city." The Tramway Committee's proposals for making a new street between St. Peter's-square and Albert-square, and for carrying out certain widenings are not supported, and it is recommended that negotiations be opened with Salford for co-ordinating the future working of the two tramway systems.

Southend.—Last week the Highways Committee recommended the Corporation to purchase four electric two-ton "Orwell" vehicles, with electric tipping bodies and "Ironclad Exide" batteries, from Messrs. Ransome, Sims & Jefferies, at a cost of £932 each, and that application be made to the L.G. Board for sanction to borrow (for a term of five years) £4,150 for the purchase of the vehicles, motor generator, and the necessary charging plant, &c. The committee deferred the question of the purchase of the motor generator, &c., until the matter had been considered by the Light Railways and Electric Lighting Committee.

The report was adopted by the Council.

In connection with the motor generator the Light Railways Committee also reported that the electrical engineer (Mr. R. Birkett) had advised that certain of the plot under the control of the committee could be adopted, at the electricity works, at an approximate cost of £20 for charging the batteries, but that none of such plant would be suitable for installation at the refuse destructor on account of the difference between the voltage of the current produced at the destructor and that at the generating station, and the committee, being of opinion that it would be desirable for the satisfactory and

Digitized by Google

economical working of the system that the batteries should be replenished at the refuse destructor, resolved to support the proposal of the Highways and Works Committee to instal a motor generator and switchboard at the refuse destructor.

Tramway Employees' Wages.—At a conference of motormen and vehicle workers a resolution has been passed calling upon the executives of the vehicular workers of Great Britain to join with the Transport Workers' Federation in taking the "necessary steps to bring about an increase upon pre-war wages of a minimum of 20s. per week, with proportionate overtime advances," in consequence of the increased cost of living.

TELEGRAPHY AND TELEPHONY.

Japanese Telegraphs.—There are at present over 20,050 miles of telegraph line in use in Japan (compared to 19,627 miles in 1916), representing 101,480 miles of wire. Over 40,000,000 messages are transmitted annually.

Australia-N. Z. Submarine Cable.—On Saturday Sir Joseph Ward dispatched the first message by the submarine cable of the Eastern Extension Australasia & China Telegraph Co., between Wellington to Sydney. The message was one congratulating Mr. Fuller, the Acting Premier of New South Wales, on the establishment of another means of communication between New Zealand and Australia, which would be of the greatest value to both countries.

In order to improve the telegraphic communication between Australia and New Zealand, direct working has now been established between the company's offices in Sydney and Wellington by diverting the existing cables from the old landing place at La Perouse to Sydney, and from Nelson, in the South Island, to Wellington.

Wireless Telegraphy in South America.—It is reported that the Brazilian Government has refused to accede to a petition presented by the Marconi Company for the installation of a high-power station in Amazonas.

The "Review of the River Plate" says the radiographic station which, with the permission of the Argentine Government, the German community—through the intermediary of the Siemens-Schuckert Co.—are erecting in the vicinity of Plomar station, on ground belonging to Señor Joaquin Anchorena, is making rapid progress. This station is intended only for the reception of wireless messages from Berlin, and is not to be used for transmitting purposes. An official of the Argentine Government, it is understood, exercises strict supervision over the installations. There are 16 masts 100 ft. high at intervals of about 788 ft. The station is situated several miles from the nearest habitation.

IMPERIAL NOTES.

Australasia.—The Board of the Canterbury University College of Christchurch (N.Z.), who recently invited tenders for heating, lighting and power plant, have decided to defer the installation of the plant until the end of the war.

The "Australian Mining Standard" says the Victorian Cabinet has decided to place supplies of brown coal at the disposal of the public, and that, if experts support the proposition, the huge deposits at Morwell, Gippsland, will be used by the State Government for the generation of electricity.

The Premier (Sir Alex. Peacock) recently stated that it had been decided to invite Mr. H. R. Harper, city electrical engineer (of Melbourne), Mr. W. J. Clements, of the Melbourne Electric Supply Co., Mr. W. Stone, chief electrical engineer for railways, and Mr. H. Herman, Director of Geological Survey, to report on the feasibility of generating electricity at Morwell as a State enterprise and supplying it to the public for various purposes.

At a recent conference of the Victorian Workers' Educational Association, presided over by Prof. Harrison Moore, the report of a committee appointed to consider a suggestion for a free University was presented. The committee reported that the question of means in relation to a free university was much more than one of the mere remission of University fees. The maitenance of the student during his University career might be met by the grant of bursaries, but as the degree courses in the University were based upon a liberal secondary education, the student entering the University must ordinarily have been continually at school until 17 or 18 years of age, and his economic conditions must have made it possible to meet his school and living expenses to that age. At present, of some 155,200 boys and girls between 14 and 19 in Victoria, not more than 14,000 were receiving secondary education, and of these, only a much smaller number could be receiving an education which would qualify them to enter the University. Unless the question of secondary education is grasped, the mere remission of University fees would do little to extend the possibilities of University education, and would mainly release from the payment of fees those whose conditions are sufficiently prosperous to provide for the secondary education of their children and to maintain them at the University. The interest of the community demanded such a provision for elementary, secondary, technical, and University education as would allow every member of the community, irrespective of means, to develop his talents to the utmost. One method would be a remission of fees at every stage in the case of students who showed themselves qualified to profit by the particular form of education for which they presented themselves. Another was to retain fees in general, but to provide by scholarships for those who reached the required level. A mere indiscriminate abolition of University fees would do less to give the reality of a free University than an extension of the Victorian scholarship system. The report was referred back to the committee for full consideration of the whole question of free education, the mover, Mr. D. K. Picken, expressing the opinion that an extension of the scholarship system would be preferable to the remission of University fees.

The Government of New Zealand has issued an Order-in-Council controlling the use of electricity and coal gas, restricting the wasteful consumption of coal, and making provision for the maintenance of industries dependent upon an adequate supply of coal, which are essential for the public welfare.

The Victorian branch of the Workers' Educational Association recently decided to approach the Government and urge the need for the establishment of a school of economics, and that various labour organisations should be invited to join in the movement. Mr. G. Holloway, president of the Victorian Political Labour Council, said it would be of great advantage if they had a school in which the present economic state of society could be analysed in an effort to bring about a better system than they now had.

In March last Prof. Kennedy (commercial attaché of the United States in Australia) suggested the sending of young Australians to learn the engineering, electrical and other trades at American factories, but the "Australian Mining Standard" has expressed the opinion that Australian artisans trained in America would be naturally apt upon their return to prefer handling American goods and appliances, and to recommend their use in place of similar British imports. Consequently it suggested that special facilities might be given by members of the British Engineers' Association for training Australian apprentices in England. H.M. Trade Commissioner in Australia (Mr. G.T. Milne) also took up the matter, and in reporting it to his department in London, suggested that some action on lines similar to the American invitation might be taken by British manufacturers. The first result was the offer to Australian apprentices from the British Engineers' Association. Mr. Milne considers it highly probable that the example of the engineers will soon be followed by other manufacturing groups in Great Britain.

Following upon the recommendation of the Associated Chambers of Manufacturers that the Advisory Council of Science and Industry be immediately established on a permanent basis as a Federal department, some of the Australian papers demanded evidence of practical energy, on the part of the council itself. In reply it is pointed out that 17 special committees have done a large amount of research work that will clear the ground for various practical experiments, the more important of which will be undertaken as soon as the Government does its part.

The revenue of the Melbourne City Council's electric supply department for 1916 was £197,099, and expenditure £94,849, and after deducting interest, &c., the net profit was £47,911. Of this sum sinking fund and other appropriations absorbed £11,648. The increase in units sold amounted to 14·89 per cent. Lighting units increased 6·74 per cent. Power and heating sales increased 14·36 per cent. The increase in revenue from all sources was £14,505. There was an increase in lighting sales of £4,969, but owing to the reduction in meter rents the lighting revenue account showed a decrease of £1,939.

In a recent speech on the undeveloped mineral wealth of Queensland, the Minister of Mines (Mr. A. J. Jones) mentioned some indispensable secondary industries. He said he had learnt that although copper was electrolytically treated in the Commonwealth, the refined copper had to be sent to Great Britain to be rolled, and the ridiculous position of sending pure copper home for such a process was obvious. The same was true of copper wire, the pure copper being sent home, and the wire being sent back. At present copper was electrolytically treated at Port Kembla. If Australia could go as far as that, there was no necessity why she could not roll the metal needed for Australia. As a matter of fact a company is now erecting extensive wire drawing and rolling mills at Port Kembla. If the conversion of the iron ore into pig iron were tackled on a large scale, Mr. Jones is of opinion that steel works in Queensland would very quickly follow.

Mr. G. T. Milne (H.M. Trade Commissioner in Australia) states that at the steel works of the Broken Hill Propy. (Ltd.), at Newcastle (N.S.W.), large quantities of steel rails have been rolled, principally for the Port Augusta-Kalgoorlie Government railway. Channel sections, even of the smallest size, are also being rolled for the Government. The company can also roll 4-ft. plate, and an immense market for its products is expected in Australia. A firm has already purchased land near the Newcastle steelworks, with a view to the erection of galvanising plant.

The ratepayers of Otaki (N.Z.) have approved of a proposal to borrow £9,500 for an electric supply scheme.

Canada.—Concrete ships 200 ft. long and costing under $100,000 are to be constructed by a syndicate at Montreal. They will be ready in less than three months.

The Ontario Power Scandal.—The "Financial Post" (of Canada) reports that the Electrical Development Co. has been given permission to appeal to the Privy Council against the decision of the Ontario Courts denying the company the right to proceed against the Hydro-Electric Commission with regard to the contemplated Chippewa power development.

The Electrical Development Co. sought for an injunction to restrain the Hydro-Electric Commission and the Government of the Province of Ontario from taking water from the Niagara or Welland rivers (Chip-

Digitized by Google

pewa River) for generating electrical power on the ground that the original franchise given by the Government to the company contained the stipulation that the Government itself would never take water from those rivers to compete against the company. The Government has received large sums as rental for the franchise rights, and it claims when the franchise was granted and the rent was fixed at approximately $125,000 a year that it was pointed out that the company would be unable to pay this rent should there be any Government competition, and a clause was inserted in order to protect the company. The company points out that in the case of an individual an injunction would be granted to prevent the breach of contract, but when a writ was issued against the Government and the Commission, the latter took refuge under the provisions of an Act passed by the Government itself, which provided that no action could be brought against the Hydro-Electric Commission except upon the consent and fiat of the Attorney-General. The latter, however, refused his consent, the writ was set aside and the action dismissed. The company also claimed that the Provincial Government had no power to close the Courts and to prevent the hearing of the case, and that the Act of Parliqment was unconstitutional.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says the Compañia Italo-Argentina de Electricidad has entered into an agreement for the supply of current to the Compañia de Tramways Eléctricos del Sud and other important new business.

An application for a concession of an automatic telephone service within the Municipality of Buenos Ayres has been presented to the Municipal Commission by La Positiva Co. This is distinct from the concession recently asked for by Mr. A. Schwimmer.

Chili.—The "Review of the River Plate" says a North American engineer (Mr. Lawrence) is organising a company, with a capital of $10,000,000, to exploit hydraulic power in the South of Chili. The electrification of the railways is said to form part of the company's programme.

Platinum in Spain.—In the report of the Geological Institute of Spain some particulars are given of the investigations made to discover platinum in the Serrania de Ronda district.

From the first limited investigation it was impossible to determine the average platinum content of the platiniferous rocks, but some very rich zones were found where the ore contains from 2 to 3 grammes of platinum per cubic metre. From an economic point of view the nature of the platiniferous gravel or sand is excellent, as it has no clay to make the washing expensive, and no large rocks to interfere with dredging. The deposits are loose peridotite sand found in the river beds at a depth of 10 to 15 metres.

The Spanish Government accepted the documents of the detailed findings of the engineers, and arranged for an exhaustive investigation by the Geological Institute. In addition to the study of platinum deposits an investigation is being made to look into the deposits of magnetite, chrome and nickel. The River Verde was chosen for the site of the first workings, and up to June, 1916, a distance of nearly 2¼ miles had been covered. The platinum content of this zone, which had been considered an average one, increased gradually from 8 centigrammes per cubic metre at the lower end to 20 centigrammes per cubic metre at the last point worked. The results of the investigation are, therefore, considered very encouraging, but as so small an area has been thoroughly covered, it is not yet possible to form an accurate estimate of the potential value of the platinum deposits.

Swedish Electric Furnaces.—It is stated that a new iron smelting works has commenced operations at the Porjus Falls, electrical energy being taken from the Porjus Falls hydro-electric undertaking.

The first furnace produces 8 tons daily; this will be raised to 20 tons with the opening of a second furnace for iron pyrites. A third furnace will produce chrome-iron and other alloys. This is stated to be the first step in the treatment of North Swedish ore on the spot. The Swedish Government has lately been making efforts to encourage the utilisation of hydro-electric power in ironworks.

Switzerland.—The Federal Council has issued an order empowering the Cantons to take steps to promote economy in the use of coal and electric power, including authority to close public establishments, theatres, &c.

MISCELLANEOUS.

British Industries Fair.—This fair, which is being organised by the Board of Trade, will be held in Glasgow from Feb. 25 to March 9 next. The work of organisation and of booking exhibitors is being proceeded with. The general manager of the fair is Mr. J. M. Freer, 38, Bath-street, Glasgow.

Burmese Wolfram.—It is reported that Messrs. Harland & Wolff, of Belfast, have acquired an important interest in large wolfram deposits in Burma.

Customs Decisions.—It is announced that lamps of patterns approved by the Minister, including incandescent Mazda and New Miniature electric lamps, specially fitted and peculiarly adapted for microscope work, are admitted into New Zealand free of import duty. There is, however, a primage duty of 1 per cent. upon such goods.

Electric Furnaces.—The installation of electric furnaces cannot now be made in this country except under the permit of the Ministry of Munitions.

Electric Steel.—A recent issue of the "Iron Age" gives the following figures of the output of electric steel by six of the leading countries during 1916, 1915 and 1913:—

	1916. Tons.	1915. Tons.	1913. Tons.
Germany†	180,335*	129,000	101,755
United States	169,918	69,412	30,180
Great Britain	49,256	22,000	—
Austria-Hungary†	47,247	23,895	26,837
Canada	43,790	61	—
France	—	—	18,000*
Totals	490,546	244,368	176,772

* Estimated. † Metric tons.

Engineers' Wages.—At the quarterly meeting of the Executive of the Federation of Engineering and Shipbuilding Trades last week representations were made from the various branches as to the inadequacy of the 3s. award which came into operation on Aug. 1. The meeting endorsed the protest, and decided to seek an interview with the Minister of Labour and the Food Controller on the subject

Miners' Wages.—The Executive Committee of the Miners' Federation of Great Britain met the Controller of Coal Mines on Tuesday and put before him a request for an increase of 25 per cent. on present earnings.

The President (Mr. Smillie) and the Vice-President (Mr. Herbert Smith), of the Federation, stated the grounds on which the request was based. The Controller undertook to lay the matter before the Government and to communicate the result to the Secretary of the Federation at the earliest possible moment.

It was reported that the Miners in one of the important Midland areas were at present working out their notices, and threatened to come out on strike unless an immediate advance in wage was given. The Controller and the Executive of the Miners' Federation expressed the hope that no action of this kind would be taken until the Government had had time to consider the application.

Munition Workers' Wages.—One of the causes of industrial unrest is said to be the discrepancy between the wages of skilled men on day work and those of semi-skilled on piece-work in munitions establishments.

With a view to arriving at an immediate decision as to the remuneration of skilled day workers, the Minister of Munitions has appointed a Committee to consider and report on the matter. Major J. W. Hills, M.P., is chairman of the Committee, and the Secretary is Mr. John Murray, Ministry of Munitions. On the Committee there are representatives of the Engineering Employers' Federation and other Masters' Associations, as well as of the A.S.E.

Newcastle-on-Tyne Signal Companies.—A joint meeting of the electrical section of the Newcastle and Gateshead Chamber of Commerce and the local section of the Institution of Electrical Engineers was held last week to hear a statement on the need for raising Signal and Electric Light Companies.

Mr. H. W. Clothier presided, and after Col. Blackett and others had spoken, the following resuoltion was carried unanimously:—"That this meeting, representing the electrical industry in Northumberland and Durham, gives its whole-hearted support to the proposals of the military authorities." The meeting then divided into two sections, one under the direction of Col. Blackett, for conversations with men resident in Durham, and the other under Capt. Barnes for men resident in Northumberland. The N.E.S. Co. has a special military unit to raise among its own men in connection with its own plant. Members were signed on and arrangements made with firms' representatives for individuals and firms to spread the news of the requirements in order to raise the necessary five signal sections and three electric lighting companies.

Prohibited and Restricted Exports.—In the list of prohibited and restricted exports from the United Kingdom the words in italics below have been added:—

(A) Telegraphs (including wireless) and telephones, and instruments and material for, *including valves for wireless telegraph apparatus.*

(A) Wire, iron and steel, *and articles wholly manufactured thereof.*

(B) Vanadium ore has been added to the list.

Registration of Directors' Names.—In a pamphlet by Mr. Herbert W. Jordan on the Companies (Particulars as to Directors) Act, there is a good critical digest of the scope and operation of the Act. It is published at 6d. net by Messrs. Jordan & Sons, Chancery-lane, London, W.C. 2.

Royal Assent.—On Aug. 21 the Royal Assent was read to the following new Acts of Parliament:—

Expiring Laws Continuance Act, Workmen's Compensation (War Addition) Act, New Ministries Act, Richmond (Surrey) Electricity Supply Act.

Digitized by Google

Trading with the Enemy.—The Controller of the Foreign Trade Department has issued a new consolidating list (No. 33A) containing the names of over 2,000 persons and firms with whom persons in the United Kingdom are forbidden to trade.

EDUCATIONAL.

University of Edinburgh.—The next session opens on Oct. 9. The preliminary or entrance examination is held in September. There are complete courses of instruction in civil, mechanical and electrical engineering, qualifying for the degree of S.Sc. in engineering, and extending over three years. Particulars of examinations, scholarships, &c., from the Matriculation Office, the University, Edinburgh.

Armstrong College, Newcastle-on-Tyne.—The session 1917-18 will commence on Sept. 24. Full courses leading to the degree of B.Sc. in engineering are provided in mechanical, marine, civil and electrical engineering, naval architecture, mining and metallurgy, &c. Particulars can be obtained from the secretary, Mr. F. H. Pruen, M.A.

University College of North Wales.—The new session commences in October, and in the electrical engineering department a systematic course of instruction is given in electrical measurement and practical electricity for students proposing to enter the profession of electrical engineer. The fee for the course, which extends over two sessions, is £17. 1s. Further information will be supplied by Mr. J. E. Lloyd, M.A., Secretary and Registrar.

Royal Technical College (Glasgow).—The session 1917-18 will begin on Sept. 25, and the diploma of the College is granted in civil, mechanical and electrical engineering, mining, naval architecture, chemistry, metallurgy, &c. The diploma course extends over either three or four sessions, and the average fee per session is £12. 12s. The College is affiliated to the University of Glasgow, and the degrees of the University in engineering and applied chemistry are open to its students. Prospectuses may be obtained from the Director.

City and Guilds Technical College, Finsbury.—The next entrance examination will be held on Sept. 18. The training is adapted to the needs of pupils from secondary schools above the age of 15 and men who, having served a pupilage or apprenticeship in works, desire to go through a more systematic training. There are engineering, electrical, physical and chemical laboratories and dynamo rooms. The professor of electrical engineering is Prof. W. H. Eccles, D.Sc., A.R.C.S., M.I.M.E. Programmes may be obtained from the Registrar of the College, Leonard-street, Finsbury, E.C.

TENDERS INVITED AND ACCEPTED.

Telephone Material.

The NEW ZEALAND POST AND TELEGRAPH DEPARTMENT require tenders by 4 p.m. Sept. 5 for the supply of 30,000 dry cells for telephones, 3 000 cards, 2,0 0 watch receiver diaphragms, 15,000 insulator bolts, and 20,000 cups to fit same. Form of tender, &c., from the Storekeeper, Post and Telegraph Department, Christchurch, or the Telegraph Engineers, Auckland and Dunedin.

Meters.

DUBLIN Electricity Supply Committee invite tenders for single-phase and three-phase meters for one year. Tenders to Chairman of Committee by noon Sept. 11.

Rotary Converter.

BERMONDSEY (London) Borough Council invite tenders for a 500 kw. rotary converter. Specifications from the borough electrical engineer, and tenders by noon Sept. 7 to the town clerk, Town Hall, Bermondsey, S.E.

Coal Bunker.

BOOTLE Corporation invite designs and tenders for erection of an Overhead Coal Bunker at Marsh-lane generating station (for at least 400 tons of coal). Particulars from the Borough Engineer. Tenders to the Town Clerk by noon Sept. 12.

Electric Lighting.

Dunfermline School Board require tenders by 10 a.m. Sept. 6 for the electric lighting of a new school at ROSYTH. Schedules of quantities from the Clerk, 104, High-street, Dunfermline.

SWANSEA.—The Harbour Trustees have accepted the following tenders:—

British Insulated & Helsby Cables, Ltd., aerial cable, £511. 5s. per mile; W. T. Henley's Telegraph Works Co., 185 yards submarine cable, £351. 1s. 7d.; New Switch Gear Construction Co., switchboard, £189. 5s

GLASGOW.—The Corporation has accepted the following tenders for the tramways department:—

Hadfields Limited, special track work; Edison-Swan Electric Co. and General Electric Co., traction lamps; A. Wiseman (Ltd.), steel pinions; Equipment & Engineering Co., gear cases.

WITNEY.—The Urban Council has accepted the tender of Pritchetts & Gold and Electrical Power Storage Co. for the supply of storage battery.

SOUTHEND.—The Council has placed the following orders:—

Ransomes, Sims & Jefferies, 4 electric 2-ton "Orwell" vehicles, with electric tipping bodies, and "Ironclad Exide" batteries, £932 each; Sidney Stone & Co., 48 tram seat frames, £1. 14s. each; Hider Dempster & Co., 9 tram wheel centres, £9. 10s. each; J. G. Brill & Co., tramway castings and journal boxes, £44. 11s.

Government Contracts.—The following tenders were accepted by the British Government Departments during July:—

War Office.—W. Maxwell & Co. and J. Sax & Co., electric bells; Edison Swan Electric Co., buzzers; Medical Supply Association, X-ray couches; Stothert & Pitt, cranes; Aster Engineering Co., & O. Stott (Ltd.), generating sets; Craigpark Electric Cable Co., gutta percha; Ingram & Kemp, electric instrument terminals; British Insulated & Helsby Cables, Shropshire Iron Co. and F. Smith & Co., copper wire; Edmundson's Electricity Corpn., electric power installation.

Post Office.—British L. M. Ericsson Mfg. Co., protective apparatus; India Rubber, Gutta Percha & Telegraph Works Co., telegraph apparatus; British L. M. Ericsson Mfg. Co., Gent & Co., Peel Conner Telephone Works, Siemens Bros. & Co. and Western Electric Co., telephone apparatus; Craigpark Electric Cable Co., Fullers Wire & Cable Co., General Electric Co., Johnson & Phillips, New Gutta Percha Co., Union Cable Co. and Western Electric Co., telegraph cable; British Insulated & Helsby Cables, telephone cords; Bullers (Ltd.), insulators; C. M. Powell Bros., jointing sleeves; British Insulated & Helsby Cables, solder; Bullers (Ltd.), Guest, Keen & Nettlefolds and C. Richards & Sons, insulator spindles; British Insulated & Helsby Cables and Siemens Bros. & Co., insulated bronze wire.

APPOINTMENTS VACANT.

London County Council invites applications for the position of charge shift engineer at their East Greenwich generating station. Commencing salary £250, rising by £10 a year to £300. Applications, on official form to be obtained from the Clerk of the Council, Council Hall, Spring Gardens, S.W.1, must be in by 1 p.m. of Sept. 24. *See advertisement.*

Five assistant foremen are required for service in the gun and shell factory, Cossipore (India), one to act as assistant electrical engineer, one as first-class turner acquainted with shell machines, one as draughtsman and two experienced in the manufacture of fuses and able to make own gauges and tools. Engagement for five years. Salary 280 rupees per month, rising by annual increments of 10 rupees per month to 320 rupees. Particulars and forms of application from the Director-General of Stores, India Office, Whitehall, S.W. 1. *See advertisement.*

BUSINESS ITEMS.

Sale by Auction.—Mr. Robert H. Ruddock has been instructed by the liquidator of the R. E. T. Construction Co., Ltd. (Mr. A. Page) to sell by auction at 1 p.m. on Sept. 4, on the premises (62, Hunslet New-road, Leeds), some machine tools, including two Gridley automatic piston and piston-ring making machines, various lathes and other tools, drilling and slotting machines, &c. On view day prior to and on morning of sale, and catalogue of Messrs. Josolyne, Miles & Co., C.A., 28, King-street, Cheapside, London, E.C. 2, and of the Auctioneers, 71, Fleet-street, London, E.C. 4. *See also an advertisement.*

Plant for Sale.—Oldham Corporation Electricity Committee advertise for sale two Willans-Siemens 740 kw. sets. Particulars from Mr. F. L. Ogden, joint engineer and manager, Electricity Works, Greenhill, Oldham.

LIQUIDATIONS.

Claims against Rural Districts Electric Undertakings (Ltd.) are to be sent by Aug. 31 to Mr. G. W. Brown, 24, Martin's-lane London, E.C.

Alfred Herbert (France) (Ltd.) is being wound up voluntarily, and Mr. D. M. Gimson, 1, Welford-road, Leicester, has been appointed liquidator. Claims to Mr. Simson by Oct. 31.

A second dividend (1s.) will be payable on Sept. 10 at the offices of Messrs. Corfield and Cripwell, 111, Finsbury-pavement, London, E.C., in the liquidation of the Leitner Electrical Co. (Ltd.), Maybury, Woking.

CATALOGUES, &c.

J. & P. SPECIALITIES.—Three leaflets have just been issued by Messrs. Johnson & Phillips, Ltd., Charlton, London, S.E. 7, dealing with fuses isolating switches and underground boxes respectively.

In the first leaflet particulars and dimensions are given of the tubular pattern of J. & P. fuses. The second is devoted to the firm's isolating switches. These are suitable for use on h.t. and e.h.t. alternating-current circuits for 3,300, 6,600 and 11,000 volts, and they have been designed to meet the requirements of the Home Office. The third leaflet relates to underground non-disconnecting boxes for all types of cables. These boxes are of substantial construction, ample electrical clearances and fitted with compound filling plugs. The list illustrates the firm's standard range of boxes, but other patterns can also be supplied.

H. I. INSULATORS.—From the Jeffrey-Dewitt Co., Detroit, Mich., we have received a pamphlet giving illustrated particulars of the J.D. hight-tension disc insulator. The distinguishing feature of the insulator is its great thickness of di-electric and perfectly balanced field of stress due to the identical metal electrodes above and below.

Digitized by Google

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Aberdeen.—The tramway accounts for the past year were received by the Corporation on Monday.

The accounts showed that the revenue was £100,073 (an increase of £5,745 over that of the previous year). It was decided that of one-third of the surplus revenue (amounting to £2,921), £2,000 should be placed to Common Good Fund, and £921 contributed towards cost of city improvements.

Bolton.—The tramway department's accounts for the year ended March 31 show gross capital expenditure £570,063 (increase £490), £231,830 has been applied in redemption of debt, and depreciation fund amounts to £65,(05.

Revenue was £152,930 and working expenses were £83,082, leaving gross profit £67,097 (compared with £66,169 last year), in addition to £2,751 (£2,332) allowances to employees on service with H.M. Forces. Interest and income tax absorbed £16,875 (£13,518), parliamentary charges, &c., £3,241 (£2,332) and repayment of loans £17,787 (£17,671). £17,022 (£18,544) has been set aside for renewals and £16,000 (£17,000) voted in aid of rates. Average total revenue per car-mile was 13·7d. (13·097d.), and working expenses 7·44d. (6·78d.), including power. Average fare charged per mile was 0·633d. Passengers carried 34,477,902. car-miles run 2,678,957 and units used 4,564,776.

Darwen.—The accounts of the tramways department for the year ended March 31 show gross capital expenditure £89,692 (increase £365), of which £37,280 has been redeemed.

Income on the Darwen section was £13,712 (=14·802d. per car-mile) and working expenses were £11,445 (=12·355d.), leaving gross profit £2,266, and after providing for interest, sinking fund and principal repaid, there was a net deficit of £1,314.

Income on the Hoddlesden section was £1,981 (=14·677d. per car-mile) and working expenses were £1,887 (=13·979d.), leaving gross profit £94. After providing for interest and sinking fund the net deficit (after taking into account £47 received as interest on investments and bank interest) was £710.

Islington (London).—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £577,940 (increase £9,308).

Revenue was £82,087 (compared with £69,660 in 1915-16), and working and general expenses were £51,129 (£39,051), leaving gross profit £30,958 (£39,051). Interest required £13,934 (£14,227), and repayment of loans £14,226 (£13,559), the net profit being £2,073 (£2,117). Total running costs were 1·18d. (1d.) per unit sold, and total cost, including capital charges, &c., 1·89d. (1·79d.). There are 3,776 (3,618) consumers, and total connections are equal to 430,709 (397,278) 30-watt lamps. Maximum load was 5,740 kw. (4,989 kw.) and load factor 19·18 (19·57) per cent. Units generated were 12,342,040 (10,652,980), and sold 9,644,248 (8,552,729).

Leeds.—Since the beginning of April the receipts of the Corporation tramways have shown an increase of over £1,000 a week compared with 1916.

In the year ended March last the income was £515,806, and it is probable that this record will be passed before March 31 next, as nearly half the sum has been taken already. Last week the number of passengers (2,373,000) showed an increase of 135,000. The main cause of the greater use of the tramways is the restriction of train services and the higher cost of railway travelling, with the development of munition works. In the past 23 years the tramways department has contributed over £1,000,000 to the relief of rates, last year's contribution being £79,000, or the equivalent of a rate of 8½d. in the pound.

Marylebone (London).—The accounts of the electric supply department for the year ended March 31 show total capital expenditure £2,146,058 (increase £4,141), of which £1,708,990 is outstanding. £48,286 was paid off during the year.

Revenue was £215,034 (compared with £202,640 in previous year), and the gross profit, after providing for all expenditure on revenue account, including £4,044 for national service allowances and guard expenses, was £121,445 (£122,192). Interest and special charges required £67,841 (£70,100), repayment of and provision for loans £46,640 (£49,721), leaving a net surplus of £6,964 (£2,371). Coal cost 0·515d. (0·465d.) total working costs were 1·216d. (1·136d.), and capital and special charges 1·557d. (1·789d.). Maximum load on feeders was 9,737 kw. (8,986 kw.) and load factor 20·7 (20·3) per cent. There are 10,800 (10,470) consumers connected. Units generated were 24,159,759 (22,251,773) and sold 17,647,146 (16,069,870).

The report of the Electric Supply Committee states that the sales and publicity department shows a credit balance of £1,464 (£479). The aggregate value of apparatus hired out is £11,867.

Southampton.—The accounts of the electricity department for the year ended March 31 shows gross capital expenditure £277,759, of which £116,694 has been redeemed.

Revenue was £66,459 (compared with £55,673 in previous year), and working expenses were £47,366 (£41,842), leaving gross profit £19,092 (£13,830). Interest required £7,496 (£7,592), and redemption £8,716 (£8,695), the surplus being £2,880 (against a deficit of £2,437), of which £1,842 has been employed to defray special expenditure, and £1,038 placed to depreciation and renewals fund. Working expenses were 1·334d. (1·290d.) per unit sold, and coal expenses, including capital charges and special expenditure, 1.842d. (1·902d.). Units generated were 9,767,422 (8,994,728) and sold 8,518,687 (7,784,134).

Torquay.—The accounts of the electricity department for the year ended Dec. 31 last show gross capital expenditure £86,616 (increase £380) and stock cancelled and bonds paid off amount to £24,163.

Revenue was £16,775 and working and general expenses were £11,896, leaving gross profit £4,879. Interest required £1,829, and sinking fund £2,796, and the total outgoings on net revenue account, including new services, meters and transformers (£500), and allowances to employés on war service (£651) were £5,869, the net deficit therefore being £960. Units generated were 2,452,920, and sold 2,298,376. Total maximum demand was 1,315 kw.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

JAMES BRIDGE COOPER WORKS (LTD.) (148,305).—Private company, reg. Aug. 24, capital £30,000 in £1 shares, to take over the business of the James Bridge Copper Works, formerly carried on by E. Kreiger as Kenneth Page & Co., and to carry on the business of metallurgists, &c. Governing director: E. Kreiger. Reg office: 42, Billiter-buildings, E.C. 3.

PORTABLE ELECTRIC MOTORS (LTD.) (148,223.)—Private company reg. Aug. 14, capital £2,500 in £1 shares, to acquire certain inventions and rights relating to portable electric cutters, &c. Agreement with G. Fryer. First directors are:—Lord Clifford of Chudleigh and G. Fryer. Reg. office: 121, Victoria-street, S.W.1.

MORTGAGES AND CHARGES.

SPENSERS (LTD.)—Debenture for £3,?50 dated July 30, 1917, to rank pari passu with £7,000 first mortgage debentures and a debenture for £750, and in priority to second debentures.

WRIGHT & WOOD (LTD.)—Particulars of £1,000 second mortgage debentures created Aug. 10, 1917, have been filed, amount of present issue being £900. Property charged: Company's undertaking and property, present and future. No trustees.

CITY NOTES.

ADELAIDE ELECTRIC SUPPLY CO. (LTD.)—Payment of the dividend on the 6 per cent. preference shares for the half-year ended 31st inst. will be made on the 1st prox.

COMPANIES TO BE STRUCK OFF THE REGISTER.—The following companies will be struck off the register of Joint Stock Companies, unless cause to the contrary is shown before Nov. 24:—Advisory Engineer's Corporation, All-British Electrical Co., Alphons Custodis Chimney Construction Co., Fletcher's Electric Fittings, Lighting Supplies, Magneta Time Co., Midland Magneto Co., Ship Carbons.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The directors have declared an interim dividend on the preference shares at the rate of 6 per cent. per annum (less tax) for the half-year to June 30, and an interim dividend on the ordinary shares for the same period at the rate of 5 per cent. per annum (less tax), both payable on the 15th inst.

MANGANESE, BRONZE & BRASS CO. (LTD.)—The directors have declared an interim dividend of 2½ per cent. (less tax) on the ordinary shares.

MELBOURNE ELECTRIC SUPPLY CO. (LTD.)—Holders of 7 per cent. first cumulative preference share warrants to bearer of £5 each will receive on Sept. 1 payment of dividend at the rate of 7 per cent. per annum for the half-year ending Aug. 31 (less tax) on presentation of coupon No. 16 at the Bank of Australasia, 4, Threadneedle-street, E.C.

OXFORD ELECTRIC CO. (LTD.)—A half-yearly interim dividend at the rate of 5 per cent. per annum (less tax) has been declared.

TYNESIDE TRAMWAYS & TRAMROADS CO.—The directors' report states that the surplus of receipts over expenses is £7,489. 16s. 10d., which, with balance brought forward (£664. 14s. 10d.), makes a total of £8,154. 11s. 8d. After deducting interest on debentures, loans, &c. (£1,012. 6s. 9d.), the available balance is £7,142. 4s. 11d. The directors propose to pay a dividend on the preference shares at the rate of 5 per cent. per annum and a dividend on the ordinary shares at the rate of 4 per cent. per annum (less tax), to place to reserve for renewals, depreciation and other contingencies, £1,000 and to place to special reserve account to meet contingencies, £1,000; to set aside for the reduction of registration and formation expenses, &c., £389. 1s. 6d.; leaving to be carried forward £1,474. 3s. 5d. The traffic receipts increased by £5,538. 15s. 5d., compared with the corresponding period of last year.

UNITED ALKALI CO. (LTD.)—The directors have declared an interim dividend of 1s. per share (less tax) on the ordinary shares.

Digitized by Google

THE ROUND TABLE.

By "KVA."

This Week's Chestnut.—General Pershing (to chauffeuse, who was delayed in driving the official car up to H.Q.): "Say, you are two minutes late."

Chauffeuse (with a twinkle): "Say, General, you are two years late; get in, and don't waste any more time."

* * * *

An American engineer has offered to cut the Channel Tunnel in three months. The worst of the Yankees is they never like to make a job last!

* * * *

One of the mottoes of the Sun Electrical Company's calendar reads: "The only way you can get to Heaven is to work your passage." Some of us will want a lot of dope on our wings, I'm thinking!

* * * *

Master of the House (arriving home after a somewhat "stiff" night at the club to a newly completed job): "Great Scott! I told the fool (hic) to put one light here, not all these."

[From "Glover's Almanac."

* * * *

London was visited last week by what the lay papers have described as a "wonderful electric storm." All the writers went into raptures over the brilliance of the lightning, and in one case it was remarked upon as "absolutely silent!" Expert observers say it was not lightning at all, but the signals of searchlights. I'm inclined to think it was a mirage and that the flashes were those of the guns over in France! One suggestion seems as good as another, though everybody's agreed there was no thunder, not even that of the guns!

* * * *

The war has done a great deal to break down the barrier between electricity and gas. I hear that at the Front they are now sufficiently intimate to take part conjointly in gas attacks on the enemy; the gas is turned on by electric distance control.

THIRTY-SEVEN YEARS AGO.

[From The Electrician, August 28, 1880.]

British Association.—One of the most interesting applications of the telephone yet made will shortly be ready for exhibition. We refer to the telephone line just laid down from the Velindra Reservoir to the office of the borough surveyor in the Swansea Town Hall. The distance between the two points is over 7 miles. Another important illustration of the practical uses of electricity will be the lighting of the Pavilion by the electric light. This work has been undertaken gratuitously by the Compagnie Générale d'Eclairage Electrique, of Paris. The lighting will be on Jamin's principle, and will be under the control of Mr. J. A. Berty, C.E.

Electrical Apparatus for Catching Fish.—At the exhibition of fishing appliances which recently took place at Berlin, a patented electrical fishing apparatus attracted considerable attention. This consisted of a kind of small boat, worked by a screw, and capable of being directed to any required point in the water. On arriving at this point the boat anchors itself, and at the same moment the hook and line are projected. The boat contains a battery and electro-magnetic apparatus, which is set in action by the closing of the circuit, this being effected by the slightest pressure upon the hook, produced by the fish in the act of taking the bait. The circuit being thus closed, the fish is "struck," and instantly hauled into the boat, a bell being at the same time rung to signify that a capture has taken place. The boat is then drawn to shore by means of a cord connecting it with the bank. The arrangement is, no doubt, very ingenious, and consequently is of some interest; but our angling friends seem to be of opinion that a "leger" line is far simpler, and at least equally efficacious, besides being preferable from the point of view of the sportsman.

Iron and Steel Trades.—In the annual report of the British Steel Smelters and Kindred Trades Association it is stated that steel and iron works have been engaged to the utmost of their capacity.

New plant is being erected, and considerable improvements and extensions are taking place at many works in various parts of the country. It is estimated that about £15,000,000 additional capital has been invested in the industry since the war began, but, notwithstanding this, the present production does not satisfy the needs of the Government. The additional plant and the demands of the military authorities have caused a shortage of labour, and many men have been brought back from the Army to help to supply the deficiency.

Monazite Supplies.—The Mineral Survey which is being conducted in Ceylon (in co-operation with the Imperial Institute) has led to the discovery of beach deposits of monazite sand.

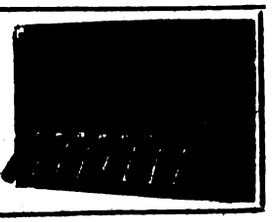
Samples of the sand have been investigated by the Imperial Institute and the results are so promising that the Government of Ceylon has arranged to work the deposits. Suitable British concentrating machinery has been selected by the Institute for the purpose and will shortly be shipped to the colony. Formerly the monazite deposits in Brazil were the only commercial source of supply of thoria, and these were controlled by the German Thorium Syndicate. This monopoly was broken by the discovery of extensive deposits of monazite in Travancore (India), so rich that samples examined by the Imperial Institute were found to contain nearly twice as much thoria as the Brazilian monazite. The German syndicate, however, obtained control of the company formed to work the Indian deposits, and they continued to exercise a dominating influence over the industry till the outbreak of the war. Since then the company has been reconstructed and given a British character.

Power Plants of Canal Supply Boats.—The "Panama Canal Record" for July 18 states that the Canal Board has placed in service at each terminal a supply boat for delivering supplies to ships. The cargo hold of each boat has a capacity of about 20 tons and the boats are equipped with Diesel engines.

The power plant for these boats consists of a Diesel engine of 120 B.H.P. operating at 350 revolutions. It drives a propeller 52 in. in diameter by 30-in. pitch. This engine is started by air, under a pressure of 900 lb. and burns a low grade of fuel oil. The auxiliary outfit consists of a 24-H.P., 4-cycle Palmer petrol engine, connected by clutches and belts to an air-compressor, 3-kw. dynamo, a centrifugal pump, and bilge pump, all attached to one bedplate. The boat is well ventilated and lighted, and, considering its dimensions, embodies characteristics not often seen in vessels of its size.

'IGRANIC'

No. 30. MULTIPLE SWITCH STARTERS
with TOGGLE JOINT interlocking levers
and HEAVY LAMINATED CONTACTS.



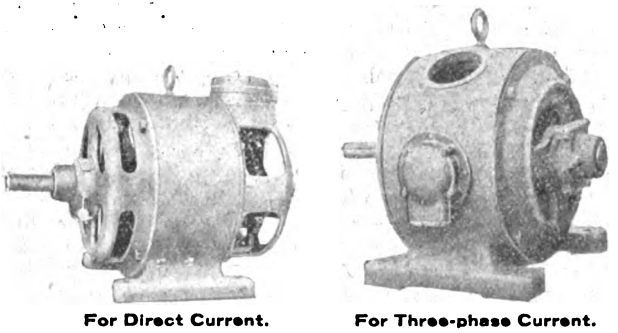
High inertia machinery, such as crushing mills, individually driven by electric power impose abnormal stresses on the motor starter for which special provision must be made. Sliding contact starters under such conditions have only a short life and require constant renewals. Toggle Joint Multiple Lever Starters always withstand this severe service satisfactorily and give full protection to the motor.

IGRANIC ELECTRIC Co LTD 147, QUEEN VICTORIA STREET, LONDON.

Digitized by Google

SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current. For Three-phase Current.

for
ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
Head Office: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: Western 6349. Telegrams: "Siembralos, Kens, London."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: City 5350 Telegrams: "Siemotor, Cent., London."
HOME BRANCH ADDRESSES:
Birmingham—Central Ho., New St. | Manchester—196, Deansgate.
Bristol—30, Bridge Street. | Newcastle—64-68, Collingwood
Cardiff—89, St. Mary Street. | Sheffield—22, High St. [Bldgs.
Glasgow—66, Waterloo Street. | Southampton—46, High Street.
Branches in Principal Towns Abroad.

FOR
High and Low Tension
SWITCHGEAR
THE
NEW SWITCHGEAR CONSTRUCTION CO., Ltd.
SUTTON, SURREY, ENGLAND.
ABC Code 5th Edition. Telephone: Sutton 773.

VULCANIZED FIBRE. ELECTRICAL. MECHANICAL.
DYMFYBR
LARGE STOCK. PROMPT DELIVERY.
J. BURNS, Ltd., 187 & 189, Central Street, LONDON, E.C.

REWINDING AND REPAIRING
of ARMATURES, MOTORS & DYNAMOS.
PROMPT EXECUTION and MODERATE CHARGES.
A. BROWN, 1, Norgrove St., BALHAM, S.W. 12

ELECTRIC VEHICLE COST ACCOUNTING SYSTEM.

The electric vehicle section of the National Electric Light Association recently issued a report of the Operating Records Committee, setting out a very comprehensive cost accounting system, which is, we are informed, being adopted by a number of the prominent central stations.

The general purpose of the Committee was to devise a complete accounting system for the transportation department of public utility companies covering electric vehicles, petrol cars, motor cycles and horses and wagons. The Committee's report covers the following items: (1) A standard classification of accounts, (2) a standard classification of statistics for comparison of performance data between companies, (3) a form of comparative report for interchange of information, and (4) the application of the system to typical installations. The object is to enable the companies to present their accounting results in a standardised form, thereby making the form readily available for comparison, and through such comparison increasing the efficiency of their respective transportation departments. It is also believed that when the operation costs of electric vehicles are intelligently contrasted with those of petrol and horse-drawn vehicle operation the merits of the electric vehicle will be quickly apparent. In this report the Committee cover the following topics: A standard classification of accounts, a standard classification of statistics for comparison of performance data between companies, a form of comparative report for interchange of information, and application of the system to typical installations.

Standard Classification of Accounts.

This classification will cover the details necessary in subdividing the transportation expenses which are provided for under account No. 254, "Clearance, Equalisation and Apportionment Accounts," in the standard classification of accounts of the N.E.L.A. To conform to this classification it is suggested that the method of numbering used below be adopted.

254.1 Transportation Expense (Motor Vehicles).

254.11 *Operating and Maintenance*
254.111 Lubricating oils.
254.112 Charging current.
254.113 Gasoline.
254.114 Charging and care of batteries.
254.115 Battery renewals.
254.116 Tyre renewals.
254.117 Repairs—chassis.
254.118 Repairs—body.
254.119 Sundry expenses.
254.12 *Overhead Expenses.*
254.121 Garage rent.
254.122 Garage labour.
254.123 General garage expenses
254.124 Administration.
254.125 Vehicle taxes and licenses.
254.13 *Fixed Charges.*
254.131 Interest.
254.132 Insurance.
254.133 Amortisation.
254.14 *Operators' Wages.*
254.15 *Suspenses.*
254.151 Tyre suspense.
254.152 Battery suspense.

254.2 Transportation Expense (Horses and Wagons).

254.21 *Operating & Maintenance.*
254.211 Feeding and bedding.
254.212 Medical expenses.
254.213 Repairs—wagons.
254.22 *Overhead Expenses.*
254.221 Stable rent.
254.222 Stable labour.
254.223 Sundry stable expenses.
254.224 Administration.
254.225 Vehicle taxes and licenses.
254.23 *Fixed Charges.*
254.231 Interest.
254.232 Insurance.
254.233 Amortisation.
254.24 *Drivers' Wages.*

254.1 Transportation Expenses (Motor Vehicles).

Charge to this account all expenses, including supplies, electricity, petrol, repairs, maintenance, taxes, interest, depreciation, &c., in connection with the operation of the motor vehicles of the transportation department, as covered in the following classification. Subdivide the account as follows:—

254.11 *Operating & Maintenance.*
254.111 Lubricating oil.
254.112 Charging current.
(Charge to this account the cost of electric energy consumed in charging the batteries as measured before entering the charging rheostat.)
254.12 *Overhead Expenses.*
254.121 Garage rent.
254.122 Garage labour.
254.123 Garage expense.
254.124 Administration.
254.125 Vehicle taxes & licenses.
254.113 Petrol.
254.114 Charging and care of batteries.
254.115 Battery renewals.
254.116 Tyre renewals.
254.117 Repairs—chassis.
254.118 Repairs—body.
254.119 Sundry expenses.
254.13 *Fixed Charges.*
254.131 Interest.
254.132 Insurance.
254.133 Amortisation.
254.14 *Operators' Wages.*
254.15 *Suspenses.*
254.151 Tyre suspense.
254.152 Battery suspense.

254.2 Transportation Expense (Horses and Wagons).

Subdivide this account as follows:—

254.21 *Operating & Maintenance.*
254.211 Feeding and bedding.
254.212 Medical expenses.
254.213 Repairs—wagons.
254.22 *Overhead Expenses.*
254.221 Stable rent.
254.222 Stable labour.
254.223 Sundry stable expenses.
254.224 Administration.
254.225 Vehicle taxes & licenses.
254.23 *Fixed Charges.*
254.231 Interest.
254.232 Insurance.
254.223 Amortisation.
254.24 *Drivers' Wages.*
Classification.

Digitized by Google

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite—Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1912 to 1917.

ATTWATER & SONS,

Telegrams: Attwaters, Preston. Telephone No. 1046 (2 lines).

Hopwood St. Mills, PRESTON.

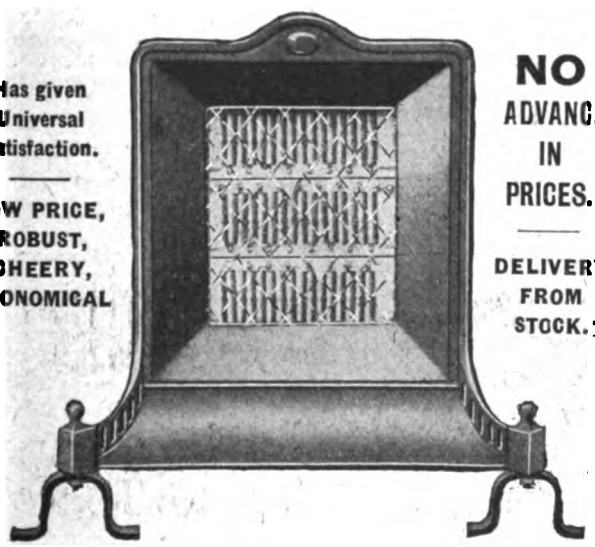
Established 1868. Codes: 5th Edition A B C & Western Union.

— THE —

ARORA

ELECTRIC

FIRE



Has given Universal satisfaction.

LOW PRICE, ROBUST, CHEERY, ECONOMICAL

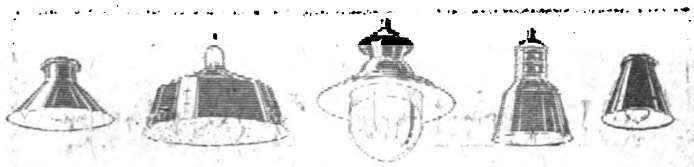
NO ADVANCE IN PRICES.

DELIVERY FROM STOCK.

Write for LIST G (Fires and Cookers),

to Sole Manufacturers—

THE ARORA CO., LOUGHBOROUGH.



THERE IS A SEARCHLIGHT ON FACTORY EFFICIENCY

SOONER or later the Factory Acts will compel good lighting.

Why wait for compulsion, when money can be saved by dealing with the matter now?

The greatest waste of to-day is that of artificial light in our factories. Millions of tons of coal are burnt, and much human effort is spent, to produce electric light, of which a large proportion is wasted in glare, and in the creation of shadows, and thus the light which was intended to add to our national efficiency is made to militate against it.

With Simplex Steel Reflectors properly installed, every ray of light is diverted to useful work, there is no glare, and there is "Efficiency and Economy."

Simplex Conduits Limited

Works: Garrison Lane, BIRMINGHAM

113-17, Charing Cross Rd., London, W.C.
16, Corporation Street, Manchester.
72a, Waterloo Street, Glasgow.
61, High Bridge, Newcastle.
11, Denmark Street, Bristol.
96, Whitechapel, Liverpool.
6, White Horse St., Leeds.
14, Heathfield St., Swansea.
4, Westgate St., Cardiff.
1, Crimon Place, Aberdeen.
281-3, Attercliffe Common, Sheffield.

Digitized by Google

Electrical Testing Laboratories

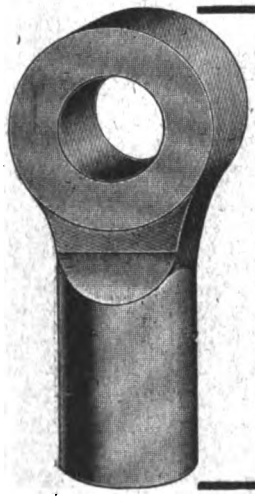
(U.S.A.)

Acceptance Tests of Machinery and Materials for Export.

Electrical, Photometrical, Mechanical and Chemical Tests and Investigations at the Laboratories in New York or anywhere in the United States of America.

80th Street and East End Avenue, New York, N.Y.

Note.—Through the courtesy of "The Electrician," copies of a booklet describing the Laboratories and its work, and listing testing fees, may be obtained from its London Office.



E. SHOWELL & SONS, Ltd.

STIRCHLEY, BIRMINGHAM.

Cast Cable Sockets.

Suite E74. Made in all Sizes.

Type A.—Straight.
„ B.—Offset.
„ C.—Right angle.

Illustrated Dimensioned Showcard for Drawing Office use supplied free on application.

Sole Agent for the Electrical Trade:—

LIONEL ROBINSON, 3, Staple Inn, London, W.C.

Telephone: *Holborn* 6323.

Standard Statistics for Comparison of Performance Data between Various Companies.

It is recommended that the following data be kept by all companies in order that the results shown may be comparable.

1. Capacity. (In the case of trucks, both petrol and electric, this item covers the rated carrying capacity of the vehicle, expressed in pounds; in the case of passenger vehicles, the rated carrying capacity expressed in the number of persons.)
2. Make and number reported.
3. Batteries.
4. Classes of service and number.
5. Average investment per vehicle
6. Average age of vehicle.
7. Description of tyres.
8. Number of cars in company's garage.
9. Number of cars in outside garages.

The Standard Performance data to be kept by all companies adopting the methods recommended by this Committee should be reported in "Average Performance per Vehicle," and should cover the following items:—

10. Miles travelled.
11. Kilowatt-hours charging.
12. Gallons of petrol.
13. Miles per kilowatt-hour.
14. Miles per gallon of petrol.
15. Days actually used.
16. Work days out of commission for maintenance.
17. Work days available but not used.
18. Miles covered per work day in use.

Form of Comparative Report for Interchange of Information.

The Committee has arranged the data to be exchanged in a form which will be of very material service to the various companies.

Application of System to Typical Installations.

The ultimate object in the adoption of the standard system of accounting is to enable the companies to present their accounting results in a standardised form The work of the Committee would be almost valueless without definite action on the subject of the interchange of information. Eight of the large companies, through their representatives on the Committee, agreed to interchange reports.

ELECTRIC POWER IN BITUMINOUS COAL MINES.

At the recent war convention of the American Institute of Electrical Engineers Mr. R. L. Kingland submitted a Paper dealing with the best form of electric power for a bituminous coal mine.

The "Electrical World" reports that for the larger mines a three-phase 60-cycle system, with voltage high enough to permit a 10 per cent. power loss, is considered the most practical scheme. Three hundred volts with an allowable fluctuation of 10 per cent. is favoured for underground portable machines, but medium or high voltages can be used safely for stationary machines if proper protection is afforded. Haulage is one of the chief factors determining the form of electric power to use underground. As no practical means has been developed for heavy haulage by the use of alternating currents, it is necessary to use direct current. Synchronous converters delivering 300-volt direct current can be installed above and below the ground where necessary, thus reducing the amount of copper required in the mine to a mihimum. In small mines locomotive haulage cannot be used to advantage, and all machinery may be run with alternating current if available.

For concentrated loads of 100 h.p. or over the author found that separate lead-covered steel-armoured cables leading direct from the surface through special bore holes were very satisfactory for supplying alternating current for pressures up to 11,000 volts. For underground distribution bare copper wire is used extensively.

With proper voltage the squirrel-cage induction motor is ideal for driving the chain machines used for cutting coal. However, shunt or compound-wound motors are most frequently used for certain reasons. For drilling machines a constant-speed motor is required. A high starting torque is not necessary. Motors for coal-loading machines should have the same characteristics as those for coal-cutting machines. For the small pumps used for delivering drainage water to one or more central points the same form of power should be used as is employed for

ISENTHAL & CO. Ltd.

(DEPARTMENT 4)

Denzil Works, Willesden, London, N.W. 10.

Regulating Resistances.

LIST POST FREE.

Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, &c.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

PRESCOT INSULATING VARNISHES

We have a good range of these well tried varnishes and enamels.

The following are some of their principal features:—

PERMANENTLY ELASTIC
HIGH INSULATING VALUE (even when insufficiently stoved)
PENETRATING
CONSISTENT
LASTING
WITHSTAND HIGH TEMPERATURES
MAY BE STORED WITHOUT A SPECIAL LICENSE
NO EXCESSIVE LOSS BY EVAPORATION

Our Yellow and Black Stoving are eminently suitable for Field, Armature, and Transformer Coils, and have been proved of great value in protecting metal surfaces, both as an electrical insulator, and as a preservative against adverse atmospheric conditions.

Let us know your requirements, and we are confident we can meet them.

BRITISH INSULATED & HELSBY CABLES.

Cablemakers and Electrical Engineers, LTD.,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED **SECOND HAND**

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.

Phone: Victoria 4036. Grams: Vicmaster, Sowest London.

For Effective Impregnation
use "LACWATT"
Black or Golden Brown.
JENSON & NICHOLSON, Ltd., Insulating Varnish Department, Goswell Works, Stratford, E.15.

Digitized by Google

cutting, drilling and loading. The larger pumps used to remove the water from these central points should be treated as concentrated loads. Underground lighting can be most easily accomplished by the power that is used for other purposes where the lamps are required.

Shop drive and lighting should depend on the primary source of power, as they may be required when everything else about the mine is shut down. They should not depend on the operation of any more machinery than is absolutely necessary. Ventilation is of first importance in a great many bituminous coal mines, so it is necessary to have very reliable equipment. The squirrel-cage induction motor is especially suitable for this service as it is the most rugged as well as the simplest form of electric motor. If alternating-current power is not available, shunt motors should be used, but the commutators prevent the same reliable service being given as by the induction motors.

NEW SOUTH WALES MINING.

The annual report of the New South Wales Dept. of Mines has been issued, and states that the value of the mineral production of the State during 1916 was £10,975,742, an increase of £911,173, mainly due to the high prices of copper, lead, zinc, &c.

At most of the large collieries, and more particularly at those having electrical installations for power purposes, the shaft bottoms, sidings, main flats, and clipping on stations, are all lighted by incandescent electric lamps. Clusters of electric lights are provided in the sinkings at Aberdare Central and Aberdare South Collieries. There is increased efficiency in the sinking due to the electric light, and it is also much more comfortable for the men than any other kind of lighting. While many of the large collieries have a few electric safety-lamps for the use of officials only, and in case of special emergency—such as where it is imperative that travelling should be done for short periods in gassy atmospheres—there are only two mines which are at present using electric safety-lamps in the face workings—viz., Dudley, where about 20 (designed and made locally) are in daily use; and 360 Wolf lamps, at South Bulli Colliery.

In the report of the consulting electrical engineer (Mr. W. Corin) it is stated that the draft revision of the electrical special rules has been completed. In connection with the proposed State coal mine a suitable site has been selected for a power station, which will supply electric power for all mining and industrial purposes, pumping water, &c., in Lithgow and neighbourhood and in the Blue Mountain district.

In the report of the electrical inspector of coal mines (Mr. J. F. Dent) a list is given of over 50 mines in which electrical appliances are used and inspections were made. Only one electrical accident occurred during the year. An engine fitter working at night time in a fitting shop attempted to tap on an extra light to the motor leads, and in so doing caused a short circuit. The flash affected his eyes, causing partial blindness for about three days. In general, the conditions of the electrical equipments about the mines are good, and no trouble has been experienced in keeping the various installations in conformity with the rules, and considering the extent to which electricity is now used in mining operations, both above and below ground, it is pleasing to note how well the plants are maintained, and also the care exercised by the officials and workmen in the use of same.

TORONTO HYDRO-ELECTRIC SYSTEM.

The sixth annual report of the Toronto Hydro-Electric System for the y ar ended Dec. 31 last states that the gross income was $1,706,177, and after deducting costs of generation and of operation and management the surplus was $634,042. Interest, sinking fund and depreciation abs rbed $615,646, leaving a net surplus of $18,396.

In the report of the general manager (Mr. H. H. Couzens) it is pointed out that the gross income represents an increase of 5·3 per cent. over that of 1915, and that the increase in the commercial income was 5·5 per cent. The year's commercial income amounted to 67 per cent. of the total. The total units sold increased by approximately 27 per cent.; the total revenue increased by 6 per cent. in spite of rate reductions; the total number of private customers is 43,460, with a connected load of 70,500 kw.-hours. The capital expenditure amounts to $6,902,000; the sustained 20-minute peak load on Dec. 4, 1916, was 47,165 H.P.; the average revenue per unit for the whole system was 1·2 cents in 1916, compared with 1·44 cents in 1915. The total number of units sold is 139,000,000, compared with 109,000,000 in 1915, and 83,000,000 in 1914. The total cost of operation and maintenance shows a consistent decrease from $550,000 in 1914 to $548,000 in 1915 and last year to $543,000. Over 18,500 pieces of electrical apparatus were sold from the hydro-electric shop (excluding lamps), an increase of more than 30 per cent. over the previous year. A branch demonstration sales office has been opened in connection with the new Carlaw-avenue sub-station, which provides facilities for the patrons of the system in the eastern section of the city. The total assets of the system were $8,882,171—viz., fixed assets, $7,501,186; stores on hand, $425,259; accounts receivable, $241,461; capital funds in hands of city treasurer and cash in bank, $710,141. The necessary amounts have been set aside for interest, depreciation and sinking funds, in accordance with the regular policy of the commissioners, which is to set aside out of earnings from year to year the following sums: (1) The amount necessary to meet all interest on the debenture issue for the purchase of the enterprise; (2) the amount necessary to constitute a sinking fund, which, accumulating at a given rate of interest, shall be sufficient to pay for the debentures at maturity; (3) the amount necessary to accumulate by the end of the life of the various items of the plant a fund sufficient to replace the same without making any further demands upon the city for new issues of debentures for replacing apparatus.

BUYERS of every description of Scrap Metals, viz:
COPPER, BRASS, GUN METAL, BRONZE, ALUMINIUM, LEAD, ZINC, &c.
All descriptions of RESIDUES.
ESTABLISHED 1867.
METALS. J. B. GARNHAM & SONS,
132, UPPER THAMES ST., LONDON, E.C.
Telegraphic Address: "Garnham Cannon London."
Cables .. .. .. "Garnham London."
Telephone .. .. .. Bank 5726.
ABC Code, 4th and 5th Editions and Lieber's Code.
ENQUIRIES SOLICITED
SELLERS of
COPPER and BRASS SHEETS,
PLATES, TUBES, RODS, WIRE, &c., &c.

The OMEGA
INSULATION SET with GENERATOR.
ROBT. W. PAUL
NEW SOUTHGATE, LONDON, N.

H. Weidmann, Ltd., Rapperswil, Switzerland.
WE ARE SPECIALISTS IN THE MANUFACTURE OF—

PRESSPAN (2)
(Pressboard)
Best Quality.——Proved by repeated tests.
Sheets in thickness from 0·1 upwards.
Endless Rolls and Strips from 0·1 to 1 mm. thickness.
Presspan Coils and Tubes for Transformers.
Presspan Armatures, Discs and Shaped Articles.
VARNISHED PRESSPAN. BLACK PRESSPAN.
OILED PRESSPAN. MICA-COVERED PRESSPAN, &c.
Grand Prix: Marseilles 1908. Gold Medal: Berne 1914. Silver Medal: Paris 1900.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,051. [Vol. LXXIX. No. 23.] FRIDAY, SEPTEMBER 7, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 881
Arrangements for the Week 883
Tests on Oil Switches. By Dr. Georg Stern and Josef Biermanns. Illustrated 884
Magnetic Control as Applied to Large Mine Hoists. By E. C. Gooch. Illustrated 886
Repetitions of E.M.F. in Armature Windings. By C. C. Hawkins. Illustrated 888
On the Wave-Lengths and Radiation of Loaded Antennæ. By Balth. Van Der Pol, Jun., D.Sc. Illustrated 891
THE WORK OF THE COMMITTEE FOR SCIENTIFIC & INDUSTRIAL RESEARCH 894
A Capacity Test for Localising a High Resistance Break in Short Lengths of Submarine Cable. By H. V. Higgitt. Illustrated 897
Economy of Electric Vehicles 898
Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1916-17 899
Electric Current Measuring Instruments with Parabolic Law of Deflection. By Prof. J. K. A. Wertheim Salomonson 901
Patent Record 902
Volunteer Notices 902
COMMERCIAL AND INDUSTRIAL SECTION 905
Electricity Supply 906
Tenders Invited and Accepted 909
Financial Matters 910

NOTES.

Tests on Oil Switches.

THE article under the above title abstracted on another page is particularly interesting as showing that, in spite of war conditions, the technical development of the electrical industry in Germany is receiving very considerable attention. In fact, the description of the special testing installation put down by the Allgemeine Elektricitäts Gesellschaft, whereby oil switches may be tested under short-circuit loads up to 600,000 k.v.a., is likely to make British switchgear engineers' "mouths water." There can be no doubt that for the development of such apparatus in this country at the present moment the position of affairs is most unsatisfactory. Few engineers will deny that to-day the limiting feature of high-voltage transmission lies in the switchgear, and it follows that if we are to take a leading place in the future development of such work similar testing facilities will have to be placed at our disposal. In Germany and America, owing to the more centralised control of the electrical industry, it is possible for the big manufacturing concerns in those countries to incur the expense of providing the plant and supporting the experimental staff necessary. Moreover, owing to the co-operation which exists among the leading firms in those countries, experimental data when obtained are immediately available to the great majority of the factories which need them. With us, for good or ill, the electrical manufacturing industry is divided up among a considerable number of relatively small concerns, which have, as yet, hardly learned the rudiments of co-operative action. The result of this is at once seen whenever an attempt is made to enter the world's markets in many directions. If, for example, endeavours are made to supply some of the requirements in high voltage switchgear of the Italian power stations, one is at once met with the demand to supply switches and other goods made in accordance with the German V.D.E. Rules. If it were possible to meet this difficulty by pointing out that British Rules and Standards existed which were as good as the German, the position could be met. But this is not possible, as the British Rules do not exist. We understand endeavours are now being made to formulate such, but in the absence of the experimental facilities before mentioned it is difficult to see that real and independent progress can be made. Even if a British firm were to incur the expense of laying down such plant, the results obtained would, it is highly probable, be regarded as private property, and would only become diffused among engineers after many years.

The Need for a National Effort.

IT is our firm conviction that real progress in this, as in many other directions, can only be made, under the conditions obtaining in the British electrical industry, by a national institution supported by public funds. The niggardly granting of a few hundred pounds for researches on such subjects, which is as far as we have got at present, is simply playing with the matter. What is wanted is a strong body of first class engineers with large funds at their disposal, who can devote their whole time and energy to the elucidation of such problems. It is possible that this could be obtained by a development in the direction indicated of the work of the National Physical Laboratory. We are, however, doubtful of this. The organisation of the American Bureau of Standards appears to us to be more on the lines required. As regards the subject matter of the article itself, we would recommend this to the earnest consideration of all persons interested in high-voltage power transmission work. Particularly interesting is the clearing up of the question of current limiting reactances versus resistance switches. The results obtained with the new devices for increasing the rupturing speed of the switches are remarkable. Unfortunately the authors do not describe the construction of the apparatus in any detail. But this is not surprising, seeing that the tests were carried out and published by the manufacturers themselves.

Reform of the Consular Service.

WE are glad to note that the Government have at length decided to take definite steps in the reform of the consular service, and that the development of the Commercial Intelligence Department and a wide extension of the system of Trade Commissioners within the Empire is to be taken in hand. The Foreign Office have also elaborated schemes for strengthening and developing the Commercial Attaché and Consular Services and of increasing their utility to British trade. Some difficulty, however, has been experienced in defining and adjusting the limits of responsibility of the Foreign Office and the Board of Trade. Obviously, dual control is liable to give rise to inefficient service, and should, therefore, be eliminated. In order to consider these and other kindred matters, a committee was appointed last January, with Lord FARINGDON as Chairman, but failed to come to a unanimous agreement. Two main questions were under consideration. The first was whether the Foreign Office or the Board of Trade should control the Commercial Intelligence Service abroad, which is rendered by the Commercial Attachés. Upon this point the Committee agreed unanimously that the control of the Commercial

Digitized by Google

Attaché should be left to the Foreign Office acting in close consultation with the Board of Trade, and that both this service and the Consular service should be enlarged and improved. With this object in view a committee, on which the Treasury and the Board of Trade are represented, together with representatives of the Association of Chambers of Commerce and the Federation of British Industries, has been appointed by the Foreign Office to consider what changes are desirable in the allocation of posts and in the rates of pay of Commercial Attachés and Consular Services. The other question referred to the Committee was whether the work of collating and distributing commercial intelligence from foreign countries among the commercial community of this country should be continued to be performed by the Department of Commercial Intelligence of the Board of Trade or should be dealt with by a Department to be created at the Foreign Office. Here the Chairman and the representative of the Board of Trade were in favour of this part of the work being left in the hands of the Board of Trade, whereas the majority of the Committee favoured the transfer of the work to the Foreign Office.

The New Scheme.

THE whole question has now been further considered by the two Departments concerned, and it has been decided to create an enlarged Commercial Intelligence Department, the control of which will be in the hands of a new Parliamentary Secretary, who will occupy the position of that of additional Parliamentary Secretary at the Board of Trade and also additional Parliamentary Under-Secretary for Foreign Affairs This Parliamentary Secretary will, therefore, act as a link between these two Departments. The official head of the new Department will be an officer appointed jointly by the President of the Board of Trade and the Secretary of State for Foreign Affairs. The Trade Commissioners will, as hitherto, be controlled by the Board of Trade, and the control of the Commercial Attachés and Consular Service will be in the hands of the Foreign Office, but the new Department will deal with all commercial intelligence, and will make the necessary arrangements for keeping the overseas services in close touch with the commercial classes in this country. There will be a constant interchange of staff between the Department and both the Foreign Office and the Board of Trade, so as to get members thoroughly acquainted with the work. Further, the Department will be assisted by an Advisory Committee of business men, and it is hoped that it will be possible to arrange for a sub-committee of this Committee to meet at frequent intervals in order to advise the Department on its current work. It appears to us that this scheme is certainly a move in the right direction, though there are many details on which the public will wish to have further information. In comparing the proposed scheme with that suggested by the Federation of British Industries it appears that the responsibility of the Foreign Office is more limited than was proposed in that report. Possibly a kind of joint department may be the most satisfactory solution, though most people have now become suspicious of the efficiency of the Board of Trade in commercial matters. Undoubtedly, one of the most important points is the question of stimulus in Government work, on which stress was laid in the F.B.I. report. We trust that this matter will not be overlooked. There are also many evils in our present system, such as the transfer of officials from one consulate to another, whereby their local knowledge becomes useless, and the large number of unpaid officials, who in the very nature of things cannot give an efficient service. We trust that the attempt to remedy the present state of affairs will not be made by adopting any half measures.

Glass Technology at Sheffield.—The new department at Sheffield University, which has erected an experimental glass house, should be watched with close interest. It is to be hoped that the work carried on there will be helpful to makers of lamps and glass reflectors, &c. It is stated that special instruction is now being given in glass-blowing—an art insufficiently cultivated in this country before the war, and it is suggested that this work is well worth the attention of discharged soldiers.

Institute of Metals.—The annual autumn meeting of the Institute of Metals will be held on Wednesday, September 19th, in the rooms of the Chemical Society, Burlington House, London, when a number of Papers will be read. Invitations to be present at the meeting can be obtained by non-members on application to the secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria-street, S.W.1. So great is the present interest in metallurgical matters that the membership of the Institute has increased, we are informed, since January 1st last by over 30 per cent.

Water-Power Development in France.—According to "L'Industrie Electrique," the war has had a remarkable effect in stimulating the development of water-power in France. The water-falls in the French Alps are being utilised to an ever-increasing extent, and power-houses of a total capacity of 40,000 h.p. are in course of erection. Electro-metallurgical and electrochemical work in their vicinity has been greatly developed, and it is calculated that if all these sources of power were fully exploited as much as 15 billion kw. per annum would be available.

Municipal Tramways Association.—The 16th annual general meeting of this association will be held at Blackpool on Thursday and Friday, September 20th and 21st. On the Thursday, after the presidential address by Mr. Henry Mozley, a Paper will be read on "Notes on Tramway Finance," by Messrs. J. Barnard, G. W. Holford and P. Priestly, followed by a discussion on "Rule of Footpath," introduced by Mr. J. Dalrymple. On the afternoon of the same day a Paper on "Differentiation in Fares for Workmen and other Passengers on Tramways" will be read by Mr. W. Murray, and there will be a discussion on "Development of Tramways," introduced by Mr. Arthur Ellis. The Friday will be occupied by business meetings.

Junior Institution of Engineers.—The Junior Institution of Engineers has instituted a "Cadet Associate Membership," whereby engineering pupils in works or college (day or evening students) may be registered for a nominal yearly fee of 5s. It is open to youths of 15 years and over who are still undergoing training, and who, as certified by a principal of a technical college or head of department of an engineering works, are making satisfactory progress in the development of their abilities as engineer pupils. The registration as a Cadet Associate Member of the J.I.E. is for one year only, and renewals can only be accepted when satisfactory progress and development is vouched for by a responsible authority under whom the applicant is serving. The Institution undertakes certain duties in regard to these cadets, which are set forth in a pamphlet which may be obtained upon application to the Secretary, 39, Victoria-street, Westminster, S.W. 1.

Early Electric Lighting in Trains.—The "Railway Gazette" refers to some of the earliest examples of electric train-lighting in the country. An experimental run was undertaken by the London, Brighton & South Coast Railway in October, 1881. A Pullman car was run between London and Brighton, twelve incandescent lamps being used, and the current supplied from a battery of 32 cells, capable of supplying light for six hours. This battery was carried under the car and had to be removed every night for charging. About the same time the North British Railway equipped a train with electric lighting, current being supplied from a small rotary steam engine and dynamo fixed on the locomotive. In 1883 the London, Brighton & South Coast Railway fitted up three trains with Stroudley's system, utilising a dynamo in the

Digitized by Google

guard's van, driven from one of the axles by a belt through the floor, a lead battery being used to supplement the dynamo. In the next few years 20 trains were similarly equipped. From 1894 onwards many systems were introduced, and electric lighting of separately equipped carriages now forms a more or less standadised feature of passenger rolling-stock equipment.

Phototelegraphy between Berlin and Constantinople.—According to the "Annales des Postes, Télégraphes et Téléphones," Dr. Korn proposes to introduce his system for the telegraphic transmission of pictures on the Berlin-Vienna-Sophia-Constantinople-Bagdad route. For this purpose either telegraphic or telephonic connections could be utilised. So far as telephone connections are concerned, one could conceive stations at Vienna and Budapest in connection with Berlin, the lines being occupied for a quarter of an hour only. In these circumstances pictures of an event taking place in the afternoon could appear the next day in the Vienna journals. Transmission for longer distances (*e.g.*, from Berlin to Constantinople) would involve the use of telegraphic lines, which would enable an ordinary photograph to be transmitted in about an hour. The chief expense involved is the occupation of telegraph and telephone lines between such distances, but it is thought that the Governments of the four countries concerned might grant very moderate rates if the lines were only used during hours when there is little or no traffic.

Radio-Telephones for Load Dispatching.—At the present time the United States Government has forbidden the use of wireless telegraph and telephone equipment, except under its supervision, but it is stated in the "Electrical World" that the Public Service Co. in Northern Illinois is already considering the use of radio-telephone connection for load-dispatching in the future. Two radio-telephone sets are being installed between sections 150 miles apart, and are being tested with the co-operation of the United States Navy Department. Should the units prove satisfactory, one will probably be installed in the system operator's office at the new generating station at Joliet (Ill.), and the other at the company's generating station at Blue Water Island. This connection will facilitate load-dispatching in emergencies caused by failure of the company's private metallic circuit line. Ultimately the system will be applied to other distribution centres. The use of radio-telephones was preferred to wireless telegraphy on the ground that it avoids a knowledge of the Morse Code, and also enables messages to be transmitted with greater speed.

The Absolute Measurement of Sound.—Accurate sound-measurements present very great difficulties, one of the chief which is the absence of any agreed standard source. Recent tempts have been made to deal with this side of the problem Messrs. H. D. Arnold and G. B. Crandall, and by Mr. E. C. ente respectively, the investigations in both cases being summarised in the "Physical Review." The first-named investigators propose the use of a thermophone, the action of which is based on the fact that an acoustic effect is produced when an alternating current flows through a thin conductor. It is suggested that the thermophone can be used (*a*) as a precision source of sound at any frequency, and (*b*) as a source of sound of known relative loudness at different frequencies throughout the acoustic range. In the other researches mentioned the source of sound is a condenser transmitter of the electrostatic type. A stretched steel diaphragm and a metal plate with air between them, forming a condenser, will give out a note when subjected to an alternating P.D., owing to the varying electrostatic stress between the metal parts. This apparatus was calibrated over a wide range of frequencies, and the efficiency can be made uniform for frequencies up to 10,000 cycles per second. When properly calibrated this apparatus is also regarded as a precision source of sound and can be applied to the measurement of sound at any of the frequencies within the wide range available.

The Future of the British X-Ray Industry.—An address on the above subject by Mr. Geoffrey Pearce is published in the last issue of the "Journal" of the Röntgen Society. In reviewing the British Röntgen Ray industry Mr. Pearce mentions an experience that is unfortunately true of many other industries in this country. So far as efficient work is concerned we have no reason to fear comparison with other nations; but most of the new appliances have originated elsewhere either in Germany Austria or America. No doubt, as Mr. Pearce states, Germany's geographical position facilitating intercourse with medical experts in other countries has been of great assistance. But this freedom of intercourse is also due to the thorough way in which German Universities and hospitals have studied the subject. Students from Italy, Spain, South America and the United States, for example, frequently attend German Universities to complete their training, and thus a favourable opening for trade is built up. In this country research propaganda and publicity all deserve more attention from manufacturers, and it is asked whether we cannot establish in London something resembling the Röntgen Congress in Berlin. Prof. A. W. Porter, who opened the discussion, likewise emphasised the need for better facilities for research; and Mr. R. S. Wright referred to the deep-seated impression amongst doctors that the best apparatus invariably comes from abroad. It may be true that in many directions British manufacturers have lagged behind; but it is a pity that the pioneering work that *has* been done in this country is so little known.

OBITUARY.

PROF. A. F. GANZ.—The death of Prof. Albert F. Ganz is announced. Prof. Ganz, who was 45 years of age, had been Professor of Electrical Engineering at the Stevens Institute of Technology, Hoboken, N.J., since 1902. He was the author of many contributions to American journals on corrosion by electrolysis, &c.

DEATHS ON ACTIVE SERVICE.—The following deaths on active service are reported:—

Bombardier W. Bingley (R.F.A.), formerly in the India Rubber Co.'s general office, has been killed in action.

Pte. Geo. Owen (Welsh Regt.), formerly a Cardiff tramcar driver, has been killed in action.

Pte. John Johnson (1st Essex), who was formerly a Burnley tramcar conductor, is now officially presumed dead. He had previously been reported missing.

Gunner A. Wheadon (R.F.A.), another Burnley tramway employee, has been killed in action.

Corpl. Geo. Child (Scottish Rifles), who was formerly a tramcar conductor at Colne, has died in action.

Pte. J. Kinsey (K. O. Lancaster Regt.), who was formerly employed at Blackpool electricity works, has been killed.

Pte. Chas. Sayle, a Blackpool and Fleetwood tramwayman, has died in action.

PERSONAL.

The Sultan of Egypt has conferred the Order of the Nile, Fourth Class, upon Mr. S. Dennett, Superintending Engineer of Sudan Government Posts and Telegraphs.

Mr. A. Hollingworth, of Huddersfield, has been offered the post of manager of Holmfirth Urban Council's electricity department.

NAVAL APPOINTMENT.—Mr. Walter Turnbull, warrant telegraphist, has been appointed a commissioned telegraphist as from Aug. 31.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, Sept. 8th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. At the Swan Hotel, New-street, Birmingham. Paper on "The Manufacture of Commutators for Electrical Machinery," by Mr. A. F. Green.

TUESDAY, Sept. 11th.

CIRCLE OF SCIENTIFIC, TECHNICAL AND TRADE JOURNALISTS.

4.30 p.m. In the Hall of the Institute of Journalists, Tudor-street, London, E.C. Paper on "Industrial Reconstruction," by Mr. E. J. P. Benn.

Digitized by Google

TESTS ON OIL SWITCHES.*

BY DR. GEORG STERN AND JOSEF BIERMANNS.

The disturbances caused by short-circuits present some of the greatest difficulties in the handling of the transmission of energy on a large scale by high-tension alternating currents. The most important precautions that have to be taken include the provision of means to deal with the mechanical strains set up and to secure satisfactory interruption of the current at the switch-contacts. The theory of the phenomena occurring during the process of switching-off is still very obscure and the development of modern oil-switches has taken place on empirical lines without the support of experiment.

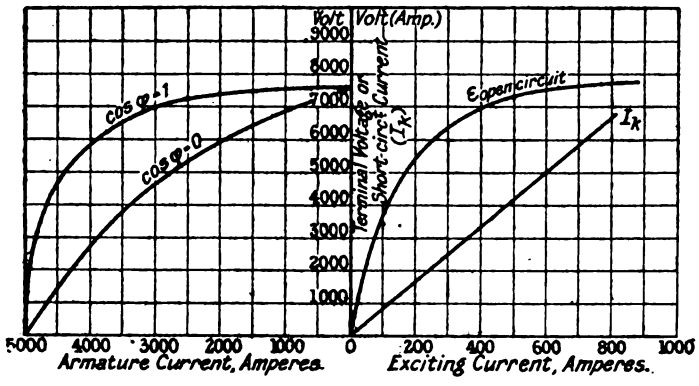


FIG. 1.

It is true that a certain number of tests have been made by various engineers in charge of large generating stations, bu the list is short and the sco e has been of necessity limited by considerations of safety to the plant and on this account systematic tests have not been possible.

In the year 1904 the General Electric Co. carried out short-circuit tests at Niagara on three machines of 3,750 k.v.a. each at 2,200 volts, the results of which are not yet published. In 1911 tests were made in Chicago at the Fisk-street Station of 12,000 k.v.a., 9,000 volts. These have been described by Merriam † and Schuchardt and Schweitzer ‡. The oscillograms referring to these tests were reproduced without scales of voltages and currents. The maximum apparent three-phase short-circuit was 164,000 k.v.a. and the maximum three-phase energy developed at the switch-contacts was 71,500 k.v.a. Vogelsang § describes an experiment made in Norway in 1911 in which five generators of 3,400 kw., 12,000 volts, were connected in parallel. Only one short-circuit test was made and oscillograms and particulars of the magnitude of the short-circuit current have not been published. Marguerre ¶ published the results of tests on five types of oil-switches using three generators of a combined capacity of 50,000 k.v.a. at 10,500 volts. The highest power at the switch was only 42,400 k.v.a. at 10,300 volts (21,200 kw. at cos $\varphi = 0{\cdot}5$). No short-circuits were made, and the object of the tests was to obtain results at low power factors. Recently the commission on high tension apparatus appointed by the Institution of Swiss Electrical Engineers has issued a report in the name of B. Bauer. || For these tests one generator of 1,100 kw., three-phase, at 8,000 volts of the Benznau station was available. Short-circuits were not investigated, but the tests were made at various voltages and power-factors with loads of different magnitudes adjusted before the operation of the switches. The highest power at the switch was 900 k.v.a. at cos $\varphi = 1$, single-phase.

The Allgemeine Elektricitäts-Gesellschaft have carried out tests from time to time at various stations installed by them, but it was decided to construct a permanent testing station, in which the problems connected with the operation of oil-switches could be systematically examined. This installation is described below, together with a selection from the tests that have been performed there. The plant is being used to study in an exhaustive manner the effects of short-circuits on transformer windings, rotary converters and relays and the action of fuses and air- and oil-switches on short-circuits.

The laboratory consists of two main parts, a closed room containing the machines, auxiliary apparatus and measuring instruments and an open-air installation, in which the oil-switches are installed. A large three-phase generator is coupled by an elastic coupling to a 1,100 kw. three-phase synchronous motor, and its excitation is supplied by a 130-kw. rotary converter. A single-phase transformer of rated capacity 15,000 k.v.a. at 85,000 volts, may be interposed between the generator and the switch under test. The generator has at its maximum voltage of 7,500 volts a rated capacity of 15,000 k.v.a. It runs at 500 revs. per min. and has 12 poles. The effective leakage reactance is about 6 per cent. and so very high momentary currents are obtainable. The rotating field-system weighs 50,000 kg. and its flywheel effect (112,000 kgm.²) is so great that the driving motor need not be disconnected from the line during the short-circuits. The generator drops about 5 per cent. in speed when these occur. The characteristic curves of the generator are given in Fig. 1. The tests are carried out by gradually increasing the voltage of the generator to a point where it is suddenly short-circuited through the switch under test by means of an intermediate switch. This switch in its motion automatically cuts off the short-circuit at an adjustable interval of time after the production of the short-circuit. The pressure inside the container of the oil-switch and the speed at which the contacts open are measured by suitable instruments.

The power controlled by the switch is generally defined as the product of the current at the beginning of the operation and the voltage across the contacts after the operation. In most of the tests the interruption of the short-circuit was so rapid that the short-circuit current was not stationary at the beginning of the process of its interruption, and on this account the current broken by the switch is defined as the mean of the current taken over the short-circuit period; this mean is not very different from that of the last amplitude before the operation of the switch, if the damping is small.

The operation of the switch is always attended by the formation of an arc, which may not necessarily be extinguished during the first passage of the current through zero. In fact, the arc is usually maintained for a number of half-periods. This is due to the hysteresis of the arc caused by a lag in the heating effect of the arc behind the current producing it. On this account when the arc would be extinguished the voltage has risen to such a value as to restart it. The operation of the switch is completed as soon as the contacts have opened far enough to prevent this restarting of the arc and the arc-length will increase with the value of the voltage available to produce the restarting at each passage of the current through zero. If the current is displaced in phase relatively to the voltage this restarting voltage is greater than if the current is in phase with the voltage, and on this account the arc length reaches its greatest length with about 50° to 60° phase displacement between the voltage and current. The arc length also increases with the magnitude of the voltage in the external circuit and to some extent with the magnitude of the current. The most destructive effects are produced in the opening of short-circuits, as in this event the greatest current is obtained in association with low power factors.

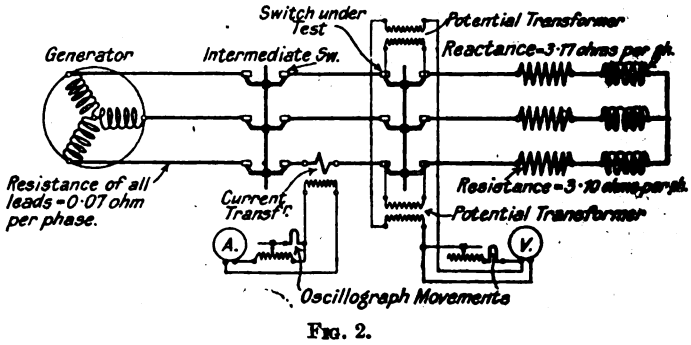


FIG. 2.

The conditions become increasingly unfavourable to the switch the nearer the short-circuit point approaches the generators, as the current and phase displacement increase with a decrease of the external impedance of the circuit; thus the most dangerous short-circuits are those taking place on the bus-bars. The most unfavourable conditions likely to occur in practice were initiated by short-circuiting the generator at its terminals and causing the interruption of the current to take place so soon that the tested

* Abstract of an article in the "Elektrotechnische Zeitschrift," Nos. 46 & 47, Vol. XXXVII.

† "Proc." Am. Inst. El. Eng., July 1911, p. 1431.

‡ "Proc." Am. Inst. El. Eng., July 1911, p. 1669.

§ "Elektrotechnische Zeitschrift," 1913, p. 1.

¶ "Elektrotechnische Zeitschrift," 1912, p. 709.

|| Bulletin of the Schweitzer Elektrotechn. Verein, 1915, Vol. VIII. Abstract "Electrician" March 3, 1916.

Digitized by Google

switch had to break not the stationary short-circuit current but the far greater momentary current, and so soon that the voltage still had nearly its open-circuit value. The voltage could even be raised by momentarily increasing the excitation of the generator, as the loads were only of short duration. In this manner loads of 10 to 20 times the rated capacity of the generator were obtained.

In order to examine the dependence of the length of the arc on the phase-displacement the connections were made as in Fig. 2, the phase-displacement being adjusted by varying the resistance in series with the choking-coil in each phase. This coil had a three-phase winding and was rated at 10,000 k.v.a., 5,600 volts, 50 cycles, and had only about 80 kw. internal losses. The switch under test had a double break in each phase and a travel of 150 mm., the speed of opening at the contacts being about 2 to 3 m/s.

Table I. gives a few results obtained at an open circuit voltage of 7,500 volts at 50 cycles.

Table I.

Current I ..... (effect. value of last half-wave)	1,700	780	1,170	1,350
K.v.a.	22,000	10,000	15,000	17,500
Duration of arc in half-periods ...	3	2·3	1·6	0·9
Phase displacement	88°	50°	25°	10°

From a number of results of this kind average values were obtained, and these are plotted in Fig. 3.

This shows that the phase-displacement has only a small effect on the time of switching when the angle of phase-displacement exceeds about 30°. This result is of great practical importance as it bears upon the controversial question whether current-limiting reactances should be used to protect generators, transformers and oil-switches by reducing the maximum currents that flow on a short-circuit.

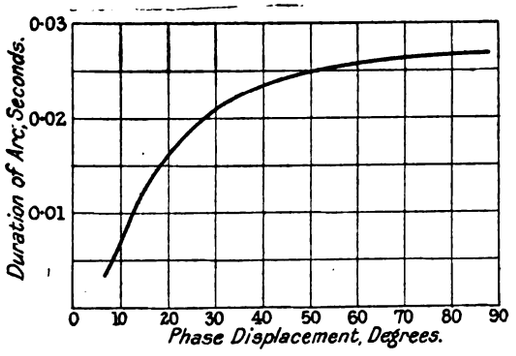


FIG. 3.

It has been argued * that the use of such reactances is disadvantageous, as the switches would have to operate at low power-factors, and the use of protective resistances has been suggested. The following numerical example will illustrate this point. In large turbo-alternators the resistance and reactance are of the order of 0·8 and 2·5 per cent. respectively. This would permit a maximum instantaneous short-circuit current of about $100/\sqrt{(0·8)^2+(2·5)^2}$ or 38 times the full-load current to flow, if the armature reaction be neglected; values of 32 times the full-load current have actually been recorded. If a reactance of 5 per cent. be connected in series with the alternator, which would only slightly affect the regulation, the short-circuit current would be reduced to $100/\sqrt{(0·8)^2+(7·5)^2}$ or 13 times the full-load current. On the other hand, the phase lag of the current would be increased from 72° in the unprotected machine to 84° in the protected machine, which would, according to the above tests, increase the duration of the arc at the switch by only 8 per cent. For the slight increase in time we have gained the advantage of reducing the power to one-third of its previous value. If the reactance is replaced by a resistance, also of 5 per cent. of the synchronous reactance of the alternator, and a two-step oil-switch is used so as to insert the resistance before breaking circuit on the second step, the generator itself is not protected thereby and the current will be reduced, only on the second step, to 16 times the full-load current. At the same time the phase-displacement will be decreased to 23°, which would reduce the arc duration by 27 per cent. The conditions on the second step of the switch have, therefore, been improved to some extent. Nevertheless the first step has to break the full current of 37 times the normal current at 10 per cent. of the no-load voltage. Thus at the first moment the shaft is exposed to a torque of $37 \cos 72° = 11$ times the full-load torque, the corresponding value with the reactance being only 8·5. On the other hand, a torque of $16 \cos 23° = 15$ times the full-load torque would be exerted on the shaft when the resistance is introduced. This rough calculation shows the advantage of using the reactance, which has the further advantage of not requiring to be short-circuited during normal operation.

* Bauer, loc. cit.

It is an open question whether it is advantageous to break the current at a number of gaps under the oil. In general it may be said that with the same velocity of the switch-contacts the speed of the opening of the contacts increases in proportion to the number of breaks, so that it is not easy to determine the exact cause of the improvement of the operation of the switch when the number of gaps is increased. In order to investigate this point the tests recorded in Table II. were made, in which the values (a) were obtained with one pole of the switch and normal travel and velocity of the contacts; the values (b) were obtained with two poles connected in series and with a travel limited to half that in (a) and with the velocity reduced by a counter-weight to half the value in (a); and the values (c) were obtained with the arrangement of (b), but with counter-weight removed so that the velocity of the switch contacts was normal as in (a).

The current I_1 is the effective value of the first (maximum) half-wave of the current, and I_2 the average of the effective values of the half-waves of the current during the whole duration of the arc. All currents and voltages in the tables are given in effective values.

The tests show an obvious advantage of the arrangement (b) as compared to (a); on the other hand the increase of velocity and travel in (c) does not afford any marked improvement.

The conditions are quite different if we compare multi-gap switches equipped with enclosed arc-extinguishing chambers. If the fixed contacts of the switch are surrounded by small cylindrical chambers of metal, closed at the top excepting small holes to allow the oil to circulate, and if the lower movable contacts are formed cylindrically so as to fit loosely into the metal chambers, then the oil will be subjected to a high pressure in the chambers when the arc forms. This increase of pressure accelerates the destruction of the arc. This device is preferable to the arrangement that has been employed, which consists in keeping the whole oil chamber under a continuous pressure, as it is simpler, less costly and less dangerous, as with the oil vessel under pressure burning oil is liable to be scattered if the enclosing casting breaks on a particularly severe short-circuit. The pressure in the extinguishing chambers is produced by the arc itself and the oil-container is not exposed to any great pressure. In one experiment in which 23,000 k.v.a. at 38,000 volts was broken (single-phase) with a single-pole switch fitted with extinguishing chambers the arc was maintained for 11 half-periods. The highest pressure measured in the oil-chamber was only 0·4 kg./cm.², whereas the pressure in the extinguishing chamber rose to 5 kg./cm.² In other tests the pressure inside the chamber reached 20 times the pressure in the oil-well. Tables III. and IV. show the superiority

Table II.

E	I_1	I_2	Single-phase short-circuit power. Maximum. K.v.a.	Single-phase short-circuit power. Interrupted. K.v.a.	Duration of arc in half-periods.	Arrangement.
5,100	2,300	950	12,800	4,850	16	a
5,100	2,400	1,100	12,200	5,600	5	b
5,100	1,600	1,080	8,150	5,500	3	c
6,050	3,500	1,000	21,200	6,050	21	a
6,050	3,150	1,000	19,000	6,050	11	b
6,050	1,800	950	10,900	5,750	8	c
6,950	3,150	1,400	22,000	9,750	23	a
6,950	3,500	1,250	24,300	8,700	17	b
6,950	2,500	1,050	17,400	7,300	15	c

Table III.—*Single-poles witch* 100,000 *volts*, 400 *amperes, with six-fold break, mean velocity of switch* 5·0 *m/s.*

E	I_1	I_2	Single-phase short-circuit power. Maximum. K.v.a.	Single-phase short-circuit power. Interrupted. K.v.a.	Duration of arc in half-periods.
60,000	485	270	27,100	16,200	17
65,000	570	260	37,000	16,900	19
69,000	465	290	32,100	20,000	18
67,000	375	275	25,100	18,400	26
65,000	420	265	27,300	17,200	14
65,000	500	234	32,500	15,200	24

Digitized by Google

Table IV.—*Single-pole oil-switch 100,000 volts, 400 amperes, with double break and extinguishing chambers, mean velocity 3·23 m/s.*

E	I_1	I_2	Single-phase short-circuit power.		Duration of arc in half-periods.
			Maximum. K.v.a.	Interrupted. K.v.a.	
70,000	550	360	38,000	25,300	7
80,000	580	360	46,500	28,700	8
80,000	500	330	40,000	26,500	9
80,000	500	410	40,000	33,000	7
80,000	440	440	35,000	35,000	8

of the switches provided with the new device. It is seen that 17,300 k.v.a. are interrupted in 20 half-periods with a six-fold break and the consequent high speed of separation of the contacts (5 as against 3·23 m/s.), whereas as much as 29,700 k.v.a. are interrupted in only 8 half-periods with a two-fold break if the extinguishing chambers are provided. It was thought to be too dangerous to test the switch of Table IV. at such high loads, as the arc would certainly have been maintained permanently. In the switch of Table IV. the total travel was 1·05 m. Thus at a mean speed of 3·23 m/s. only one quarter of the travel was covered in 8 half-periods and the switch was by no means loaded up to its limit. A new type of switch was built embodying the results of the above tests, the

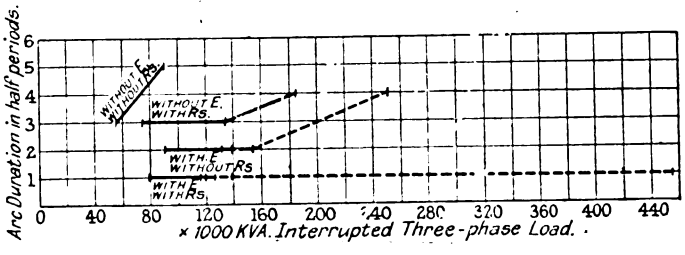

Arc Duration in half periods.
WITHOUT E. WITHOUT RS.
WITHOUT E. WITH RS.
WITH E. WITHOUT RS.
WITH E. WITH RS.
0 40 80 120 160 200 240 280 320 360 400 440
x 1000 KVA. Interrupted Three-phase Load.

FIG. 4.

contacts being all enclosed in cylindrical metal chambers, and the rate of opening at the switch contacts being accelerated. This was effected by constructing the moving parts as so to offer the smallest possible resistance to motion through the oil and by keeping the contacts closed during the first part of the motion of the switch and opening them suddenly towards the end of the motion by the action of springs. The results of the tests with the switch are given in Table V. and Fig. 4, the dotted portions of this figure being obtained by multiplying measured single-phase powers by 3. It will be seen that the duration of the arc increases with the power if extingishing chambers and rapid contacts are not used. The addition of rapid contacts improves the switch up to 130,000 k.v.a. and again the use of extinguishing chambers alone is found to be of advantage. The same arc duration of 0·03 sec. is obtained at 60,000 k.v.a. without the chambers or rapidly acting contacts, at 140,000 k.v.a. with the rapid contacts and at 200,000 k.v.a. with extinguishing chambers. When both these devices are used together the duration of the arc did not exceed 0·01 sec. at any of the loads that were available. The highest maximum three-phase short-circuit power that was handled was 600,000 k.v.a. and the highest interrupted short-circuit power 450,000 k.v.a. The conditions of the tests were somewhat less exacting on the switch than they would be under normal service, as the switch was caused to open sooner after the occurrence of the short-circuit than would be the case in practice and owing to the fact that the leads between the generator and the switch were considerably shorter than they would be likely to be in a generating station. Taking these facts into consideration it may be estimated that the tests correspond to the case of a generating station with turbines of a capacity of 75,000 kw. to 100,000 kw. protected by choking-coils with about 5 per cent. voltage drop. The new oil-switch shortens the duration of the arc to 1/100 sec., and the destructive gases produced in the oil are rendered innocuous by containing them in closed chambers where they do useful work in blowing out the arc that is formed.

Table V.

E	I_1	I_2	Single-phase short-circuit power.		Duration of arc in half-periods.	Remarks.
			Maximum. K.v.a.	Interrupted. K.v.a.		
5,400	14,000	6,000	131,000	56,200	3	Without E. Witho't RS.
6,500	11,000	7,500	123,500	84,800	5	
5,300	15,000	8,100	138,000	74,500	3	Without E. With RS.
6,750	20,000	11,500	234,000	134,500	3	
7,700	17,000	14,000	237,000	186,000	4	
6,500	15,000	8,000	168,000	90,400	2	With E. Witho't RS.
7,650	13,500	10,500	178,000	139,400	2	
7,650	16,500	10,000	218,000	132,500	2	
7,650	15,500	11,500	204,000	152,500	2	
7,650	19,000	10,500	145,000*	80,000*	3	
7,650	19,000	11,000	145,000*	84,000*	4	
6,500	18,500	7,000	211,000	79,000	1	With E. With RS.
7,650	11,000	9,500	146,000	126,000	1	
7,650	13,500	9,000	179,000	119,500	1	
7,650	26,000	8,600	345,000	114,000	1	
5,100	33,000	9,000	168,000*	46,000*	1	
6,760	...	15,000	...	110,000*	1	
7,550	...	20,000	...	151,000*	1	
6,750	22,000	12,000	148,500*	81,000*	1	
7,500	27,000	16,000	202,000*	120,000*	1	

E = Extinguishing chambers. RS = rapid acting switch contacts.

* 1-phase.

MAGNETIC CONTROL AS APPLIED TO LARGE MINE HOISTS.*

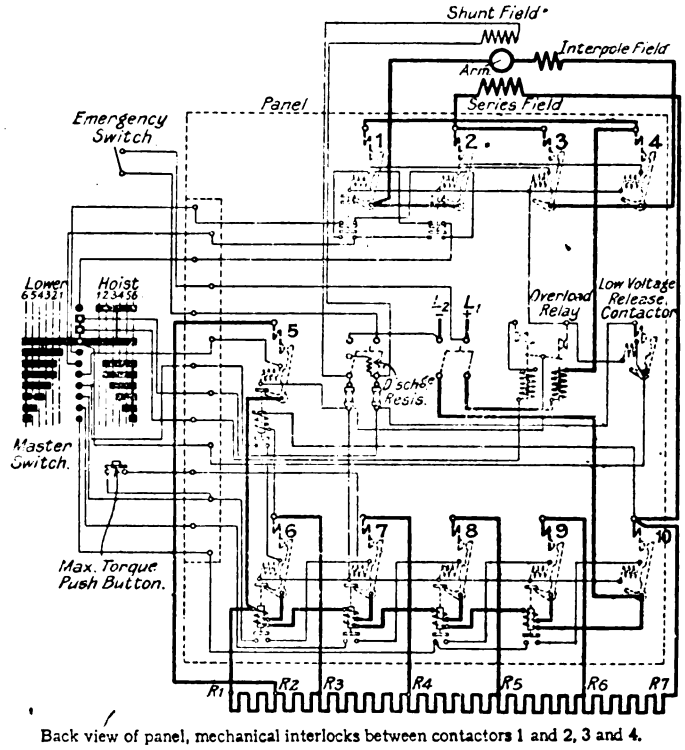
BY E. C. GOOCH.

This article is confined entirely to a discussion of magnetic control equipments as applied to mine hoists; the characteristics of motors will be discussed only in so far as is necessary to describe the control.

A mine hoist may be considered as a sort of elevator which must run according to a definite schedule. It may be driven in any of several ways:—

1. The Ward Leonard system in which a shunt-wound hoist motor is direct connected electrically to a direct-current generator of a motor-generator set. With this method of control the speed of the hoist motor can be varied, by weakening or strengthening the generator field in about the same ratio as the generator voltage.

2. A direct-current motor geared directly to the hoist controlled by means of a resistance in series with the armature, cut in and out of circuit either by a manually operated drum controller or by magnetic contactors operated by a master switch. Fig. 1 shows the



Back view of panel, mechanical interlocks between contactors 1 and 2, 3 and 4.

FIG. 1.—DIAGRAM OF CONNECTIONS OF TYPICAL STRAIGHT REVERSIBLE MAGNETIC CONTACTOR OPERATED BY MASTER SWITCH.

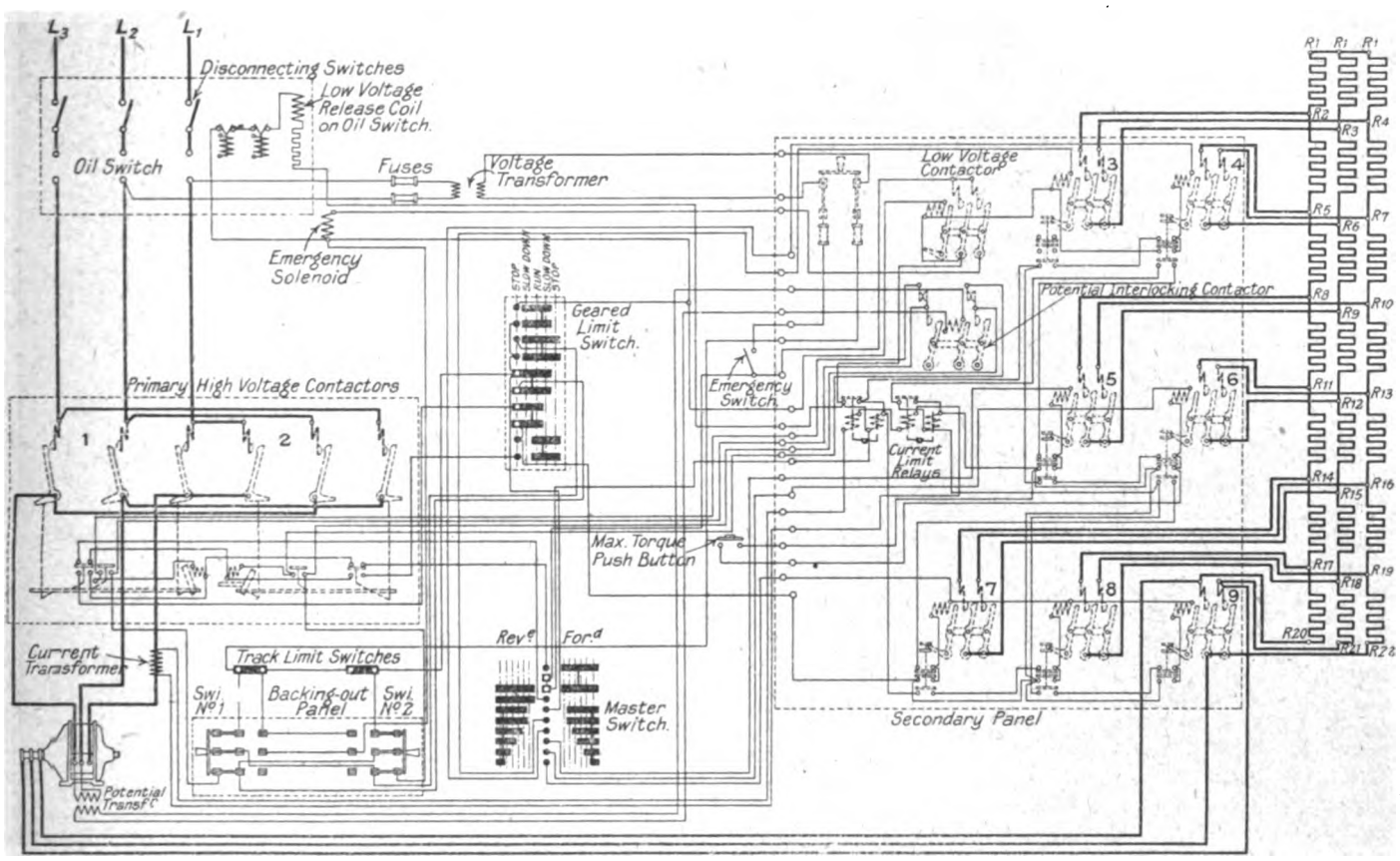
connections of a typical straight reversible magnetic direct-current control equipment. (In this system dynamic braking may be used for lowering unbalanced loads.)

* From the "General Electric Review," slightly abbreviated.

Digitized by Google

3. A slip-ring induction motor geared directly to the hoist drum, the speed of the motor being varied by changing the amount of resistance in the secondary circuit. This resistance may be varied either by a liquid rheostat or by cast grids or other metallic resisters, cut in and out of circuit either by manually operated controllers or by magnetic contactors operated by a master switch. This is one of the most commonly used systems for the electric drive of mine hoists.

The connection diagram shown in Fig. 2 is of a typical high-voltage control equipment for a slip-ring induction motor. This equipment includes the following: Two three-pole mechanically and electrically interlocked primary reversing contactors; secondary contactor panel; overwind protection, using geared and track type limit switches; potential interlocking feature; low-voltage protection; emergency cut-out switch; maximum torque push button; emergency solenoid; master switch; current and voltage transformers; and secondary resistance.



Back view of panels.
In case of over travel, which drops out contactor No. 1, it will be necessary to throw No. 1 T. P. switch inward in order to reverse hoist.
If No. 2 contactor drops out, No. 2 switch must be thrown inward to reverse hoist.
Both switches must be in outward position for normal running.
Mechanical interlock between contactors 1 and 2.

FIG. 2.—CONNECTIONS OF TYPICAL HIGH-VOLTAGE CONTROL EQUIPMENT FOR SLIP-RING INDUCTION MOTOR.

The equipment just outlined furnishes eight control points both for hoisting and lowering as indicated on the speed-torque curves in Fig. 3. These curves are based on the assumption that the breakdown torque of the motor is at least 250 per cent. of the torque required to hoist the maximum load.

With the six-point master switch and the eight-point control equipment (Fig. 2), the speed torque curves (Fig. 3), show the acceleration of the motor. Curves *A*, *B*, *C*, *D*, *E*, and *H* are of hand control by the master switch. Curves *B*, *C*, *D*, *E*, *F*, *G* and *H* are of automatic control by the current-limit relays. When the master switch handle is thrown from the "off" position to the full "on" position, automatic acceleration is obtained as indicated on the curves and vertical lines by *C*, *D*, *E*, *F*, *G* and *H*. The curves show that the current-limit relays operate at 125 per cent. of full-load torque. (This value should be from 15 to 25 per cent. above the torque required to hoist maximum load at full speed.) With a four-point master switch and a seven-point control equipment, the torque curves are exactly the same as in Fig. 3, except that curve *B* is omitted.

Referring to Fig. 2, the geared limit switch provides for opening contactors 3, 4, 5, 6 and 7 at a pre-determined distance from each end of the travel, thus allowing the motor to operate at a reduced speed just before the load reaches the dumping horns of the hoist. The amount of resistance that should be cut back into circuit by the geared limit switch depends upon the maximum load hoisted and upon the permissible speed of the hoist cage at the time it reaches the dumping horns. Obviously, the same amount of slow down cannot be obtained for all conditions of load, and in the case of an overhauling load the motor will speed up when resistance is cut into circuit. This limit switch also provides for opening the hoisting or lowering contactors and sets the emergency solenoid. It does not, however, open the oil switch, for this is not intended as a service operation.

The track limit switches are located so as to be tripped by the hoist cage above the point where the geared limit switch operates to cut off power, and they are so connected as to open the main line oil switch and all contactors, thus completely cutting off power from the motor.

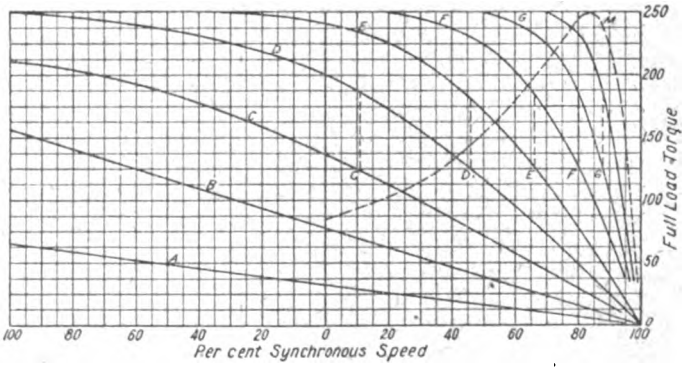


FIG. 3.—SPEED-TORQUE CURVES AS GIVEN BY SIX-POINT SWITCH AND EIGHT-POINT CONTROL EQUIPMENT.

The "backing-out" panel consists of two three-pole double-throw switches connected so that for normal operation both switches must be left in the outward position. In case of an over-travel, which drops out a main line contactor, the corresponding switch must be thrown inward before the hoist can be operated in the other direction.

Digitized by Google

Low-voltage protection is provided as a part of the control equipment, in addition to that embodied in the oil switch. The double-pole low-voltage release contactor completes the control circuit to all contactors and is so connected that its magnetising coil is energised when the master switch is in the "off" position. When it closes, it establishes a holding circuit through one of the contact tips, the other tip being used for the emergency solenoid.

The potential interlocking scheme consists of a small transformer having its prinary circuit connected across one primary phase of the hoist motor and its secondary circuit connected to the coil of the normally closed contactor shown on the secondary panel, Fig. 2. The magnetising circuit of the primary reversing contactors is completed through the normally closed contacts of the contactor just mentioned, and the holding circuit is completed through interlock discs on the primary reversing contactors; that is, in order to close a main line contactor the potential interlocking contactor must be de-energised. Just as soon as one main line contactor is closed this potential interlocking contactor is energised and remains energised until the main line contactor is entirely open and the arcs broken. If an arc should hang on any phase after the main contactor is open, the interlocking contactor will remain energised and will effectively prevent the other main contactor from being closed and a short-circuit occurring.

The emergency switch, Fig. 2, is intended to be used in case of emergency so that the equipment can be shut down with the least possible delay. The switch should be located within easy reach of the hoist operator. The purpose of the maximum torque push-button is to by-pass the current-limit relays and close the secondary resistance contactor which allows the motor to exert its maximum torque. The emergency solenoid is not intended for service operation, but is connected so that it will trip in case of overload, low voltage and overwind, and also be the emergency switch.

The resistance is designed to give 33 per cent. full-load torque at standstill on the first controller point, 77 per cent. torque on the second, and 130 per cent. torque on the third. The last four resistance steps are designed for accelerating the motor with peaks of about 225 per cent. full-load current.

REPETITIONS OF E.M.F. IN ARMATURE WINDINGS.

BY C. C. HAWKINS.

For the purpose of attaching equalising rings or for connection to a static balancer, it is often required that a multipolar armature winding should be divisible into portions which give at every instant the same E.M.F., whatever the shape of the flux curve of the field. For the purpose of suppressing ripples in the E.M.F. wave of alternators, it is on the other hand often desirable that component portions of a multipolar winding should not at every instant give precisely the same E.M.F., since if they do, any ripples in the component E.M.F.'s are maintained in the same degree in the resultant E.M.F. From both points of view the leading features of armature windings have been investigated in detail by Dr. S. P. Smith, in his paper on "The Theory of Armature Windings" which recently appeared in the "Journal" of the I.E.E. (Vol. LV., p. 18). The study of the conditions which fix whether an armature winding can or cannot be divided into portions which at every instant give an E.M.F. equal in amount and in phase with each other, can, however, be approached in different ways. Attention having been re-directed to the subject, it may not, therefore, be out of place to put forward an elementary method of treatment to serve as an introduction, leading up to the same conclusions as those of Dr. Smith so far as repetitions of E.M.F. are concerned, but reaching them by a somewhat different route. It should be added that only one specific point is here discussed, viz., whether or no given armature windings will show repetitions of E.M.F., in which connection Dr. Smith has rightly shown the decisive importance of the slot positions. The further question of whether an armature winding which gives repetitions falls into the class which Dr. Smith has defined as "symmetrical" or into the "unsymmetrical" class is not directly touched upon, and for this the reader is referred to the paper above-mentioned.

The assumption is made that every double pole-pitch yields a field of flux identical in amount and distribution with that of every other pole-pitch. It is further assumed that there are n_s equidistant slots in an armature with N_2 coils or sectors coupled up after a regular law and closing naturally, *i.e.*, without any irregularity of connection which would cause what may be termed forcible closure. Let all slots be equally filled with u_n coil-sides arranged in two or more layers as in Fig. 1, and let $u_l = \frac{1}{2}u_n$ = the number of commutator sectors per slot. Thus in an ordinary two-layer winding, u_l is also the number of coil-sides per slot in one layer (Fig. 1 *a*), but this is in no way necessary to the argument, since the coil-sides may equally well be arranged vertically one above the other (Fig. 1 *b*).

The fundamental fact is then that a coil-side occupying the same relative position within a slot as another coil-side in another slot will give an E.M.F. the same in amount and phase as that of the latter at every instant, provided that the two slots occupy the same position relatively to poles of the same sign.

Now when n_s is prime to the number of pole-pairs, p, *i.e.*, when p and n_s have no common factor higher than 1, it is evident that there are no two slots which at any moment have the same position relatively to poles of the same sign. Consequently in such cases there can be no starting-point for repetition of the slot positions relatively to the field to begin, and *a fortiori*, no possibility that a second coil-side corresponding to an initial coil-side from which a start is made may repeat the latter's position in the slot and also the latter's position relatively to the field. It follows, therefore, that if n_s is prime to p, there can be no repetitions of the E.M.F. between different portions of the winding. This consideration at once enables certain numbers of slots and pole-pairs to be ruled out as not admitting of any repetition of E.M.F., whatever the nature of the winding, and the field left for investigation is thereby reduced.

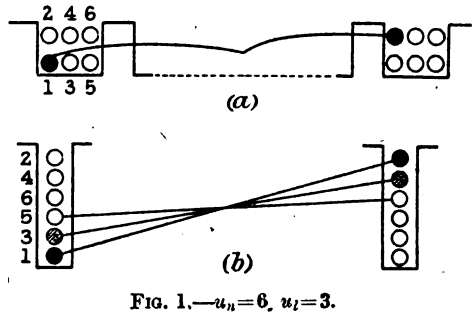


FIG. 1.—$u_n = 6$, $u_l = 3$.

When a common factor higher than unity exists between n_s and p, let f be the H.C.F. between them, of value 2 or more. Then the slots are divisible into f groups of $n_s/f = n'_s$ slots, and similarly the pole-pairs into f groups of $p/f = p'$ pole-pairs; and the two sets of groups exactly correspond to one another. The number of slots that at any instant repeat exactly the same position relatively to poles of the same sign is then evidently f, and each such repetition in space affords a possible starting-point for repetition of E.M.F., since the slots which follow in each of the f groups are pitched at equal distances apart. It still, however, remains to be investigated whether the actual winding can take advantage of these possibilities, and the only further conclusions that can at present be drawn are that under no circumstances can the number of repeating systems giving precisely the same instantaneous E.M.F. exceed f, and that the maximum value of f can never exceed p, since this is the highest common factor that is possible between p and n_s, if, as is the case in practice, n_s exceeds p.

Limiting our inquiry to machines with 24 or fewer poles, it is then an easy matter to divide up all slotted armatures into two classes, according to whether n_s has or has not any

Digitized by Google

factor common to p and higher than unity. The latter class shown below on the left-hand side of Table I., admit of no possibility of repetition, and, therefore, come into question in connection with the suppression of ripples; the right-hand side, on the other hand, will come into consideration for continuous-current armatures needing equipotential connections. In each case n is here any whole number.

In drawing up this table we need never in the expression $n_s = pn \pm x$ raise x above $\frac{1}{2}p$, since, *e.g.*, $11n \pm 6$ is the same as $11n \pm 5$, with the values of the whole number n raised or lowered by 1 as the case requires.

The next question will be to ask whether, when the numbers of slots of Table I. are considered with further reference to the number u_l of commutator sectors per slot, there are any limitations to the kinds of winding that are mechanically possible. With lap-winding, simplex or multiplex, any of the above values for the number of slots are possible mechanically; if multiplex, since the number of commutator sectors, $N_2 = n_s u_l$, there will be two or more independent helices or a single closed helix according as the commutator pitch $y_k = m$ has, or has not, a common factor higher than unity with either u_l or $n_s = pn \pm x$ or pm.

So too with wave-winding; whatever the value of u_l, all the above numbers of slots can be wound with a wave-winding, simplex or multiplex. A particular value or values for a, the number of pairs of armature paths,* will in each case result, but it is always mechanically possible to connect the $n_s \cdot u_l$ coils as a wave-winding. The possible values of a are governed by the fact that the commutator pitch—

$$y_k = \frac{n_s \cdot u_l \pm a}{p} = \frac{n_s \cdot u_l}{p} \pm \frac{a}{p}$$

must be a whole number, and examination of this relation leads to certain consequences. But at this point it is interesting to note that there is no possibility of repetition of E.M.F. in any wave-winding in which a/p is a proper or improper fraction in its lowest terms, *i.e.*, whenever a is prime to p.

Table I.

Not admitting of repetitions. No. of slots prime to p. $n_s = n_s'$.	No. of pole-pairs, p.	*Admitting repetitions.* No. of slots having a common factor >1 with p. n_s	*Admitting repetitions.* No. of repetitions = H.C.F. of n_s and p. $= f$	No. of pole-pairs in virtual unit machine $= p/f$. $= p'$	No. of slots in virtual unit machine $= n_s/f$. $= n_s'$
$2n+1$	2	$2n$	2	1	n
$3n \pm 1$	3	$3n$	3	1	n
$4n \pm 1$	4	$4n$	4	1	n
		$4n+2$	2	2	$2n+1$
$5n \pm 1$, $5n \pm 2$	5	$5n$	5	1	n
$6n \pm 1$	6	$6n$	6	1	n
		$6n+3$	3	2	$2n+1$
		$6n \pm 2$	2	3	$3n \pm 1$
$7n \pm 1$, $7n \pm 2$, $7n \pm 3$	7	$7n$	7	1	n
$8n \pm 1$, $8n \pm 3$	8	$8n$	8	1	n
		$8n+4$	4	2	$2n+1$
		$8n \pm 2$	2	4	$4n \pm 1$
$9n \pm 1$, $9n \pm 2$, $9n \pm 4$	9	$9n$	9	1	n
		$9n \pm 3$	3	3	$3n \pm 1$
$10n \pm 1$, $10n \pm 3$	10	$10n$	10	1	n
		$10n+5$	5	2	$2n+1$
		$10n \pm 2$	2	5	$5n \pm 1$
		$10n \pm 4$	2	5	$5n \pm 2$
$11n \pm 1$, $11n \pm 2$, $11n \pm 3$, $11n \pm 4$, $11n \pm 5$	11	$11n$	11	1	n
$12n \pm 1$, $12n \pm 5$	12	$12n$	12	1	n
		$12n+6$	6	2	$2n+1$
		$12n \pm 4$	4	3	$3n \pm 1$
		$12n \pm 3$	3	4	$4n \pm 1$
		$12n \pm 2$	2	6	$6n \pm 1$

* The symbol "a" is here used solely in the sense originally given to it by Prof. E. Arnold, as "the number of pairs of armature paths."

Just as all lap-wound multipolar windings, whether simplex or multiplex, in which n_s is prime to p admit of no repetitions, the same fact that there are no repetitions of slot positions relatively to poles of the same sign has consequentially the result of eliminating all cases of a prime to p. Since $y_k = (N_2 \pm a)/p = n_s \cdot u_l/p \pm a/p$ must be a whole number, and since a/p is then a fraction proper or improper with no factor common to numerator and denominator other than 1, $n_s \cdot u_l/p$ must yield a corresponding fraction in order to balance a/p. Hence p is then prime to n_s and to u_l taken separately and therefore to their product.* It will be seen that when p is itself a prime number to start with, *e.g.*, 2, 3, 5, 7, 11, there can only be repetitions when $a = p$ or a multiple of p.

It remains to consider the cases in which it is possible that the coils may begin to repeat their slot and field positions, and to determine how many such repetitions there are in the complete armature winding. The cases of windings forming (A) a single closed helix and (B) two or more independent helices are somewhat different and will be considered in succession.

(A.)—Windings consisting of a Single Closed Helix in two or more layers.

Confining ourselves for the present to windings, whether lap or wave, with two or more layers in each slot which form a single closed helix, and, therefore, have no common factor between y_k and N_2 higher than 1, the question to be answered resolves itself into two stages.

1. Starting from any given sector of the commutator or coil-side, and tracing the winding continuously through, coil by coil, how soon shall we come upon another coil whose first coil-side occupies exactly the same position *within a slot* as the original coil-side which formed the starting-point?

2. Having determined this, will any whole number of such steps bring us to another slot which occupies exactly the same position *relatively to a pole of the same sign* as our starting slot? If and when such a slot is reached, the whole sequence of E.M.F.'s begins to repeat.

The measurement of the steps may be made in terms of angles or pole-pitches or slot-pitches. But whatever the unit of measurement, it must be remembered that we may have to travel round the armature more than once in order to pass through all the coils. Thus when the complete set of armature coils of a closed winding is traced through, the total angle described round the periphery of the armature is 2π radians or some multiple of 2π, this being simply the mechanical condition that results from closure of the winding. In continuous-current windings forming single closed helices, the number of tours round the armature before closure is always the whole number, y_k', equal to the commutator pitch in sectors. The total angle that is described when the whole winding is traced through is therefore $y_k' \cdot 2\pi$. Similarly the number of double pole-pitches that is passed by is $y_k' \cdot p$, each pole-pair every time that it is passed being counted separately; and finally the number of slot-pitches passed by before the winding closes is $y_k \cdot n_s$.

Of the three units the slot-pitch is the most convenient, and will be here adopted, so that the two questions take the following forms:—

1. Starting from a coil with its sides in any given position within the slots, how many slot-pitches B must be passed by in tracing through a given type of winding before another coil is encountered with its sides in the same relative positions within the slots as those occupied by the coil from which the start was made? This must, of course, be some whole number.

* For let either n_s or u_l contain a factor k common to p and higher than 1, *e.g.*, let $n_s = kn_s''$ and $p = kp''$; then $n_s \cdot u_l/p$ is not in its lowest terms and can be reduced to $n'' \cdot u_l/p''$. But no fractional term having the smaller quantity p'' for its denominator can yield a whole number through addition or subtraction of a fraction a/p having the larger quantity p for its denominator unless a also contains the same factor k, which is *ex hypothesi* excluded in our present case.

Digitized by Google

2. Is any whole number k_1 of such steps of B slot-pitches equal to n_s/f or to any multiple of it ? If so, the *lowest* number must be found, since we desire to know *how soon* the E.M.F.'s begin to repeat.

The problem, therefore, resolves itself into finding if measurements made in steps of different lengths will at any point coincide, and at what point coincidence is first reached. Measuring off distances from a given starting-point, first by steps of A units, and secondly by steps of B units, where A and B are both whole numbers, a whole number of steps of both kinds will coincide for the first time when the distance traversed is the L.C.M. of A and B (Fig. 2). If A and B have no common factor other than 1, there will be no coincidence until we have taken B steps of A units, or A steps of B units, so that the total distance traversed is in either case AB. But if $A=k_1f'$ and $B=k_2f'$, where f' is the H.C.F. of A and B, the L.C.M. of A and B is k_1k_2f', and distances marked by the two kinds of steps will first coincide when $A\times k_2=B\times k_1=k_1k_2f'$.

In the present investigation, one of the standard steps remains throughout always the same, viz., the number of slot-pitches included before repetition of the slot-positions relatively to poles of the same sign begins. This has been shown to be the whole number $A=n_s/f$. The second standard B is also a whole number, but varies according to the type of winding and must be determined for each. The condition for electric repetition is therefore,

$$(n_s/f)\times k_2=B\times k_1=k_1k_2f',$$

where k_1k_2f'=the equipotential pitch, y_p, in slots, and this must always be less than $y_k \,.\, n_s$. If k_1k_2f' reached the value $y_k \,.\, n_s$, the winding has closed, and there is *no* repetition.

The value of B for different windings must now be determined, and it will be found that the results turn upon the question of the relation of y_k to $n_s \,.\, u_l$, and to its two components n_s and u_l considered separately.

Lap-winding.—In the ordinary simplex lap-winding, the coils following on one another in close succession, it is evident that we must pass through the u_l coils (corresponding, for example, in a two-layer winding to one layer of a slot) before we come upon another coil whose sides will occupy the same positions within their slots as the first coil from which the start was made (cp. Fig. 2). The advance then made in slot-pitches is one, so that the answer to the first question is $B=1$.

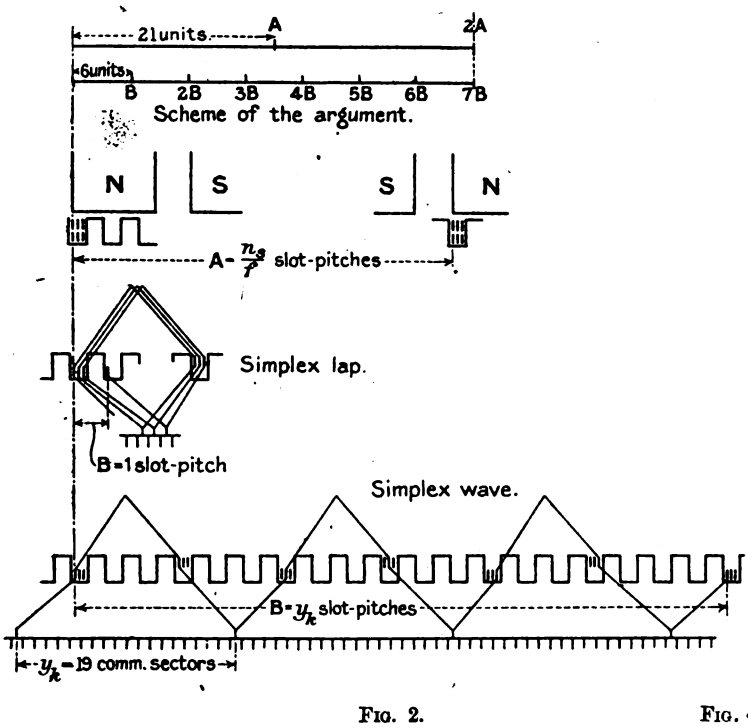


FIG. 2.

In multiplex lap-winding the advance per coil traversed takes place by small steps of m sectors where m is any whole number greater than 1 ; it is, therefore, more rapid. Yet so long as we confine our consideration to windings forming a single closed helix, it still remains necessary to pass through u_l coils before a coil is found repeating the slot-positions of the first coil from which the start was made. The advance in commutator-sectors for one coil traversed is m, or reckoned in slots is m/u_l. If this were a whole number, a second coil would occupy exactly the same position within its slots as the first coil in slot No. 1. But so far from this being the case, m is necessarily prime* to u_l, so that u_l coils must be passed through to yield a whole number of slots. Hence $B=m$.

Wave-winding.—In the wave-wound armature, the advance round the armature per coil traversed takes place by long strides, but whether simplex or multiplex, the advance in the position within the slot of the coil-side for each coil traversed is precisely the same as for the corresponding lap-wound armature. Reckoned in commutator sectors, the advance per coil traversed is y_k, and in slots is y_k/u_l. If this were a whole number, the second coil would occupy exactly the same position within its slots as the first coil in slot 1. But since y_k and $N_2=n_s \,.\, u_l$ have no common factor other than 1, y_k is

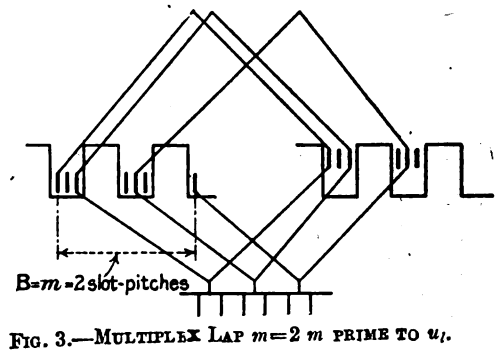


FIG. 3.—MULTIPLEX LAP $m=2$ m PRIME TO u_l.

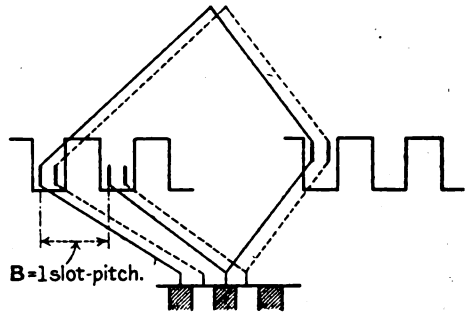


FIG. 4.—MULTIPLE LAP, INDEPENDENT WINDINGS, $m=W_l=2$.

prime to u_l, and, therefore, as in the lap-wound armature. u_l coils must be traced through in order that the total advance in slot-pitches may yield a whole number y_k (cp. Fig. 2). Thus B is in this case=y_k slot-pitches.

It will now be noticed that $B=y_k$ is really the general expression for all the above windings, for in the simplex lap-wound armature $y_k=1$, and in the multiplex lap-wound armature, $y_k=m$.

If then $B=y_k$ as shown above, there can be no common factor other than 1 between $B=y_k$ and $A=n_s/f$. For y_k and n_su_l in the present class of winding have no common factor other than 1, and, therefore, none can be present between y_k and n_s/f. Thence f' is unity, and the equipotential pitch in slots is simply the product of the two standards of measurement, or in general for single closed helices,

$$y_p \text{ in slots}=y_kn_s/f,$$

f being greater than 1, y_p is less than $y_k \,.\, n_s$, as it must be in order that repetition may occur. It is thus proved that any

* This follows from the fact that in the single closed helix, $y_k=m$ and $N_2=n_s \,.\, u_l$ have no common factor other than 1. Hence there can be no common factor between m and u_l higher than 1.

Digitized by Google

single closed helix can take advantage of the possibilities presented by the f groups of slots, and in all cases the number of repeating systems is f. Summarising the results :—

	A.	B.	y_p in slots $= AB$.
With simplex lap-winding	n_s/f	1	n_s/f
With multiplex lap-winding	n_s/f	m	mn_s/f
With wave-winding	n_s/f	y_k	$y_k \cdot n_s/f$

The last expression is also the general case, and

the equipotential pitch in coils or commutator sectors

$$= y_p \cdot u_l = y_k N_2/f;$$

the equipotential pitch in elements or coil-sides

$$= 2y_p \cdot u_l = y_k N_1/f.$$

The number of repetitions is f, and the number of pole-pairs over which one repeating system extends is $p' = y_k \cdot p/f$.

The number of repetitions is a maximum when n_s/p is a whole number ; f is then $= p$, *i.e.*, repetition begins as soon as one double pole-pitch is passed, and each double pole-pitch repeats every other double pole-pitch. We then in effect have p machines. For example, an 8-pole machine with 120 slots, *i.e.*, $n_s/p = 120/4 = 30$, is, in fact, four 2-pole machines, each containing 30 coils, giving the same E.M.F. at every instant. But if there are 122 slots, the H.C.F. of n_s and p is 2 only, and we virtually have two 4-pole machines, each with coils filling $122/2 = 61$ slots. The unit of which the real machine is made up is thus a machine with n'_s slots and p' pole-pairs.

Again, in an 8-pole machine* with multiplex lap-winding, let $n_s = 52$, $u_l = 5$ and $m = 3$. $N_2 = n_s u_l = 52 \times 5 = 260$, which has no common factor with m higher than 1, but the H.C.F. of n_s and p, *i.e.*, of 52 and 4, is $f = 4$. Thence $p' = mp/f = 12/4 = 3$, *i.e.*, after passing 3 pole-pairs and traversing one-quarter of the whole winding, repetition begins and the whole winding is divisible into four portions, giving strictly equal E.M.F.s at every instant, with each portion extending over 6 poles, so that we virtually have four 6-pole machines. Hence, in general the unit machine composing a multipolar is a $2p'$-pole machine with n'_s slots, and of such virtual units the number in the real machine is f.

(To be concluded.)

ON THE WAVE-LENGTHS AND RADIATION OF LOADED ANTENNÆ.*

BY BALTH. VAN DER POL, JUN., D.SC.

Summary.—A mathematical treatment of the subject is given, and it is pointed out that the radiation resistance of a loaded antenna, and also the radiation, depend not only on wave-length, but also on current values at top and bottom. This invalidates some existing formulæ. The Paper also discusses directions in which the energy is most strongly radiated under different conditions.

The real function of an antenna as used in wireless telegraphy is to radiate electromagnetic waves into space. The actual measurement of the amount of this radiation is a difficult matter, so that a general theoretical investigation may have some interest.

Antennæ in practice have a great variety of forms. They often consist of one or more straight, parallel, vertical wires continued at the top by others more or less horizontal. At the bottom of the vertical part an inductance coil is placed, used as one side of a mutual inductance arrangement for the purpose of transferring electromagnetic energy from a primary oscillation circuit to the radiator.

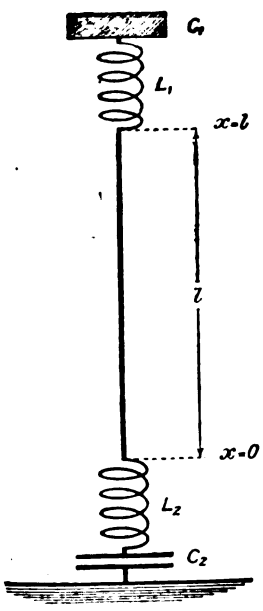


FIG. 1.

A condenser of variable capacity is often inserted at the earthed base of the aerial, especially when the latter is used as a receiving arrangement. The horizontal wires at the top of a symmetrical antenna act principally as a capacity attached to the vertical part of the aerial.

To bring the many forms of these arrangements within the reach of mathematical analysis we assume that the antenna has the form of Fig. 1—*i.e.*, there is a long vertical part in which the static capacity and the static self-inductance per unit length ($\bar{C}$ and $\bar{L}$) are equally distributed over the whole length. At the same time a self-inductance L_2 and a condenser of capacity C_2 are inserted at the earthed bottom end of the antenna, and at the top we suppose a self-inductance L_1 and capacity C_1 attached in addition. The inductance L_1 is generally not found in actual antennæ, but is inserted here to make the problem symmetrical.

The first things to find are the distributions of the current and of the potential over the vertical part, and also the possible wave-lengths with which the whole system can vibrate.

Taking the vertical as axis of x, with the zero point at the bottom of the vertical wire (*see* Fig. 1), whose length is l ; calling the current at any part i and the potential v, we have to find expressions for i and v which will be a solution of the equations,

$$\bar{L}\frac{di}{dt} = -\frac{dv}{dx},$$

$$\bar{C}\frac{dv}{dt} = -\frac{di}{dx},$$

with the boundary conditions,

for $x = o$: $$v = -\frac{1}{C_2}\int_0^t i\,dt - L_2\frac{di}{dt}$$

and for $x = l$: $$v = \frac{1}{C_1}\int_0^t i\,dt + L_1\frac{di}{dt},$$

taking the direction of x from the bottom to the top as positive.

In order to simp ify the problem, we assume that undamped oscillations exist in the antenna. This assumption is valid, as the distribution of the current is, as a first approximation, independent of the damping.

Combining the two equations we are led to the well-known formula, $$\bar{L}\bar{C}\frac{d^2i}{dt^2} = \frac{d^2i}{dx^2},$$

and a similar equation in v.

If we call the velocity of the disturbance $a = 1/\sqrt{\bar{C}\bar{L}}$, the angular frequency of the vibration ω, and take a suitable zero-point of time, the solution of the well-known formula for one single frequency may be written in the form,

$$i = T_0 \cos\left(\frac{\omega x}{a} - \beta\right) \cdot \cos \omega t,$$

and $$v = V_0 \sin\left(\frac{\omega x}{a} - \beta\right) \cdot \sin \omega t,$$

where T_0 and $V_0 = \sqrt{(\bar{L}/\bar{C})} \cdot T_0$ are the maximum current and potential amplitudes respectively at an antinode. This antinode eventually may not be found on the antenna itself, but can always be calculated when the actual current distribution over the antenna is known.

Putting $$\theta = \omega/a = 2\pi l/\lambda,$$

the total vertical capacity

$$C = \bar{C}l,$$

and the total vertical inductance

$$L = \bar{L}l,$$

we can readily derive from the above formulæ the relation :—

$$tg\theta = \frac{tg\alpha + tg\beta}{1 - tg\alpha tg\beta} = \frac{\left(\frac{C}{C_1\theta} - \frac{L_1\theta}{L}\right) + \left(\frac{C}{C_2\theta} - \frac{L_2\theta}{L}\right)}{1 - \left(\frac{C}{C_1\theta} - \frac{L_1\theta}{L}\right)\left(\frac{C}{C_2\theta} - \frac{L_2\theta}{L}\right)}.$$

* Abstract of a Paper read before the Physical Society of London.

* It may in passing be added that the data here assumed illustrate the case of a machine which could not be recommended for the very reason that the repetitions are only 4 in number, while $a = mp = 12$. The number of slots is not divisible by a.

Digitized by Google

There are an infinite number of solutions θ to this equation, each one of which corresponds to a natural wave-length of the loaded antenna, and they can be found when the ratios C/C_1, L/L_1, C/C_2 and L/L_2 are known. The values of θ are best found by determining the points of intersection of a curve representing the periodic function $tg\theta$, and the function given by the second member of the equation.

If there is no loading either at the top or bottom of the antenna C_1, L_1 and L_2 are each to be taken as zero, but C_2 must be taken as infinite.

It is clear that α and β have the following physical meanings: The current and potential at the bottom of the antenna have maximum amplitudes respectively of $T_0 \cos\beta$ and $V_0 \sin\beta$, and the maximum current and potential at the top are $T_0 \cos\alpha$ and $V_0 \sin\alpha$.

We can find the values of θ α and β experimentally by first measuring the wave length of an antenna when the load at the top in the form of horizontal wires is present, but with no loads at the bottom. The height l being known gives us θ. For no bottom load we have to take $C_2=\infty$, $L_2=0$; which gives $\beta=0$, so that $\alpha=\theta$. In this case we have, therefore—

$$tg\theta=C/C_1\theta,$$

from which C/C_1 can be found. When, now, any capacity and (or) inductance is inserted at the bottom, leaving the top unaltered, and the wave-length λ' is measured again, we have

$$tg\alpha'=C/C_1\theta',$$

from which α' can be calculated, C/C_1 and θ' being known. Again, β' is found by the subtraction $\theta'-\alpha'=\beta'$.

Evidently it is possible, by varying the loads, to have a constant wave-length with different distributions of the potential and current over the antenna, which results in bringing the same sine or cosine function at different altitudes on the antenna.

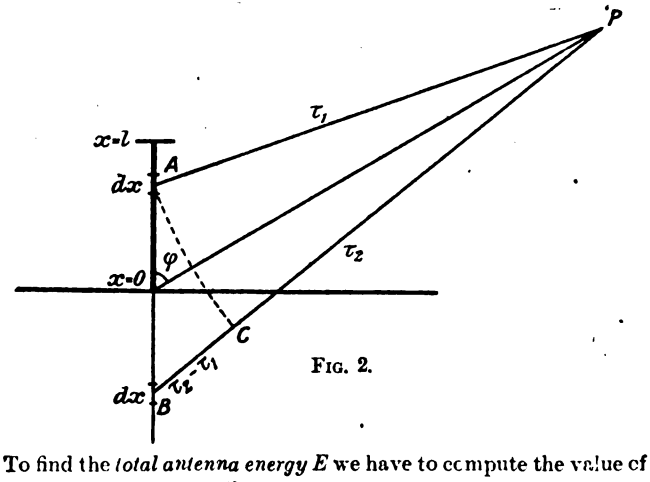


FIG. 2.

To find the *total antenna energy* E we have to compute the value of

$$E=\tfrac{1}{2}\bar{L}\int_0^l i^2dx+\tfrac{1}{2}L_2i^2_{x=0}+\tfrac{1}{2}L_1i^2_{x=l}$$

at the time of maximum current.

A little further work leads to the more symmetrical expression for the total energy of the loaded antenna :—

$$E=\tfrac{1}{4}T_0^2L\left[1+\frac{\cos\alpha}{\theta}\left(\frac{L_1\theta}{L}+\frac{C}{C_1\theta}\right)+\frac{\cos^2\beta}{\theta}\left(\frac{L_2\theta}{L}+\frac{C}{C_2\theta}\right)\right].$$

The quotient of the total electromagnetic antenna-energy by half the square of the maximum current at a current antinode may be called the *dynamic self inductance* L' of the complete system. In a similar way the *dynamic capacity* C' of the total system may be defined. It is clear that both L' and C' vary not only with the loads, but also with the harmonic in which the antenna is vibrating. The energy of an earthed vertical rod (plain Marconi aerial) vibrating in its fundamental wave-length ($\lambda=4l$) or any higher harmonic is well known as being $\frac{1}{4}T_0^2L$. As all terms in the above relation are essentially positive, we see that the energy of a loaded antenna, with the same maximum current value at an antinode, and also the dynamic self-inductance L' are always greater than the corresponding values of the same antenna when unloaded.

As we shall see further on, the radiation depends on the current distribution over the vertical part of the antenna. The original energy stored on the aerial can be increased by increasing the dynamic self-inductance of the antenna. This can be done, *e.g.*, by increasing the self-inductance L_2 at the bottom. The wave-length an the values of the current over the aerial can then be kept constant by decreasing at the same time the capacity of the condenser C_2 at the bottom in such a way that

$$tg\beta=\frac{C}{C_2\theta}-\frac{L_2\theta}{L}$$

is a constant.

By inserting, therefore, a greater inductance at the bottom, and at the same time a smaller capacity in the arrangement of Fig. 1, keeping the wave-length constant, we are able to diminish the radiating decrement of an antenna with the well-known result of sharper tuning.

The current distribution over the antenna now being known, we can proceed to find the *radiation* that will be thrown off the radiator.

In calculating this radiation we make the following assumptions :—

1. The vertical dimensions of the loadings are small in comparison with the total height of the antenna, as is actually the case, so that the contribution to the total radiation from the loadings are negligibly small.

2. The antenna is placed on a perfectly conducting earth, with the consequence that the lines of electric force round the radiator may be regarded as ending perpendicularly on the earth.

The electromagnetic field round the antenna may then be found by using the electric image of the antenna with respect to the earth (*see* Fig. 2, in which AB is the antenna). Taking, now, a point P at a distance from the radia or great in comparison with the wave-length, we can find the intensity of the magnetic and electric fields due to the current in a part dx of the antenna, *and* a part dx of its image. According to Hertz, the electric force is

$$dE=\frac{2\pi c}{\lambda r_1}i_x dx\sin\varphi\,.\,\sin\left(\omega t-\frac{2\pi r_1}{\lambda}\right)+\frac{2\pi c}{\lambda r_2}i_x dx\sin\varphi\sin\left(\omega t-\frac{2\pi c_2}{\lambda}\right)$$

$$=\frac{4\pi c}{\lambda r}i_x dx\sin\varphi\,.\,\sin\left(\omega-\frac{2\pi r}{\lambda}\right).\cos\frac{\pi(r_2-r_1)}{\lambda},$$

where we take $\frac{r_1+r_2}{2}=r$=the distance of P from the bottom of the antenna and where φ is the angle which the radius-vector to P makes with all parts of the antenna.

The author then embarks on a series of mathematical investigations from which he obtains, as the general expression for the total radiation resistance of a loaded antenna, expressed in ohms :—

$$R_\rho=15\sin 2\beta\{2Si2\theta-Si4\theta\}+15\cos 2\beta\{2Ci2\theta-Ci4\theta-lg_e\theta$$
$$-0{\cdot}577216\}+30\left\{\cos\alpha^2\left(\frac{\sin 2\theta}{2\theta}-1\right)-Ci2\theta+lg_e\theta+1{\cdot}27036\right\},$$

where $\theta=\frac{2\pi l}{\lambda}$ and $\cos\alpha$ and $\cos\beta$ are the ratios of the current amplitudes at the top and bottom respectively of the antenna to the maximum current amplitude at an antinode, and E is Euler's constant.

This formula shows us that the radiation-resistance of a loaded antenna and also the radiation from that antenna are dependent not only on the length of the waves which the aerial emits, but also in a high degree on the value of the current at the bottom and top, or, in other words, on how the current at that certain wave-length is distributed over the aerial. It is therefore clear that the radiation from an antenna *cannot* be written in the simple form,

$$\Sigma=AT^2\frac{l^2}{\lambda^2},$$

where A is a constant, and T the R.M.S. current at the base of the antenna, as is usually done in most text-books on wireless telegraphy, for it all depends on the manner in which the loading is varied (either at the top or the bottom, or both) to alter the wave-length λ. Even if we assume a flat top antenna—*i.e.*, one with a capacity load at the top in the form of horizontal wires (ship antenna and umbrella antenna)—the total radiation cannot be written as

$$\Sigma=160\pi^2T^2\frac{l^2}{\lambda^2},$$

as is done by Austin, and on which basis he calculates a table of radiation resistances for flat-top antennæ.

It is apparent that the use of the formula—

$$R_\rho=160\pi^2\frac{l^2}{\lambda^2}$$

to calculate tables of radiation resistances for flat-top antennæ up to ratios $\frac{l}{\lambda}=0{\cdot}4$, as done by Austin, is an extrapolation of Rüdenberg's results that is not justifiable, so that the figures given there often differ very much from the values calculated with the aid of our formulæ. Austin does not even state clearly how the variations of λ are to be obtained by varying the top or the bottom loads.

Rüdenberg's formula is valid only for the case of a very long wave-length emitted from a flat top or umbrella antenna with a capacity at the top large in comparison with the total capacity of the vertical part of the aerial, for then it is possible to deduce the following approximation for the radiation. For no load at the bottom $\beta=0$, and, therefore, $\theta=\alpha$. For a value of λ *large in comparison with the*

Digitized by Google

total antenna height l, θ is a small quantity. Now, the radiation is a function of θ only, and Rüdenberg's formula utilises only the first term of the complete expression, namely,

$$\Sigma = 40\beta^2 T^2 = 160\pi^2 \frac{l^2}{\lambda^2} T^2.$$

This formula is only valid for wave-lengths great in comparison with the antenna height.

For a constant wave-length the radiation from an antenna with different loadings at the top and at the bottom, can be expressed in the following way :—

$$\Sigma = \underset{\theta=\text{constant}}{T^2} \{A_1 \sin 2\beta + A_2 \cos 2\beta + A_3\},$$

where A_1, A_2 and A_3 are constants for a certain ratio of wave-length and antenna height. Bearing in mind that the current distribution is given by

$$i_x = T_0 \cos\left(\frac{\omega x}{a} - \beta\right),$$

and taking for x that height on the antenna where a current-node is found, the total energy thrown off the antenna in the form of electromagnetic waves of a constant wave-length, but at different loads, is,

$$\Sigma = T^2 \left\{B_1 \sin\frac{4\pi x}{\lambda} + B_2 \sin\frac{4\pi x}{\lambda} + B_3\right\},$$

where B_1, B_2 and B_3 are constants.

To show the form of this function for two wave-lengths Fig. 3 has been calculated, in which the abscissa gives that part of the height

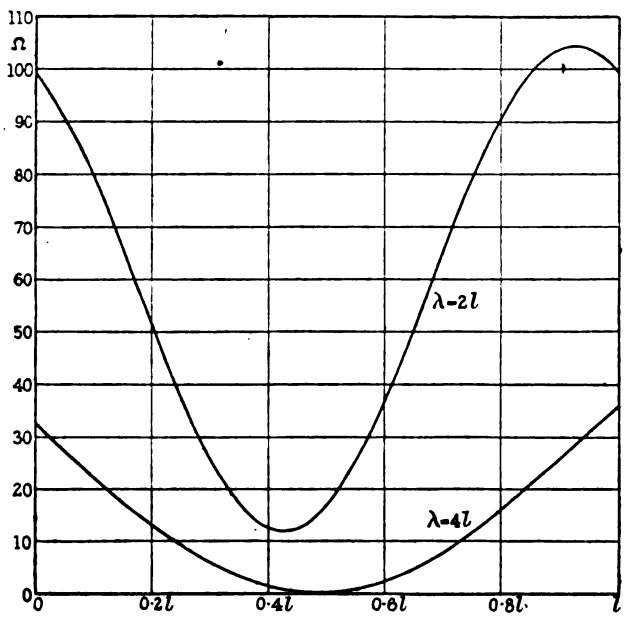


FIG. 3.

of the antenna at which a current node occurs and the ordinate represents the antenna radiation-resistance at this current distribution (1) for $\lambda = 2l$, and (1) for $\lambda = 4l$.

The formula for the radiation resistance of an antenna vibrating in a half wave-length—*e.g.*, when x is the height of the current-node, is—

$$\underset{\lambda=2l}{R_\rho} = 58{\cdot}28 - 46{\cdot}32 \sin\left(\frac{2\pi x}{l} - 1{\cdot}113\right)\Omega,$$

so that the radiation-resistance for this wave-length is a minimum and equal to 11·96Ω when the current node occurs at a point 42·7 per cent. of the height of the antenna from the base, and the same is a maximum with a value of 104·6Ω with the node at a height of 92·7 per cent. This example clearly illustrates how the current distribution, even by a constant wave-length, is of importance with regard to the radiation.

It is interesting to find out in what directions the calculated electromagnetic energy is emitted from the antenna. This is best represented graphically. By using the function in the form :—

$$\frac{1}{\sin\varphi}\{\sin\beta + \cos(\theta\cos\varphi)\cdot\sin\alpha - \cos\varphi\cdot\sin(\theta\cos\varphi)\cdot\cos\alpha\}^2 = \frac{1}{\sin\varphi}\{f(\varphi)\}^2,$$

polar curves in a plane can be drawn in four different ways having the following peculiarities and formulæ :—

1. If the radius vector r is made proportional to the energy radiated through a unit surface of a sphere of a constant radius described round the sending antenna, the curve has the equation,

$$r = \{f(\varphi)\}^2/\sin^2\varphi.$$

2. If r is made proportional to the total energy radiated through that zone of a sphere that is comprised between two cones with a slightly different apex-angle, the formula is

$$r = \{f(\varphi)\}^2/\sin\varphi.$$

3. r can be made proportional to that distance from the antenna where the radiation through a unit surface, held at right angles to the radius vector, is constant, or, in other words, r can be made proportional to that distance from the antenna where, by a given receiving arrangement, the amount of energy received is a constant. We thus have the formula,

$$r = f(\varphi)/\sin\varphi.$$

This surface has the peculiarity that the magnetic and electric forces are constant all over it. This curve can be called the characteristic curve of radiations (analogous to the similar curve in a

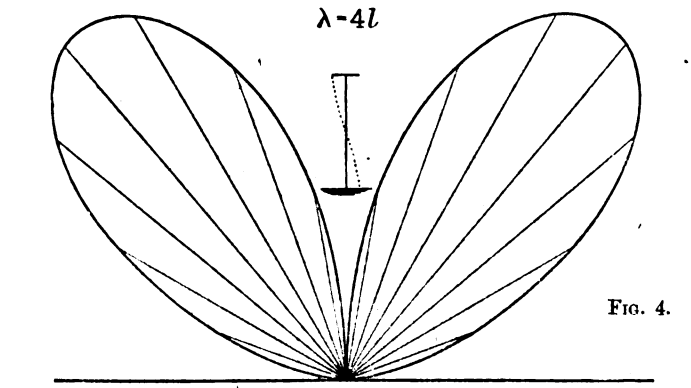


FIG. 4.

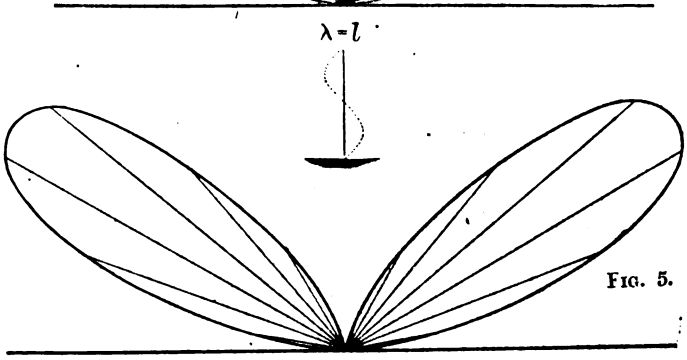


FIG. 5.

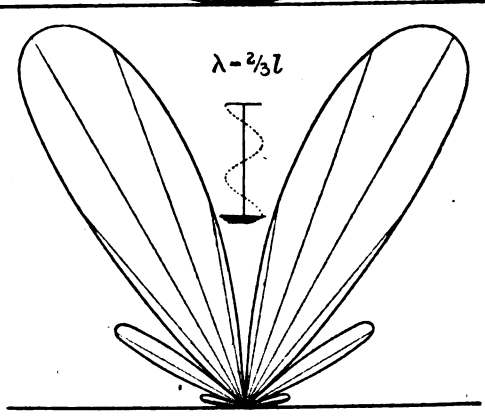


FIG. 6.

horizontal plane for directive antennæ such as used by Bellini and Tosi), and represents at the same time the maximum distances in different directions where signals can be received.

4. If $r = f(\varphi)/\sqrt{\sin\varphi}$,

the area of this surface will be proportional to the total energy radiated.

In the original Paper the author presents curves corresponding to $\lambda = 4l$, $2l$, l, $4/3l$ and $\frac{2}{3}l$ respectively. In Figs. 4, 5 and 6 three typical curves are reproduced.

All curves of the forms given are independent of the distance from the antenna, if only that distance is large in comparison with the dimensions of the antenna and the wave-length used, for which case the Poynting vector is a straight line.

The theoretical possibility of loading an antenna and exciting it in such a way that no radiation will occur in horizontal directions may experimentally be of value to detect the existence of ionised refracting layers in the atmosphere as calculated by Eccles, for which case the current in a receiving antenna would increase to a certain extent, while reception is made at a greater distance from the sending-station.

Digitized by Google

The Electrician.
FRIDAY SEPTEMBER 7th, 1917.
Editorial and Publishing Offices:—
8, BOUVERIE STREET, LONDON, E.C. 4.
Telephone: City 9853 (4 lines). Telegrams: "Benbrotric Fleet London."

THE WORK OF THE COMMITTEE FOR SCIENTIFIC & INDUSTRIAL RESEARCH.

The second annual report of the Committee of the Privy Council for Scientific and Industrial Research has come to hand, and our readers will find an abstract of this report on another page. From this it will be seen that considerable progress has been made in actually putting matters on a working basis. Naturally work of this novel character takes time; but the Committee is able to report more than preliminary steps in the establishment of a National Research Association by the great staple industry of cotton. The woollen and worsted manufacturers of Great Britain have appointed a provisional committee to draft the constitution for a Research Association, and the flax spinners and weavers of Ireland have decided to take a similar step. The Scottish shale oil industry and the photographic manufacturers have decided to establish Associations immediately. The electrical engineering firms, the British Society of Aircraft Constructors (in conjunction with the Aeronautical Society), and the Scottish shipbuilding and steel industries all contemplate the same step, and it is hoped that it may be possible to establish an association for research into the non-ferrous alloys. As our readers are aware, a Fuel Research Board has also been established, and a Committee has been appointed in Dublin to consider questions in regard to peat.

This is a good beginning. Apart from these main activities, it may be mentioned that steps are being taken to translate certain books on optics, and it is proposed to issue departmental bulletins supplying information useful to particular industries. The first of these, which is a memorandum on the "Means to be Adopted to Diminish the Decay of Timber in Coal Mines," will be circulated to mine owners. Bulletins of this kind should prove particularly valuable. Although much useful information is distributed in this way by certain Government departments in the United States, there are no corresponding publications in this country. It is also proposed to publish from time to time pamphlets under the title of "Science and Industry" as a record of progress made at home and abroad in the application of science in manufacture. The first of these was contributed by Mr. A. P. M. FLEMING, and was noticed in our columns recently.

In the report a number of researches are briefly noted, but it is a little disappointing to find that only two of these are concerned with the electrical industry. They consist of the research on the heating of buried cables and that on insulating oils. There is surely ample scope for more activity than this. We trust that there are many more electrical researches in contemplation, but possibly they have not reached the stage at which they can be included in the report. In the next annual report we hope to see evidence of much greater activity.

Some distinction is drawn between different classes of research. For example, there is research carried on by leading firms, there is the research which ought to be carried on by co-operation, and, lastly, there is the type of research which is not commercial, but of very general interest to the nation as a whole, and which, therefore, should be carried out at the national expense. Research on fuel is an example of the last named. The second type which we have just mentioned comes within the scope of the Trade Research Association. There is a vast deal to be done in this way, but it is necessary not to confuse co-operative research with individual research by manufacturers, and to imagine that the latter can be displaced by the former. As an example, we may take research on switchgear, to which we make a reference elsewhere. This is essentially a subject which should be dealt with co-operatively on a large scale, since no individual manufacturer can possibly afford to put down the plant necessary for such a research. This investigation, however, would not supersede the research by an individual switch maker developing a new type of switch with new characteristics. He would probably find it desirable to carry out his own experimental work on this type of gear for his own advantage, though he might finally submit a sample for testing to the Trade Research Association.

The end of the report is of particular interest, as it deals with two subjects of some difficulty. One of these is the assistance of the inventor. A very natural prejudice has sprung up against the inventor, owing to the fact that he is frequently of an unreasonable type who does not realise his commercial limitations. It is a prejudice which is the result of many years' experience. On the other hand, it is well known that the inventor in this country, unless he has some financial backing, stands very little chance of gaining any reward for his activities. It is otherwise in America. Consequently there is greater activity in the production of inventions in the United States than in this country. This, it appears to us, is a loss which should be remedied by more sympathetic treatment, and we are therefore glad to see that the Committee is prepared to take up a benevolent attitude in the matter. In other words, the Committee does not simply refuse to look at an inventor because his idea is patented. In fact, in suitable cases, the Department is prepared to consider applications for assistance towards researches necessary to perfect patented inventions or processes. We are also glad to see that the Committee goes so far as to include under the conditions of grants to Research Associations a clause by which employés are given pecuniary reward for inventions. It is essential to remember, in dealing with inventors, that assistance given to them cannot be productive of much good if it carries with it the idea that the inventor will get nothing.

The other subject to which reference is made is that of assistance to individual manufacturers. The Committee has considered the question of encouraging individual manufacturers who are anxious to place their works on a scientific basis. In such cases the Department is prepared to entertain a proposal to attach a young research worker to the works laboratory for an agreed length of time, which might be divided into three periods. During the first period the Department would pay the salary, during the second period the Department would pay half the salary, and during the third the firm would pay the whole.

We hope that engineering firms will not fail to take advantage of the opportunities offered by this new Department, and will bear in mind that contributions made to Trade Research Associations will be regarded by the Inland Revenue authorities as working expenses. This is a concession that renders the support of these associations an extremely good investment, and, although this is not the main inducement, it should weigh with those who are still sufficiently ignorant to regard research as an expensive luxury.

Digitized by Google

A CAPACITY TEST FOR LOCALISING A HIGH RESISTANCE BREAK IN SHORT LENGTHS OF SUBMARINE CABLE.

BY H. V. HIGGITT.

The test here described is a discharge test taken with a ballistic suspension. Two readings are taken of one discharge; the first throw, and the immediately following throw in the opposite direction. This latter reading is taken in order to eliminate the effect of the current from the break due to polarisation and primary battery effect, and also any earth current. The current from the break, although falling in magnitude, is considered in the test as being constant during the short period in which the two readings are taken, with apparently little error.

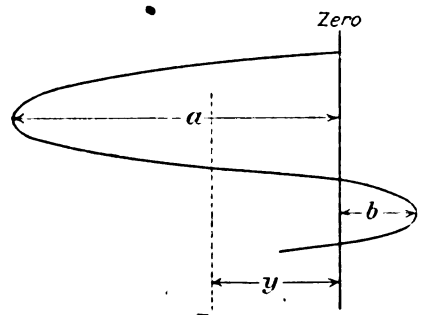


FIG. 1.

The working of the formula is shown in the diagram, ignoring for the present the decrement due to damping. Here a is the first throw, and b the following throw. After the first throw, oscillations will take place across the point that would be the steady deflection due to the current from the break at that time. This deflection, which is assumed to be constant during the time the two readings are taken, is shown by y.

Therefore, $a - y = y + b$,

$2y = a - b$,

$y = \frac{1}{2}(a-b)$.

This value of y is now introduced into the equation for a throw produced by a permanent current combined with a sudden impulse.

We have $x = \sqrt{a(a-2y)}$ (Kempe, 5th edition, art. 72).

where x = throw that would be produced by sudden impulse alone.

a = throw from combined currents.

y = permanent deflection.

Inserting the value of y as found above, this equation becomes

$$x = \sqrt{a\left(a - 2\left(\frac{a-b}{2}\right)\right)},$$

$$x = \sqrt{ab}.$$

This latter is the formula to be used in the test for finding the throw that would be obtained from the capacity alone.

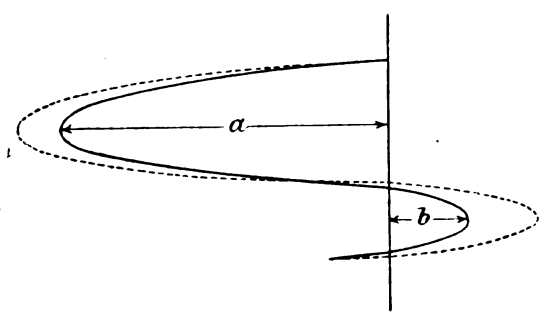


FIG. 2.

The correction for decrement is made on the first throw in the usual way—*i.e.*, $x(1+\frac{1}{2}$ log dec.). (Kempe, arts. 73-74; Fisher and Darby, art. 121; Ayrton, arts. 157-159.) The correction on the return throw is the decrement for the length $a+b$, plus the decrement for the throw a, as the drop in a causes a corresponding drop in b.

In taking the test the key must have as little play as is practicable, and is advisedly connected so that the discharge is taken upon pressing the key, as this gives a shorter free period. An observation of the D.R. up to the moment of taking the discharge can be obtained by inserting a milliammeter in the battery circuit. By this means each reading of a series of discharges can be taken with the same end resistance, thereby simplifying the reduction of the result to microfarads, which is best done by replacing the cable by an adjustable condenser shunted by a resistance equal to the break, and, working the key with the same rapidity as before, adjusting the condenser until the throw, corrected for damping, equals that obtained by the formula, the capacity then being the result required.

The following example was taken upon a capacity of 1 mfd., with a break consisting of a large exposure in series with 5,000 ohms. A Sullivan galvanometer was used, the coil having an incomplete aluminium circuit, and the soft iron intensifier being removed. The coil was weighted with a stout

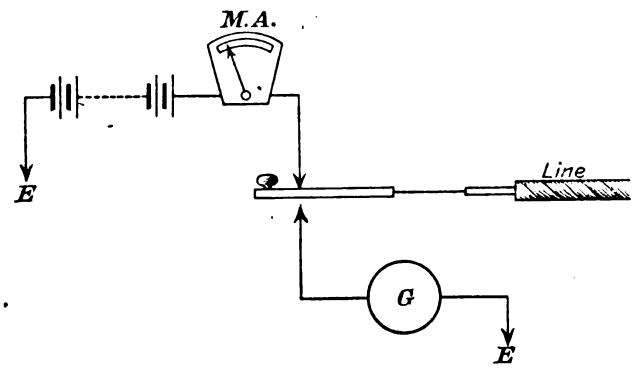


FIG. 3.

U-shaped piece of lead, and suspended with heavy strip. (Good balancing for rocking was found to be easily obtainable.) No shunt was used, the required degree of sensitiveness being obtained by moving the magnet back. When the galvanometer was suitably sensitive for the following example, the logarithmic decrement was 0·0235, giving a correction of 1·2 per cent.

The results are from 10 consecutive sets of readings.

Readings		Correction.			Results.
305	.....	+3·5	=308·5	.....	135·3
52	.....	+3·5+4	= 59·5		
307	.....	+3·5	=310·5	.....	135·9
52	.....	+3·5+4	= 59·5		
302	.....	+3·5	=305·5	.....	130·2
48	.....	+3·5+4	= 55·5		
308	.....	+3·5	=311·5	.....	136·1
52	.....	+3·5+4	= 59·5		
307	.....	+3·5	=310·5	.....	134·8
51	.....	+3·5+4	= 58·5		
310	.....	+3·5	=313·5	.....	135·4
51	.....	+3·5+4	= 58·5		
305	.....	+3·5	=308·5	.....	130·8
48	.....	+3·5+4	= 55·5		
305	.....	+3·5	=308·5	.....	130·8
48	.....	+3·5+4	= 55·5		
306	.....	+3·5	=309·5	.....	131·1
48	.....	+3·5+4	= 55·5		
308	.....	+3·5	=311·5	.....	131·5
48	.....	+3·5+4	= 55·5		
					1,331·9
				Mean	133·2

The following are 10 consecutive throws from the same capacity when shunted by the 5,000 ohms without the exposure:

Digitized by Google

The result therefore has an error of less than 5 per cent.

130	130
122	126
124	127
131	127
123	
124	1,264

Mean ..... 126·4
+1·5 for dec.
127·9

A trial with a damped suspension under the same conditions gave the same deflection of 300 divisions (with suitable shunt), with or without the capacity, although the capacity alone—shunted by the 5,000 ohms—gave a throw of 50 divisions. The throw with capacity merely moved somewhat quicker.

The three following examples were taken with an astatic galvanometer, having a logarithmic decrement of 0·2351 (giving a correction of 11·8 per cent.) and a period of three seconds. A universal shunt was employed. The same exposure was used in each case, and gave about 500 ohms with zinc before being sealed up. The tests were taken with 20 cells.

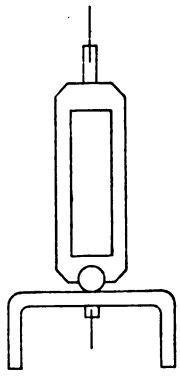


Fig. 4.

End sealed up to 50,000 ohms; 27·18 nauts, 330/225 at 0·378 micros =10·3 micros.

Readings.		Correction.			Results.
249	.....	+29	=278	.....	269
180	.....	+29+51	=260		
246	.....	+29	=275	.....	269
184	.....	+29+51	=264		
246	.....	+29	=275	.....	271
188	.....	+29+51	=268		
246	.....	+29	=275	.....	270
186	.....	+29+51	=266		
248	.....	+29	=277	.....	271
185	.....	+29+51	=265		

Throw from same capacity shunted by 50,000 ohms... 242
Decrement ..... + 29
271

End sealed up to 60,000 ohms; 3·09 nauts, 107/140 at 0·307 micros =0·95 micros.

Readings.		Correction.			Results.
250	.....	+29	=279	.....	233
122	.....	+29+44	=195		
248	.....	+29	=277	.....	236
128	.....	+29+44	=201		
247	.....	+29	=276	.....	233
123	.....	+29+44	=196		
243	.....	+29	=272	.....	234
128	.....	+29+44	=201		
243	.....	+29	=272	.....	230
123	.....	+29+43	=195		

Throw from same capacity shunted by 60,000 ohms... 207
Decrement ..... + 24
231

End sealed up to 50,000 ohms; capacity $\frac{1}{3}$ micro.
(The return throw did not cross the zero.)

Readings.		Correction.			Results.
243	.....	+29	=272	.....	122
−2	.....	+29+28	= 55		
230	.....	+27	=257	.....	118
0	.....	+27+27	= 54		
255	.....	+30	=285	.....	104
−20	.....	+30+28	= 38		
249	.....	+29	=278	.....	103
−18	.....	+29+27	= 38		
235	.....	+28	=263	.....	117
−3	.....	+28+27	= 52		

Throw from same capacity shunted by 50,000 ohms. 113
Decrement ..... + 13
126

ECONOMY OF ELECTRIC VEHICLES.

The cost of the working of a 2-ton Edison electric vehicle at Newcastle-upon-Tyne for 41 weeks has been published by Mr. J. W. Thwaites.

The number of miles run was 3,172, and the number of tons carried 2,475. After four months' working on a one-shift, on the removal of refuse in a congested area (three-quarters of a mile square), the success was so apparent that the committee decided unanimously to order a second machine.

Actual running costs.				Act. running cost per ton.		Act. running cost per mile.	
Capital charges on £1,000 for 10 years (interest calculated at 5% and sinking fund on 4% basis)...	£ 105	s. 1	d. 10	s. 0	d. 10·19	s. 0	d. 7·95
Elec. energy at 3·55 units per mile, 11,250 units at 1½d. per unit	70	6	3	0	6·81	0	5·32
Oil and grease	1	6	0	0	0·12	0	0·09
Maintenance of chassis, body and batteries	11	3	2	0	1·08	0	0·84
Maintenance of tyres (assuming life of tyres 10,000 miles, 3,172/10,000 × £40)	12	13	9	0	1·23	0	0·96
Insurance at £12. 15s. per annum...	10	1	0	0	0·97	0	0·76
Driver at £2. 4s. 8d. per week	91	15	8	0	8·90	0	6·94
Total running cost.....	302	7	8	2	5·30	1	10·86
Four lifters at 35s. per week ...	287	0	0	2	3·83	1	9·71
Total cost of removal	£589	7	8	4	9·13	3	8·57

Mr. Thwaites states that both Messrs. Harrods and Messrs. Lyons have each a fleet of electrics, and he has gathered from their experience that the more intermittent the work the greater the saving. That was indeed, natural from the experience of electric work generally, and he could also verify the statement by his own experience. He was compelled some six months ago, owing to the Government having commandeered 10 useful horses, to purchase two (2-ton Austin) cars to distribute ¼ cwt. bags of coal from door to door in the congested areas in question, and he expected the cost of delivery to be heavier than by horse. The experience was useful, and worked out as follows :—

One Austin Two-ton Car.
One week, April 25 to April 28, inclusive.

Driver's wages	£2 5 0
Assistant	1 17 6
Insurance and garage	0 7 6
Interest on capital, £760 at 5 per cent.	0 14 7½
Depreciation at 15 per cent.	2 0 6
Petrol at 2s. 4d. gallon	3 10 0
Oil and grease	0 4 6
Repairs and renewals	1 15 0
Tyres	1 18 0
	£14 12 7½
Cost per ton (92 tons lead)	0 3 2⅛
Previous cost (92 tons lead) horses	0 3 1

The saving is not worth considering either way, although great care was taken when entering a street to go to the top and brake down; but if he had been able to secure electrics the saving would have been pronounced. His committee will consider the change as soon as delivery of the cover-type Edisons are available. Electrics were too high in price, but no doubt they would cheapen considerably with the advent of normal times. Mr. Thwaites is very positive, however, that they stand alone on the work mentioned for simplicity and economy, apart from the economy question.

Reciprocating Track Grinder.—A booklet sent us by Mr. F. J. Down (of 90-93, Fenchurch-street, E.C.3) describes the reciprocating track grinder manufactured by the Railway Track-work Co., of Philadelphia. It was formerly assumed that track grinders were only valuable for the purpose of smoothing severely corrugated rails; but it is now contended that it is advantageous to employ them at an early stage, thus preventing the development of serious defects. Track grinders may either depend on a grinding wheel as the cutting medium, or may utilise a reciprocating element. It is claimed that the latter type of machine has been much simplified, and can safely be placed in the hands of an ordinary labourer, and, further, that it permits water to be introduced to facilitate cutting, which is difficult in the case of a high-speed wheel. This cutter is operated by a 3½ H.P. motor, and a number of illustrations are given showing its employment in practice. The motor is fed from the tramway circuit. The method of derailing permits quick removal and replacement on the track, about 40 seconds being the average time from stopping to beginning again. It is stated that seven hours' grinding has been accomplished in a 10-hour day with 250 cars passing on the same track, corrugation being meanwhile removed from 500 ft. of single rail.

Digitized by Google

REPORT OF THE COMMITTEE OF THE PRIVY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH FOR THE YEAR 1916-17.

This Report, which has just been issued, covers the second year of the Committee's proceedings from Aug. 1, 1916, to July 31, 1917.

The Report recapitulates the history of the formation of the Department and of the Imperial Trust for the Encouragement of Scientific and Industrial Research, which holds on behalf of the Department one million sterling which Parliament has voted for the purposes of the Department. The Report further states that during the past year the Committee concluded negotiations with the Royal Society for the transfer of the property of the National Physical Laboratory, together with the responsibility for its maintenance and development, to the Committee. The scientific management of the laboratory remained in the hands of the Executive Committee. The Report also refers to the appointment of the Fuel Research Board and the Irish Committee of Inquiry into Peat as a source of power.

A grant of £1,000 a year for five years, with a grant of £750 for special apparatus, has been made on the recommendation of the Advisory Council to the department of technical optics recently established at the Imperial College of Science and Technology. The college is providing laboratory accommodation and an equipment grant of £2,000.

The Committee has also considered and approved recommendations in respect of aid to 44 scientific investigations of industrial importance. Nine of these received aid during the year 1915-16; the remaining 35 were new proposals. The Committee reported last year that it had approved grants to a number of individual students and research workers for the year 1916-17 to an amount not exceeding £6,000. In the event it has not expended more than £3,550 odd under this head, upon 36 workers. The work has suffered in amount owing to the war and the Committee was unable to expend more than £14,524 out of the £40,000 placed at its disposal by Parliament for 1916-17. During the current year it has taken £38,050 in its estimates, in addition to the fund of a million referred to above. The annual vote is intended to cover (*a*) the cost of those researches which will not be undertaken by the proposed Research Associations; (*b*) the grants to individual research workers, both students and others; and (*c*) the cost of administration.

The second annual report of the Advisory Council is appended, and an abstract is given below.

REPORT OF THE ADVISORY COUNCIL.

Part I.

The experience of another year of work has confirmed our first estimate of the position. We have made progress. The establishment of a separate Department of State entrusted with the organisation of scientific and industrial research has brought encouragement to our efforts and the necessary financial support. "We may think of scientific research," says Prof. Bragg, "as an army advancing into an unknown country, in which it is not possible to see more than a step or two ahead." The provisioning of such an army calls for circumspection and a great deal of detailed work. Some estimate of its amount can be formed when it is stated that during the past year we have held 19 meetings as compared with 13 in our first year of work, while the Applications Committee, appointed in February of this year, has held nine meetings. Our Standing Committees have met in all nine times, while sub-committees and sections have held 52 meetings. We have also had the assistance of 28 special committees in dealing with applications for grants-in-aid.

We have addressed ourselves during this year in the main to the organisation of industrial research, firstly, because we felt the paramount importance of arousing and securing the interest of manufacturers in the application of science to industry, and secondly because the influence of the war has created in industry an atmosphere conducive to the growth of new ideas, whereas it has unfortunately made the prosecution of work in pure science and in its organisation a matter of extreme difficulty. We trust that the absence of extended reference to pure science in this report will not be taken as indicating our lack of appreciation of its importance.

The Million Fund for Trade Research Associations.—The one question of policy is the working out of the policy of co-operative industrial research foreshadowed in the last report (see THE ELECTRICIAN, Sept. 8, 1916, p. 768). Many trade associations have come into existence during the past year, some of which include research among their objects. But while we welcome this evidence of the growth of a spirit we have ensued, it does not seem likely that most of the new or previously existing associations will be qualified to avail themselves of the full benefits that the Government is prepared to offer. On the other hand we see no difficulty in the establishment of associations which would conform to the necessary conditions.

The Representation of Labour.—As regards the constitution of the Governing Body or Council of an association for research, it is obvious that capital, management and science must have suitable representation. But we believe further that greater success and a wider scope of action will be attained, if provision is made also for the inclusion of labour. In most cases only skilled labour will be concerned. We think it important, however, that the workers in an industry should be able to ascertain at first hand how science is applied to industry and how funds devoted to this purpose are expended, and that they should also be able to urge the importance of research which would result not so much in pecuniary gain as in the increased health and comfort of the workers. We were interested to read the proposals contained in the Interim Report just issued by the sub-committee of the Reconstruction Committee on Relations between Employers and Employed, which advocates the establishment of Standing Joint Industrial Councils. We believe that Councils so constituted as to be able to discuss with knowledge questions affecting both employees and employed would, if they could be brought to work successfully, greatly help the formation and development of Trade Research Associations. We notice that it is proposed that the National Councils should be empowered to allocate to District Councils the following among other questions:—"Industrial research and the full utilisation of its results; the provision of facilities for the full consideration and utilisation of inventions and improvements designed by work-people, and for the adequate safeguarding of the rights of the designers of such improvements." We think it valuable that national councils should have these powers of decentralisation, for unless each locality is carried along in the forward move we cannot hope for any steady advance. But we hope they will also retain these questions in their own hands, since it is to be anticipated that the Trade Research Associations will as a rule be national rather than local in character.

Size and Scope of Associations.—It is intended that the research associations should include as many of the firms in each industry as possible. When it is found necessary thus to sectionalise an industry, it will be important for the several research associations to combine for purposes common to more than one. One of the most promising directions for co-operation of this kind is the preparation and circulation of abstracts of scientific literature and other information of technical interest.

Proposed Research Associations.—Substantial progress has already been made towards the establishment of a National Research Association by the great staple industry of cotton. The woollen and worsted manufacturers have appointed a provisional committee to draft the constitution for a research association, and the Irish flax spinners and weavers have decided to take the same step. The Scottish shale oil industry and the photographic manufacturers have decided to establish associations immediately, the electrical engineering firms and the British Society of Aircraft Constructors, in conjunction with the Aeronautical Society, have the matter under consideration, the Scottish shipbuilding and steel industries are moving, and we have hopes that it may be possible to establish an association for research into the non-ferrous alloys in the near future. We understand that the British iron puddlers and the Diesel engine manufacturers have independently established research organisations for the benefit of their respective industries. The coal mining industry is interested, but it will necessarily take time to organise this huge industry on a national basis. In some cases the leading firms realise to the full the value of science and of a combined attack, but they cannot as yet carry the industry with them. In other cases the industry may be prosperous and the leading firms possessed of what they believe to be valuable and exclusive information, which they fear might be endangered by co-operative research, but those industries which call for the most complex organisation and are most in need of scientific guidance, if they are to meet modern conditions successfully, are for the most part those in which the smallest progress has been made towards research on a co-operative basis. At one end of the large group of what may be called the chemical industries we find a growing movement towards financial combination, *e.g.*, among the highly developed heavy chemical and allied industries. Financial combines or fusions of scientific industries on the scale we are witnessing will certainly render co-operation for research alone less attractive, if not unnecessary. At the other end of the scale are industries, like those of pottery and glass, which have been driven by adversity to seek the aid of science, and have only been able to meet the cost by operating together. Between the two extremes is a large number of industries, some of them wealthy, which appear to be uncertain in which direction to move, and would probably prefer to move in neither.

Researches Unsuited for Co-operative Action.—There will remain, however, important fields for industrial research which we can never hope to cover by means of research associations. Research into fuel is one of these. Every home in the land as well as almost every industry is directly concerned in the economy of fuel and for that reason it is simpler and more just that all should contribute through the taxes to the cost of the research. The Committee of Council have accordingly established the Fuel Research Board. Similarly we think the argument for a national board of research in timber will prove overwhelming; in both cases, however, we may hope to receive assistance if not contributions from some of the industries more immediately interested. The researches we are conducting through the British Fire Prevention Committee and the Concrete Institute respectively into the fire-resisting properties and into the general physical properties of different kinds of concrete are also cases which call for national action. We have been assured that the same considerations hold good for the scientific problems underlying illuminating engineering and cold storage. Where the conditions make it unlikely that any particular industry will undertake necessary research it may be desirable for the Department to take action for the general good, with the help and assistance of the industries concerned. It will not be possible in these cases to delegate responsibility in the manner proposed for industries capable of combination in research associations.

Digitized by Google

National Physical Laboratory.—There is still another class of scientific problems of great importance to industry, not susceptible of treatment by associations for research. We refer to the determination of constants and standards whether physical, chemical or bacteriological, and the accurate testing of manufactured products in the interest both of manufacturer and consumer. The experience of other countries goes to show that it is work which the State must itself undertake, or at least control, if it is to be adequately served. The scientific management of the Laboratory will remain unchanged and Lord Rayleigh, vice-chairman of its Executive Committee, will remain on the Council.

Methods of Financing Research.—There seems to be room for three methods of financing research: research by the individual firm at its own expense; research which is financed on a co-operative basis; and research which must be financed by the State. If the research is one which a single firm can finance and which, if successful, will yield results that a single firm can exploit to the full, there is no case in normal circumstances either for co-operation with other firms or for assistance from the State. But British manufacturing firms are not as a rule at the same time both large and complex. In the cotton industry, where some of the firms have capital funds to be reckoned in millions, manufacturing success has been obtained by specialisation in a narrow range of processes. Far-reaching scientific investigations which are likely to affect several sections of the industry are accordingly more suitable for co-operative than for single-handed attack. On the other hand the German chemical industry with its powerful firms engaged in handling the primary raw materials through all their intermediate stages up to the manifold but closely related final products would not be suited for co-operative research, though it may be prepared to go far in the direction of financial fusion—a mere continuation of the previous line of development. If, as in this country, conditions are in many respects specially favourable to co-operation in the conduct of research, the State is justified in encouraging development along these lines by means of monetary and other assistance. We find the justification for our proposals for research associations in these considerations. But when the firms have done all that it will pay them to do in the way of both private and co-operative research, there remain lines of investigation which will either be sufficiently fundamental to affect a range of interests wider than any single trade, however large, or else they will clearly have a direct bearing on the health, the well-being, or the safety of the whole population. The two types are not mutually exclusive, but research of either kind falls into the third class and must be undertaken by the State itself.

Fuel Research Board.—The investigations conducted at the National Physical Laboratory belong to this class, but by far the most fundamental work initiated during this year, so far as the industrial aspect of our labours are concerned, has been the appointment by the Committee of Council on our recommendation of a Director of Fuel Research with a Fuel Research Board to assist him in laying his plans. The Fuel Research Board have presented their first report outlining their proposals for taking stock of the coal resources of each district, classifying according to their qualities the seams which are being worked or which might, in certain circumstances, be worked, and ascertaining broadly the industrial uses to which the different kinds of coal are being put. It is intended to conduct investigations into the nature and origin of the various types of coal and into the chemical and physical behaviour of their constituents under the action of heat and other agents. Thus, this side of the inquiry will be most readily kept in touch with the practical side, and the new knowledge of the scientific worker at once becomes available for practical application. The Board have also had under consideration a number of proposals for the utilisation of peat; and they have been in communication with the Department of Agriculture and Technical Instruction for Ireland. The Board have decided, after consultation with the Irish Department and with the approval of the Committee of Council, to appoint a small Committee of Enquiry to sit in Dublin and to inquire into and to consider the experience already gained in Ireland in respect of the winning, preparation and use of peat for fuel and for other purposes and to suggest what means shall be taken to ascertain the conditions under which in the most favourably situated localities it can be profitably won, prepared and used.

We have always believed that the natural relation of ourselves and the Department to other Government Departments would be to act as the servant of them all, to supply accurate information and independent reports upon scientific problems submitted for investigation and to leave to the administrative departments the duty of applying the knowledge we may be able to furnish. This proves to be the direction in which events are moving, and the appointment of assessors from other departments to our Council has undoubtedly helped to bring it about. We have recommended that grants should be made for three pieces of research which are related to the work of the Fuel Research Board, and the Board have concurred. The first, initiated by the Sanitary Committee of the Manchester City Council, is being carried on at the Municipal School of Technology and has for its objects the use of better methods of domestic heating and improvement in the ventilation of dwelling rooms. A grant has been given to the Institution of Heating and Ventilating Engineers to enable them (*a*) to tabulate and print the result of five researches on domestic heating carried out at University College, London, during the past three years, (*b*) to carry out a research with a view to establishing co-efficients of heat transmission through standard building materials, and (*c*) to conduct an investigation on heat transmission from radiators. The third grant will secure the continuance of the work begun in 1912 by the Committee for the Investigation of Atmospheric Pollution. The grant is made subject to the condition that the number of local centres at present reporting to the central control station shall be maintained. The collection and tabulation of careful records as to atmospheric pollution in different parts of the country should be extended after the war and the statistics should supply in the future one of the means of gauging the work done by the Fuel Research Board in promoting methods of smokeless combustion. One research aided by the Department has direct reference to the conditions of labour in mines. A grant made in November last to the Institution of Mining Engineers to enable them to investigate (*a*) the influence of hot and moist atmosphere on workers employed in mines, and (*b*) the methods to be employed for cooling and drying the atmosphere of mines will lead, we hope, to an improvement in the circumstances in which a large number of miners work. Since the grant was made the principal coal-owners have been considering the establishment of a National Association for Research, which could undertake this and other researches affecting the industry. We have also undertaken a research, with the approval of the Committee of Council, having for its object the production of standard types of apparatus for mine-rescue work, and we have appointed a committee to inquire into the types of breathing apparatus used in coal mines, and by experiment to determine the advantages, limitations and defects of the several types of apparatus, what improvements in them are possible, whether it is advisable that the types used in mines should be standardised, and to collect evidence bearing on these points.

Concrete.—The Concrete Institute is controlling with the aid of the Department a series of tests into concretes made from various selected local aggregates. These researches are being conducted at nine colleges and universities in 36 districts throughout the country.

Glass.—We have not relaxed our efforts to deal with this many-sided industry in as comprehensive a manner as possible. The important research at the National Physical Laboratory carried on at the cost of the Department since 1915 has dealt with the fundamental problems of optical glass manufacture. Attention during the past year has been concentrated on the question of refractories. The development of the electric furnace, particularly for the purpose of burning refractories at very high temperatures, proceeded satisfactorily. A new type of resistance furnace was evolved Heat is generated by contact resistance between specially shaped graphite parts, and an endeavour is being made to substitute pressed carbon similar to that used in arc-lamp electrodes, as the latter can be obtained in this country. Prof. Jackson has been investigating the composition of certain optical glasses for the Department with the assistance of the Glass Research Committee of the Institute of Chemistry. He has succeeded in defining the composition of the batch mixtures necessary for the production of several glasses hitherto manufactured exclusively in Jena, including the famous fluor-crown glass. He has also discovered three completely new glasses with properties hitherto unobtainable. The dangerous position which existed when this Council was first established having now been removed, thanks to the energy and initiative of the Institute of Chemistry, their Research Committee is now free to give its attention to other less urgent but not less important problems. We have invited them to assume the direction of some of these. Our Standing Committee on Glass and Optical Instruments has been actively engaged during the past year in surveying the field for research within its purview. The Institute Research Committee is, accordingly, beginning the preparation of a reference list of vitreous compounds, their compositions, densities, refractive indices and dispersive powers which, we anticipate, will save the investigator into new glasses much time and labour. The work, one of considerable magnitude, will be carried on in accordance with a scheme prepared by the Research Committee and approved by us.

The Research Institute for Glass at the University of Sheffield has now been established with the assistance of grants from this Department and from two associations of glass manufacturers. Progress has already been made with several systematic investigations on glass problems and the results of one of them, concerned with the influence of small amounts of chlorides and sulphates in producing opalescence in glass, have appeared in the "Journal" of the Society of Glass Technology. Co-ordination has been greatly facilitated by the establishment of the Society of Glass Technologists, founded by a few of the active and enthusiastic workers at the technology of glass in and near Sheffield. It now includes all the progressive manufacturers as well as the men of science interested in the subject.

Technical Optics.—Closely related to problems of glass are those of optics and optical instruments. For that reason we established a single Standing Committee, as explained later, to deal with both subjects. But here, as in every direction, we have found that no sound progress in research is possible without strengthening the bases of our national education. We, therefore, welcomed the untiring perseverance of the London County Council, who have during many years pressed for the establishment of a national Institute of Technical Optics. In the spring of 1916 the Higher Education Sub-Committee of the London County Council put a scheme before the Board of Education, which included the establishment of a new department for post-graduate education and research at the Imperial College, the strengthening of the existing department of technical optics at the Northampton Polytechnic Institute and the appointment of a single director with a specially constituted committee to supervise the work both at South Kensington and Clerkenwell. The London County Council offered to defray one-quarter of the capital and maintenance charges of the new department at the Imperial College and have accordingly contributed £1,000 a year for maintenance, with a special capital sum of £2,500 for alterations and equipment. We recommended the Privy Council to make a grant of £750 for special apparatus and an annual maintenance grant of £1,000 a year for five years, provided the scheme agreed upon at the joint conference was put in force. The Governors of the Imperial College offered the neces-

Digitized by Google

sary accommodation for the proposed department and later voted a sum of £2,000 for equipment. The scheme was adopted by all the bodies immediately concerned and a Committee of Management under the Chairmanship of the Rt. Hon. A. H. D. Acland, was appointed. Mr. Cheshire, of the Patent Office and Ministry of Munitions, has been appointed as the first director. The new Institute promises to start well in the autumn and the optical instrument makers of London have already contributed apparatus worth more than a thousand pounds. The Ministry of Munitions and the firms concerned have co-operated with the Department in a series of experiments intended to remove the difficulties experienced by English manufacturers of X-ray bulbs, and Dr. Willows was retained, with the consent of the Governors of the Sir John Cass Technical Institute, to direct the investigations. Certain results of value have already been obtained.

The Fields for Research.—Besides the initiation and direct conduct of researches which from their nature are unsuitable for private enterprise and unlikely to be undertaken on a co-operative basis, we recognise that it will be a permanent and important part of our duties to arrange for surveys to be made of existing scientific knowledge and the fields for research in particular industries In addition to Fuel Research, surveys have been prepared on other subjects engaging our attention with a view to future action. Some of these have been or will be published. Among the former is a Report on the Resources and Production of Iron and other Metalliferous Ores, prepared by Mr. G. C. Lloyd, Secretary to the Iron and Steel Institute, the first edition of which is already nearly exhausted. The new edition now in preparation will include a number of corrections and alterations, as well as the available information regarding the metalliferous ores of those countries which were omitted from the first issue. This first attempt at making the information contained in British publications easily available cannot fail to be useful. The ferrous section of the Standing Committee on Metallurgy have also entrusted the preparation of a survey of the field for research in tungsten to a sub-committee under the chairmanship of Sir Robert Hadfield. On the advice of the non-ferrous section of our Standing Committee on Metallurgy we have also appointed a Committee consisting of members of the Institution of Mining and Metallurgy, of the Institute of Metals, of the Engineering Standards Committee and of the industries concerned to prepare for us two surveys giving the existing knowledge and practice, so far as these can be ascertained, as to the zinc industry and as to the smelting and refining of copper and the qualities of copper and the copper alloys. We are entrusting to this Committee as an interim arrangement, pending the establishment of an association for research into the non-ferrous alloys, the direction of a research into the best method of making sound castings of copper. The Brass and Copper Tube Association have offered a contribution of £1,000 towards the cost and we have recommended the Privy Council to make an equal contribution without prejudice to the amount of any grant that may be made to any research association for non-ferrous alloys that may later be established. We have asked a Special Committee of the Standing Committee on Engineering to prepare a memorandum on the field for research into lubricants and lubrication, with an analysis of the problems involved and a suggested scheme of research. We have also offered a grant to the Bradford Association for Engineering Research towards the cost of preparing a survey of the field for research into the flow of steam in pipes.

"Science and Industry."—The publication of the first number of "Science and Industry" marks the beginning of work which we expect to be a permanent part of our activities. The series is intended to record the progress made at home and abroad in the application of science to manufacture and to include papers that discuss the many problems of training, organisation and procedure involved in successful industrial research.

Departmental Bulletins.—We have also begun the issue of a series of "Bulletins" intended to convey scientific information, useful to the industries of the country and based upon research work undertaken at the public cost.

(To be concluded.)

ELECTRIC CURRENT MEASURING INSTRUMENTS WITH PARABOLIC LAW OF DEFLECTION.*

BY PROF. J. K. A. WERTHEIM SALOMONSON.

In current or voltage measuring instruments the deflection is either about proportional to the current strength passing through the instrument or it grows with the square of the current strength. In this way they constitute two different classes of instruments. The ordinary galvanometer with a movable coil or magnet belongs to the first group the deflection in which obeys a linear law. The electrodynamometer is a prototype of the second class in which a quadratic law prevails.

If the movable part of an instrument of the first group be mechanically coupled to the movable part of an instrument of the second type, the rotating axes of the two instruments being made to coincide, and we send the same current through both instruments, taking care that the constituents of the movable part try to move it in an opposite direction, we have got a new instrument type showing a few peculiarities which are not to be found in either of the constituent parts.

If I be the current strength, the deflection φ, the constant of the galvanometric part a, the dynamometric constant b, we can put

$$I=a\varphi \quad \text{and} \quad I=b\sqrt{\varphi},$$

if the constituent parts are separately considered.

For the two parts used together we find:

$$\varphi=\frac{I}{a}-\frac{I^2}{b^2}.$$

This is the equation for a parabola. It is evident that there will be no deflection either with a current $I=0$ or when $I=\frac{b^2}{a}$.

If we call positive the direction of the movement of the movable system when the dynamometric part has been short-circuited we find that a maximal positive deflection occurs when $I=\frac{b^2}{2a}$, the deflection being $\varphi=\frac{b^2}{4a^2}$.

Any current between $I=0$ and $I=\frac{b^2}{a}$ gives a positive deflection; currents larger than $I=\frac{b^2}{a}$ cause negative deflections.

For very small currents we have a sensibility $=a$, which means that a current $I=a$ gives a deflection of one division of the scale. Near the second position of equilibrium a current increment of $-a$ or a current decrement of $+a$ augments a positive or decreases a negative deflection by one part of the scale. The absolute sensibility of the instrument is the same either in the first or in the second zero position.

The relative sensibility, *i.e.*, the ratio of the current increment causing an increase of one part of the scale into the current strength approaches to 0 in the first zero position; in the second zero position it is $b^2/2a^2$ which will generally be a very large figure.

We can only use very small parts of the parabola in most cases.

In instruments of this kind the thing we aim at is a high relative sensibility near the second zero position. As an example we might take an instrument giving a full scale deflection at 10 milliamperes, and which has its second zero position at say 1 ampere; in this case a change in the current strength of only one per cent. would cause the spot to leave the scale.

Many years ago I had an instrument of this kind made for me in a rather simple form. I used it as an indicator that the current in a potentiometer remained constant during the measurements so as not to be obliged to correct the setting of the potentiometer by means of the Weston-element. For this purpose the parabolic indicator proved to be very useful. We can easily give such an instrument any relative or absolute sensibility. With a shunt to the galvanometric part we diminish the relative sensibility; with a shunt to the dynamometrical part we can increase it. A shunt to the complete instrument increases the current strength for the second zero position.

One might expect a parabolic instrument to make an excellent standard instrument. But there are a few objections to using it for this purpose. If the dynamometrical part be constructed with two astatic movable coils we may consider this part as electrically constant and invariable. But we cannot succeed in rendering the galvanometer part electrically and mechanically constant and invariable. If this part be constructed with a movable coil and a permanent field magnet, this last cannot be considered as electrically constant for more than a few hours. With a movable magnet this forms one inconstant factor, the magnetism of the earth being another. The horizontal intensity of the earth-magnetism changes every year more than 0·01 to 0·03 per cent. and restricts the utility as a standard instrument to that value. But the variation in the magnetism of a permanent field magnet or a permanent movable magnetism occur and when no stray fields are present. The influence of stray fields might perhaps be counteracted by judicially enclosing the whole instrument in a seamless cylindrical soft iron covering.

Another possible use of instruments with a parabolic law of deflection is for detecting or even measuring small changes in the horizontal intensity of the magnetism of the earth. An astatic electro-dynamometrical system should be connected with a coil without iron core, moving in the earth field only, there being no field magnet. In that case the constant a depends on the horizontal intensity of the earth field. The galvanometric part should possess a sensibility many times greater than the dynamometrical part.

* Abstract of a Paper in the "Proceedings" of the Koninklijke Akademie van Wetenschappen.

Digitized by Google

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

10,402 WRIGHT, H. R. Electric ignition arrangements for internal combustion engines. (24/7/16.) 108,182.

10,573 PILBLAD, E. J. Rotatable contact breakers for magnetos and other purposes. (26/7/16.) 108,194.

10,626 MARTIN, A. J. Slide rules for use in wireless telegraphy calculations. (27/7/16.) 108,197.

A slide rule for use in making calculations in wireless telegraphy problems in which the first scale is graduated logarithmically in terms of self-induction, the second scale being a similar logarithmic scale but reversed with respect to the first and graduated in terms of capacity, and the third graduated so that the square root of the readings of the first scale indicating the wave-lengths can be read directly on it.

10,721 KENNINGTON, W. O. Magnetos and like electric machines. (28/7/16.) 108,203.

11,100 WADDINGTON, H. R. & PARSONS, I. H. Electrical signalling apparatus for use in mines and other purposes. (7/8/16.) 108,213.

11,982 PLATT, J. J. Spark plugs. (23/8/16.) 108,220.

12,704 RIEBER, F. Apparatus for producing unidirectional electric currents of a potential sufficiently high to operate X-ray tubes. (7/9/16.) 108,226.

An oil-immersed transformer having a plurality of secondaries adapted to deliver co-phasal currents of comparatively low potential co-operates with an oil-immersed converting device comprising a plurality of converting elements, each of which is adapted to receive the current from one of said secondaries and to deliver unidirectional current of corresponding low potential, and means for connecting said elements in series to produce the desired high potential.

13,269 SWUIER, G. O., AUSTIN, L. W. & COHEN, L. Art of electrical signalling. (19/9/16.) 108,230.

13,390 BELLOW, E. A. Electric pocket lamps, electric torches and the like. (21/9/16.) 108,234.

13,803 B. T.-H. Co. (G. E. Co.). Electric motor control. (28/9/16.) 108,237.

The system comprises an induction motor having two primary windings connected to a source of supply associated with a two-part secondary winding whose parts are electrically inter-connected and shunted by a high resistance, and means for reversing the connections between one of said primary windings and the source to reverse the phase of the voltage applied thereto.

14,643 ALLGEMEINE ELEKTRICITATS-GES. Electric incandescent lamps filled with argon (11/11/15.) 102,141.

Very small quantities of electro-negative gases or vapours and particularly phosphorous vapour, or other substances which evolve these gases or vapours during the burning of the lamp, are provided in the bulb for the purpose of permitting the use of argon which is free from nitrogen or only contains a small quantity thereof.

15,561 RAILING, A. H. & ANGOLD, A. E. Electric arc lamps. (1/11/16.) (Addition to 16,694/15.) 108,252.

16,512 MASON, C. T. Ignition dynamos. (19/6/15.) (Divided application on 8,584/16.) 102,265.

17,797 MASON, C. T. Ignition dynamos. (7/1/16.) 103,291.

1917 SPECIFICATIONS.

1,578 MURRAY, T. E. Method of electrical edge-welding. (2/3/16.) 104,504.

1,678 MCLEAN, N. Portable electric hand lamps and the like. (2/2/17.) 108,270.

2,869 TURNER, W. V. & THOMAS, T. H. Regenerative braking systems for electrically-driven vehicles. (6/9/16.) (Addition to 103,959.) 108,276.

4,370 KENNINGTON, W. O. Electric ignition devices. (19/4/16.) 105,908.

4,444 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Driving and control mechanism of planing and like machines. (27/3/17.) (Addition to 18,017/15.) 108,279.

4,644 GULLETTE, W. L. & VANDERVELL & Co. C. A. Magnetos. (30/3/17.) 108,281.

5,825 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Centrifugally-actuated short-circuiting devices for dynamo-electric machines. (3/5/16.) 106,484.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

July 9, 1917.

9,868 HURST ELEC. MFG. CO. Dynamo, &c., terminals.

9,889 CHURCHILL & COOK. Protection of cable couplings, &c.

9,892 B.T.-H. Co. (G.E. Co.) Electric fluid turbines.

9,897 MARCONI'S WIRELESS TELEGRAPH CO. & SMART. Electric buzzers.

9,898 GRINSTED & LAIDLAW. Thermionic detectors for alternating currents.

July 10, 1917.

9,919 CALLENDER'S CABLE & CONSTRUCTION CO. & WATSON. Supports for electric cables.

9,953 B.T.-H. Co. (G.E. Co.) Systems of electric distribution.

9,959 WALE. (Universal Winding Co.) Electrical coils.

9,960 COOPER. Electric motors.

9,962 WESTERN ELEC. CO. Telephone exchange system.

9,964 BOSCH MAGNETO CO. Distributing mechanism for electric ignition systems. (31/1/16, U.S.)

9,973 BOSCH MAGNETO CO. Distributing mechanism for electric ignition systems. (15/2/16, U.S.)

July 11, 1917.

9,988 HORLEY. Telephone receivers.

9,994 SPENCER & WAINMAN. Device for securing in the holder electrodes of furnaces.

10,019 MCLEAN. Electric hand-lamps, &c.

10,033 WEST & WISE. Control of electrically-operated switches.

July 12, 1917.

10,052 SHEPHARD. Electric switch.

10,073 ELECTROLYTIC ZINC CO. Refining metallic zinc-bearing materials by electrolytic process. (27/6/16, U.S.)

10,079 COOK. Electric motor starter.

10,096 CAUNTER & SUTER. Magneto electric machines.

10,097 CHAWAY. Testing of sparking plugs.

10,106 LEFEVRE & PERSIN. Ignition magnetos. (12/7/16, France.)

10,109 HOLLISTER. Electrical distributors.

10,113 LEVIN. Electrodes for use in electrolytic gas generators, &c. (20/12/15, U.S.)

10,119 CREED & HECHT. Production of high-voltage discharges.

10,129 EDISON SWAN ELEC. CO. & BIRD. Electric batteries.

July 13, 1917.

10,153 FRASER. Indicating devices for fuses.

10,160 WOOLLROW. Electric welding machines. (23/10/16, U.S.)

10,163 POLINKOWSKY. (Western Elec. Co.) Call-distributing systems.

10,164 POLINKOWSKY. (Western Elec. Co.) Machine switching telephone systems.

10,178 ARMELIN. Dry batteries.

10,180 CHAMBERS & LUCAS. Ignition magnetos.

10,182 KOWALSKI. Blow-out spark dischargers for impulse excitation and high spark frequency.

10,187 REMY ELECTRIC CO. Dynamo electric machines. (19/12/16, U.S.)

10,191 GILES. Electric valves.

10,201 JAMES. Automatic control for electric brakes for feed reels.

July 14, 1917.

10,211 BROOKES. Aerial electric dispatch or transmission apparatus.

10,213 MAJOR. Ventilation and cooling of dynamo electric machines.

10,220 HENRI. Sparking plugs. (27/7/16, France.)

July 16, 1917.

10,242 BUCK. Rotary electric switches.

10,243 & 10,244 BUCK. Electric heaters.

10,269 SOUTHON. Electric circuit-breaker or interrupter.

10,279 PARKER. Electrical apparatus for detecting and indicating position of submarines.

July 17, 1917.

10,317 B.T.-H. Co. (G.E. Co.) Illuminating devices containing electric incandescent lamps.

10,325 DAVIDSON. X-ray localisation.

10,332 SFIRA. Electric recording apparatus for controlling beats.

10,335 FLETCHER. Electric hot plates.

10,338 AKTIEBOLAGET LJUNGSTROMS AUGTURBIN. Blade rings for steam turbines. (4/7/16, Sweden.)

July 18, 1917.

10,354 GOLDSTONE. Portable dry battery torches.

10,357 JONES. Winding armatures for generators, motors, &c.

10,362 B.T.-H. Co. (G.E. Co.) Centrifugal compressors.

10,363 SPHINX MFG. CO., CLARK & LONGFORD. Ignition plugs.

10,365 BERRY. Elec. heating elements for cooking, &c., apparatus.

10,372 WESTON ELEC. INST. CO. Thermo-ammeters. (27/7/16, U.S.)

10,379 BERGLUND. Extracting zinc by electrothermal process. (5/9/16, Sweden.)

July 19, 1917.

10,389 RICHINSON. Method of preventing tramcar trolley leaving overhead wires.

10,403 JOHNSON & SALT. Accumulators for miners' lamps, &c.

10,423 BENNETT. Cord grips for electric conductors.

July 20, 1917.

10,443 MOYCE. Device for guiding trolley pulley of elecric car into contact with overhead wire.

10,448 SIMPLEX CONDUITS (LTD.) & WATERHOUSE. Electric radiators.

10,469 RICHARDSON. Ships' telegraphs.

10,472 WEST & SATCHWELL. Magnets.

July 21, 1917.

10,511 EXTER. Electrical induction furnaces for treating electric conducting materials.

10,525 ERICSON. Radio-controlled torpedoes.

July 23, 1917.

10,569 B.T.-H. Co. (G.E. Co.) Elastic fluid turbines.

10,575 BRIT. WESTINGHOUSE ELEC. & MFG. CO. Circuit interrupting devices.

10,583 VICKERS & BARCLAY. Dynamo electric machines.

10,587 VERNON-WARD. Electro-therapeutic apparatus.

10,588 MELLERSH-JACKSON. (Philips-Brunton Co.)

July 24, 1917.

10,606 PEARSE. Combined electric motor and generator.

10,612 GEORGE & HUTCHISON. Electric connecting clip.

10,615 CONNER & PUCKETTE. Magneto-electric machines for ignition.

10,616 SANDEMAN. Electric starters for combustion engines.

10,636 M.-L. MAGNETO SYND. Condensers for ignition magnetos.

10,642 CLEATHERO & SPURR. Contact apparatus for magneto-electric machines

10,652 GREVILLE. X-ray tube stand and table.

July 25, 1917.

10,664 BENNETT. Electrical appliance for igniting gases.

10,682 B.T.-H. Co. (G.E. Co.) Safety devices.

10,694 SCHOLEY & WOODROFFE. Electric drilling apparatus.

10,704 SHUMAKER. Electrical heating apparatus for aircraft.

July 26, 1917.

10,737 CHIVERS & MARTER. Insulating compound for magneto distributors.

10,748 B.T.-H. Co. (G.E. Co.) Wireless signalling systems.

10,769 GENERAL ELEC. CO. Means for destroying submarines.

10,772 LE PONTOIS. Ignition current generators.

10,773 BOWLER & FREMMER. Removing and replacing storage battery connectors.

10,778 & 10,779 BERRY. Electric radiators.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Officer Commanding: Lieut.-Col. C. B. Clay, V.D.

Orders for the Week:—

Officer for the Week.—Sec.-Lieut. P. Bowden.

Next for Duty.—Sec.-Lieut. E. A. Ullmann.

Monday, September 10th.—Technical instruction (searchlight) for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling class, 6.30. Recruits' drill, 6.30.

Tuesday, September 11th.—Physical drill and bayonet fighting.

Wednesday, September 12th.—Drill and elementary bridge construction for No. 1 Company, Right Half Company.

Thursday, September 13th.—Drill and elementary bridge construction for No. 2 Company, Right Half Company. Signalling Class, 6.30. Ambulance Class, 6.30.

Friday, September 14th.—Technical instruction (searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' drill, 6.30.

Saturday, September 15th.—Commandant's parade for route march and drill. Parade Golders Green Station 2.45 p.m. Uniform. A and B men are reminded that one route march per month is compulsory. Recruits' drill, 2.30.

Uniform.—"A" and "B" men are warned to attend headquarters on Tuesday, September 11th, to be measured by the regimental tailor for the service uniform.

Musketry.—All N.C.O.s and men who have signed the "A" and "B" agreements are required to attend during this month to re-classify in order to enable the Corps to obtain the capitation grant. Preference will be given to these men in firing. This does not apply to those who hold the proficiency badge.

Armlets.—The new issue armlets can now be had at headquarters, and every enrolled man must obtain one without delay at the same time all old red armlets (now obsolete) must be returned.

NOTE.—Unless otherwise indicated, all drills will take place at headquarters (Balderton-street, Oxford-street).

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

Commercial Intelligence Department.

The following is an abstract of an official Memorandum describing a new scheme sanctioned by the War Cabinet, for the supervision of the collection and diffusion of commercial intelligence.

An enlarged Commercial Intelligence Department will be created on a scale adequate to meet the reasonable requirements of British trade after the war. Parliamentary control over the Department will be exercised through a new Parliamentary Secretary, who will occupy the position both of Additional Parliamentary Secretary at the Board of Trade, and also Additional Parliamentary Under-Secretary for Foreign Affairs. This Parliamentary Secretary will be responsible to the President of the Board of Trade for all matters within the competence of that Department, and responsible to the Secretary of State for Foreign Affairs for all matters concerning the Foreign Office. By matters concerning the Foreign Office is meant all questions concerning the direction and organisation of the Commercial Attaché and Consular Services and the commercial work of officers of these services, and of the Diplomatic Service, so far a s these matters are not dealt with by the Consular or other Departments of the Foreign Office, and also matters concerning the personnel of the Foreign Office and of the above services who may be temporarily attached to the Department, and any matters arising out of the work of the Department involving questions of foreign policy. All instructions issued to Commercial Attachés or other Diplomatic or Consular Officers will be issued in the name of the Secretary of State for Foreign Affairs. On all other matters the responsibility will lie with the Board of Trade.

The Commercial Intelligence Department will eventually comprise the existing Department of Commercial Intelligence of the Board of Trade and the Foreign Trade Department of the Foreign Office; and will take over such of the staff and records of the War Trade Intelligence and Statistical Departments as may be available and required. The official head of the Department will be an officer appointed jointly by the President of the Board of Trade and the Secretary of State for Foreign Affairs, working under the new Parliamentary Secretary. The appointment and control of the Trade Commissioners within the Empire will, as at present, rest with the Board of Trade, and the appointment and control of the Commercial Attachés and Consular Service with the Foreign Office, but the work of the new Department will comprise all matters dealing with commercial intelligence, and, so far as is necessary for that purpose, it will give directions to the oversea services and make the necessary arrangements for keeping them in close touch with the commercial classes in this country. There will be a constant interchange of staff between the Department and both the Foreign Office and the Board of Trade, so that members of those Departments may be thoroughly acquainted with the work. Opportunity will be given to diplomats and consuls in training to serve for a period in the Department. It will also draw personnel from the Commercial Attaché and Consular Services, and from men of outside business experience. In the same way officers of the Trade Commissioner Service will be trained in the Department and will be attached to it from time to time The Department will be assisted by an Advisory Committee of business men, and it is hoped that it will be possible to arrange for a sub-committee of this Committee to meet at frequent intervals in order to advise the Department on its current work

* * * *

Ministry of National Service.

The Ministry of National Service issued last week the outline of the scheme of reconstruction consequent upon the transfer of the functions of the recruiting department of the War Office to the Minister of National Service. Among the changes to be made is the expansion of the work and functions of the Reserved Occupations Committee, which in future will form a separate section, to be called the National Trade and Commercial Department.

The recruiting functions will be separate from the civil functions connected with the supply of labour for work of national importance. The Reserved Occupations Committee will form a separate section (the National Trade and Commercial Department) of the Ministry. Mr. F. H. McLeod, chairman of the Reserved Occupations Committee, has been appointed head (under the title of Commissioner) of the National Trade and Commercial Department. Mr. McLeod is also Director of the Department of Labour Statistics which has recently been transferred from the Board of Trade to the Labour Ministry, and up to the present he has been the Director of the General Trades Section of the National Service Ministry. Substitution volunteers obtained through the National Service Trade Committees will continue to be allocated by the committees. Mr. R. Graves, Deputy Chief Factory Inspector to the Home Office, and Director of the Substitution Section of the Ministry of National Service, has been appointed Deputy Commissioner for National Trade and Commerce. Mr. Graves will continue to be the Deputy Chairman of the Reserved Occupations Committee. Mr. Cecil Beck, M.P., the Parliamentary Secretary to the Ministry of National Service, has been appointed Comptroller of Finance.

National Labour Supply.

Mr. C. F. Rey has been appointed Director-General of the National Labour Supply, and Mr. T. W. Phillips (Acting Assistant Director of the Employment Department) will in future be in charge of the employment exchanges.

* * * *

Ministry of Munitions Appointments.

The following appointments have been approved by the Minister of Munitions:—

Col. W. C. Wright to be Controller of Iron and Steel Production, in the place of Sir John Hunter, K.B.E., appointed member of Council; Major A. Corbett to be Controller of Explosives Supply, in place of Sir Keith Price, appointed Member of Council; Major J. H. M. Greenly to be Assistant Controller of Administration in the Inspection Department, in place of Sir H. Ross Skinner; Sir Leonard W. Llewelyn, K.B.E., Deputy Director-General of Materials Supply, will in future be known as Controller of Non-ferrous Materials Supply.

* * * *

Electrical Trade of South Africa.

In the last issue of the "British and South African Export Gazette" it is reported that, having regard to the restrictions on the export of copper, &c., electrical supplies and sundries of all descriptions throughout South Africa appear to be more abundant than might have been supposed.

The mines, the municipalities and the railways, who are the largest buyers, must have foreseen that copper would become one of the first and greatest essentials of military construction, and provided themselves in a fairly generous way. From Capetown, Durban and Johannesburg it is reported that, with a few exceptions, the everyday domestic lines that are in most common demand are obtainable, although at greatly enhanced prices. In pre-war days electric bells of the larger varieties and metal filament lamps were mostly furnished by German firms, but British manufacturers have done much to fill up the gap created. Stocks of electric torches and batteries in South Africa are very large. There is a great shortage of small electric motors, which some Scandinavian firms who specialise in them are endeavouring to remedy. Even the second-hand ones are scarce, and are only available at fancy prices. Tenders for electrical machinery and supplies of most descriptions, whether for municipalities or the mines, continue to receive satisfactory responses from the local representatives of the big manufacturers in England and America, and orders are being steadily executed under licence, although the date of delivery is uncertain.

* * * *

Yorkshire Electric Power Progress.

Very satisfactory progress was made by the Yorkshire Electric Power Co. during the half-year ended June 30. Owing to the continually increasing demand for power for various industrial purposes the gross receipts show a substantial increase, and although the costs have also increased there is an advance of about 30 per cent. in the amount of the net profit—viz., £17,617, a ainst £13,550. The new 6,000 kw. turbo-alternator will shortly be running on load, but so great is the demand for power that the company has been compelled to order another generating unit of the same size.

* * * *

Patents in War Time.

A correspondent in our contemporary "Engineering," raises an important point in connection with the operation of the International Patents Convention.

It is pointed out that in normal times by the rigid application of the provisions of the International Patents Convention (which affords inventors protection for twelve months wherein they may apply for letters abroad) during the currency of the war is calculated to work hardship, and inflict loss upon inventors. Agents may forward their documents to their associates in ample time for lodgment, and months afterwards learn that for State reasons the fact that the ship that carried the papers was sunk was concealed. It is then too late to remedy the mischief. "In my own case a letter of inquiry to my agent in Europe also failed to reach its destination. An English inventor, in such circumstances, may be able to forward substitute documents within the prescribed time, but what resource is open to a resident of Cape Colony who fails to file his application in the United States Patent Office within nine months from the date of his provisional protection? Under the provisions of the Convention time is the essence of the contract, but no court of law would hold a party debarred from establishing his rights because the force of an enemy prevented strict compliance with one of its rules. Unless some agreement is come to by the Governments subscribing to the Convention whereby patent applications interrupted by the state of war may proceed within a reasonble time from the signing of the protocol of peace, I and a good many other inventors will be excluded by the present hard and fast rule."

Digitized by Google

ELECTRICITY SUPPLY.

GENERAL.

Aberdeen.—The Council is recommended by the Tramways Committee to increase the salary of the tramways manager, Mr. R. S. Pilcher, from £500 to £600 per annum, by annual increments of £50.

Camberley—The Board of Trade has extended for a further 12 months the period limited by the Yorktown and Blackwater Gas Co.'s Electric Lighting Act, 1909, for completion of works.

Cardiff.—The Council has approved the city electrical engineer's estimate for electric vehicle charging plant for the Wood-street depot.

Subject to L. G. B. sanction, an estimate of £6,700 for a h.t. cable to Messrs. Elliott & Jeffrey's premises.

Finchley.—Having failed to secure sanction to a proposal to increase the capacity of their generating plant at an estimated cost of £14,000 the Council are having a new scheme prepared.

Great Harwood.—The Board of Trade has extended until Aug. 7, 1918, the period limited by the Urban Council's Electric Lighting order for laying mains, &c.

Hebden Bridge.—An agreement has been entered into for the supply of electricity in bulk by Halifax Corporation to Hebden Bridge Council.

This step has been taken by the latter Council in consequence of the difficulty of obtaining additional plant at present, and the prohibitive price of fuel oil.

Kingswood (near Bristol).—The Council last week gave sanction to the laying of an electric cable by Bristol Electricity Department to Hanham Colliery.

Some members were in favour of opening negotiations with Bristol Corporation for a supply of current to the Kingswood district, but it was decided to defer consideration of the matter.

London Electricity Supply.—The London County Council is now inviting borough councils which do not own electricity undertakings to send representatives to the conferences which are to consider the subject of electricity supply in London.

Lurgan.—The Board of Trade has extended by one year the period limited by the Town Council's electric lighting order for laying mains, &c.

LIGHTING AND INDUSTRIAL POWER.

Electric Power From Niagara.—The Attorney-General of Ontario believes that a revision of the treaty between Great Britain and the United States regulating the use of the water of Niagara Falls may be necessary.

There has been an acute shortage of power in Ontario. Under the treaty the United States is allowed to use 20,000 cubic ft. a second and Canada 30,000 cubic ft. Recently the Ontario Hydro-electric Commission secured an Order in Council authorising the expropriation of exported power in order to relieve the situation. Even this does not meet the domestic demand, and if export is prohibited many American industries will be embarrassed. The increased use of power on both sides is largely due to the demand for the manufacture of munitions. It is suggested that the treaty be revised to allow both countries to divert more water from Niagara river.

Glyn-Neath (Wales).—A public meeting was held last week to consider proposals for the electric lighting of the parish. An agreement under which energy in bulk will be supplied by the Abergwm Colliery Co. and distributed by the Neath Rural District Council was approved.

Lighting Restrictions.—In the Metropolis restricted lighting begins (from Sept. 1st to Sept. 16th inclusive) at 8.30 p.m. "Summer time" ceases at 2 a.m. on the 17th.

ELECTRIC TRACTION.

Bolton.—Coun. Peter Higson has been appointed chairman and Coun. J. R. Horrocks vice-chairman of the Tramways Committee.

Dover Tramway Accident.—A coroner's jury last week returned a verdict that the recent accident on the Dover tramways, in which 11 persons lost their lives, was due to an error on the part of the driver, whom the jury considered was inexperienced.

Motormen and Military Service.—At the South Yorkshire Appeal Tribunal at Sheffield on Friday the military authorities appealed against the exemption which had been granted to 15 Rotherham tramway employés.

Eleven of the men are motormen and the others are mechanics, and on behalf of the Corporation it was stated that women could not take up the driving work on account of the heavy gradients in Rotherham, and the men were only being retained until substitutes could be found, to enable munition workers to be conveyed to and from their work. Further exemption was granted until Nov. 30 in seven cases, and the appeals were allowed in the other cases. The chairman (Lord Wharncliffe) said, "Do not expect any consideration if you come again."

Newport (Mon.).—The extension of the tramways by direct labour in Alexandra-road is making good progress, and the route is expected to be opened this month.

A trial has been made with one of the six double-deck cars purchased by the Corporation from the London County Council. These cars will not be suitable for all routes until the roads under certain bridges have been lowered.

Tramway Workers' Wages &c—The Birmingham branch of the Association of Tramway and Vehicle Workers has asked the Birmingham Tramways Committee to make applicable to the tramway motormen and conductors the award of 3s. per week made by the Committee of Production on July 14th.

Negotiations have been re-opened between the Amalgamated Association of Tramway and Vehicle Workers and the Lancashire and Cheshire Tramway Authorities, in regard to the men's claim for a further advance of 7s. 6d. per week. The Federation of Tramway Authorities have decided to take joint action, but the Amalgamated Association desire to take up the matter with each tramway authority separately, and the Secretary has tendered, on behalf of the men concerned, 21 days' notice to each of the 19 authorities concerned, unless the men's demand is grated or referred to arbitration. The application was considered at Manchester on Friday last by representatives of the 19 Lancashire and Cheshire authorities concerned. It was decided not to accede to the demand, but to refer it to the Government Committee on Production, with a request that it be a joint arbitration for all the authorities concerned.

The Rawtenstall tramcars ceased running on Sunday last, in consequence of a strike arising out of a demand by women and boys in the employ of the tramways department that they should be paid a bonus of 4s. per week as from July 1. The Corporation had agreed to pay 4s. to the male traffic staff, and 2s. 6d. to shed cleaners, women and youths.

At the meeting of the Belfast Council on Monday, Mr. Howard promised on behalf of the employees of the tramways department, who recently went on strike, that they would resume work on the old terms pending arbitration.

Tube Railway and Omnibus Fares.—Increased fares were put into operation on the London underground railways on Saturday last.

The increases vary from about 14 to 33 per cent., and are confined almost entirely to stages for which 2d. or upwards has been charged hitherto.

Increases varying from 16 to 50 per cent. have also been made in the London General Omnibus Co.'s fares.

Wolverhampton.—Mr. S. T. Allen, borough electrical engineer, explains that the temporary suspension of the tramway service from time to time has been due to want of power at the main generating station, which has been brought about by the continual increase in the demands for current by factories.

At the moment the department is also suffering from a breakdown of one of the sets. Additional plant was ordered as soon as allowed by the Government authorities, but it has not yet been completed. No factories have been stopped on account of shortage of electricity supply.

TELEGRAPHY AND TELEPHONY.

Federated Malay States.—The annual report of the Director of Posts and Telegraphs (Mr. C. H. Allin) for the past year states that in every branch of the department's activities substantial increases are recorded. The number of letters, parcels, &c., posted and delivered in 1916 was 19,125,230, an increase of 1,753,918 over 1915. During the year 410 641 telegrams were dispatched and 451,417 received for delivery, an increase of 138,014. There are 2,210 miles of telegraph and telephone line in the country and 10,461 miles of overhead wire, of which 7,914 miles are telephone wires. In addition, there are 26½ miles of underground telephone cables, containing 2,418 miles of wire, single line.

German-American Submarine Cable.—Mr Gerard, in his book "My Four Years in Germany," states that he endeavoured to obtain permission for the Western Union Telegraph Co. to land a cable in Germany, but the opposition of the German company (the Deutsch-Atlantische Telegraphen Gesellschaft), which did not desire to have its monopoly interfered with, caused the applications of the Western Union to be definitely pigeonholed. After the outbreak of the war, when Mr. Gerard related this to Ballin, of the Hamburg-American Line, and Von Gwinner, head of the Deutsche Bank, their anger at the delay on the part of official Germany knew no bounds. "Within a very short time I received (says Mr. Gerard) an answer from the Foreign Office granting the application of the Western Union Co., providing the cable went direct to America. This concession, however, came too late, and, naturally, the Western Union did not take up the matter during the war."

Venezuela Telephone Projects.—The Government has entered into contracts with Antonio J. C. Herrera, of El Callao (State of Bolivar), and Carlos R. Paredes, of Nirgua (State of Yaracuy), for the construction and working of telephone systems.

Digitized by Google

Wireless Telegraph School at Wimbledon.—The wireless telegraph school at the Municipal Tec nical Institute, Wimbledon, is to be re-opened.

Boys of 15 years and upwards will be admitted, and those making the necessary progress before reaching 18 years and three months will be temporarily exempt from military service, the exemption being continued as long as students who have passed into the mercantile marine are employed as operators at sea.

IMPERIAL NOTES.

Canadian Trade.—Some time ago the Senate of the Dominion Parliament appointed a committee of seven Senators to inquire into and report upon the best method of conserving and increasing Canada's domestic and overseas trade after the war.

The committee has already reported to the Senate, making several recommendations which aim at the securing of orders for overseas trade to replace munition orders and the financing of overseas contracts. To assist in this work the committee recommends the organisation of a trade bank, to be known as the "Canadian Trade Corporation."

South Africa.—Port Elizabeth Municipality has been forced to refrain from encouraging further expansion of its electric supply business by reduction of tariffs, in view of the difficulty of obtaining additional plant to meet the demand which would arise. Additional plant will be required as soon as British makers can supply it.

Patent Procedure in South Africa.—"The Government Gazette" of the Union of South Africa contains a notice embodying new Rules of court concerning matters relating to practice and procedure on opposition to the grant of a patent.

The rules provide that as soon as possible after the receipt of documents relating to the application for a patent, and to opposition thereto, the Registrar of the Court shall call upon the applicant to state within three months whether it is intended to proceed with the application. If within the three months' period the applicant does not notify that he intends to proceed with his application he is to be deemed to have abandoned it.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" states that a recent decree of the National Government authorises the working as a joint stock company of La Electrica Empresa de Usinas Electric a.

The town of Patagones (in Buenos Ayres Province) has been without public lighting for some time past, the service having been suspended by the company owing to non-payment of the debt due to them.

The inhabitants of Pergamino (Province of Buenos Ayres) were notified recently by the local management of the electric light company (the Compania de Electricidad de la Provincia de Buenos Ayres) that the service would be suspended in view of the difficulty the company had in collecting the municipal lighting debt, which amounts to over $107,000 m/n. An arrangement was, however, come to for the continuance of the service, the municipal authorities giving to the company the blank receipt charges for public lighting collectable from the householders and renewing their bond for $41,149.94 m/n, which fell due on May 1st last.

The Compañia de Electricidad de la Provincia de Buenos Ayres is experiencing difficulty in collecting the amounts due to it from several Municipal authorities in the Province, and has presented its claims to the Intervention Government of the Province. The amounts owing to the company by Municipal authorities in the Province amounts to $781,342 (about £68,000).

At San Justo and San Antonio de Areco (the Province of Buenos Ayres) the local electric light companies intend to suspend the public service owing to non-payment of accounts by the communal authorities

The offer of the Compañia Alemana Transatlantica de Electricidad to supply electric current for power and lighting in the building occupied by the offices and workshops of the Casa de Moneda (Mint.) for a year has been accepted by the National Government. Current for lighting is to be supplied at $0·053 gold per unit and for power $0·032 per unit. The Compañia Italo-Argentina de Electricidad, who have hitherto been supplying this service, did not tender. They declined to tender as they considered it was unfair that they should not be allowed to recoup themselves for the charges they were put to in installation.

Bolivia.—Trade statistics show a considerable falling off of imports of British goods into Bolivia in 1915.

Amongst the goods imported were electrical machinery and apparatus: from the United Kingdom £634 (compared with £4,205 in 1914), from U.S.A. £3,427 (£2,080) and from Germany £185 (£9,512).

China.—The value of the foreign trade during the year 1916 was £157,716,289, an increase of 12 per cent. over 1915.

The demand for electrical supplies, machinery, motor cars, bicycles, &c., is rapidly increasing. There was an increase in 1916 of over £1,000,000 in the value of antimony exported. Copper exports were 564,000 piculs (picul = 133⅓ lb.), or an increase of 1,200 per cent. over 1915. Lead ore and mercury exports also increased.

Colombia.—In an article in the "British and Latin American Trade Gazette" it is stated mining and industrial development is handicapped by the lack of transport facilities. The use of electricity is being steadily developed, and there is a good future for hydro-electric development when the transport difficulty is overcome.

Even now the sale of electrical machinery can (it is stated) be pushed. There is also room for good, light oil engines of moderate power, capable of being run on cotton seed, ground nut and palm oil, all of which are manufactured locally. A good deal of milling machinery for dealing with cereals, oil seeds, cocoa beans and sugar is used. Machinery is also required for the manufacture of mineral waters and ice, agriculture, timber working, &c. Of the metal imports into Colombia Great Britain supplies about £130,000, compared with about £140,000 from the United States, £100,000 from Germany and £40,000 from other countries. Our machinery exports advanced from £47,500 in 1909 to £74,000 in 1913; of hardware, from £2,700 to £9,500; other wrought and unwrought metals from £4,110 to £54,800.

Of the electrical appliances imported, the United States sold nearly five times as much as Great Britain, and Germany nearly three times, our sales reaching only a little over £2,100. Yet there is a large amount of British capital invested in telephone and other local electrical undertakings. The same phenomenon is noticeable as regards railway materials and rolling-stock, which almost entirely come from the United States, as do the mining machinery and hardware.

Mexican Tax on Electrical Energy.—The decree in regard to specia stamp taxes on electric lighting, &c., issued early in the year in Mexico, has been annulled, and a new arrangement has come into force whereby the company supplying the service is responsible to the Government for a tax of 10 per cent. on the bill of the consumer.

This tax is to be collected by the company. Persons using not more than three lamps are exempt from the tax. No tax will be levied on signs and advertisements, special illuminations, charitable institutions and schools, public lighting and federal and municipal buildings.

A tax on electric power has been fixed at 3 per cent. Government installations, power sold to companies who re-sell and distribute, and power supplied for irrigation and agricultural purposes are exempt.

Russia.—It is stated that the Ministry of Trade and Industry is to take over from the Ministry of the Interior the control of the electrical industries.

A new section of the former Ministry is to be formed to deal with the registration and inspection of generating stations, &c., the preparation of a scheme for the utilisation of the water power of the country in the generation of electrical energy, and the financing of electrical undertakings, &c.

Standard Voltages in the U.S.A.—Steady progress is being made in the United States of America towards the adoption of what has been agreed as standard voltages of electric supply—viz., 110, 115 and 120 volts.

In June last, the "Electrical World" reports that 66 per cent. of the stations in the United States were operating at a standard voltage compared with 61 per cent. in March, 1916, but in Ohio the figures were 78 per cent. and 57 per cent. respectively. 45·6 per cent. of the stations in Ohio have adopted 110 volts, 30·2 per cent. 115, and 6·5 per cent. at 112 volts, while 4·6 per cent. operate at 220 volts, and only 2·0 per cent. at 120 volts.

U.S.A. Patent Legislation.—The "Electrical World" for July 21 reports that much needed additional employés for the Patent Office at Washington are authorised under a bill introduced by Representative Charles B. Smith, and reported favourably to the House from the Committee on Patents. There will be two additional principal examiners and one examiner of interference at $2,700 a year, four first assistant examiners at $2,400 a year, four second assistant examiners at $2,100 a year, four third assistant examiners at $1,800 a year, four fourth assistant examiners at $1,500 a year, and five clerks at $1,200 a year.

The committee has also reported a Patent Office war measure to prevent the publication of inventions that might be useful to the enemy. The bill provides that the Commissioner of Patents may withdraw the granting of a patent in his discretion until after the end of the war. However, an applicant whose patent is withheld need not fear that his invention will be used by the Government without recompense. In the latter case, he may sue for compensation in the Court of Claims. However, if it is found that the patent has been published or an application for the patent has been filed in a foreign country without the consent of the United States Government, the inventor will lose this right.

In the "Trading with the Enemy" Act, read and referred to the Senate Committee on Commerce on July 13, provision is made for granting patents to alien enemies and safeguarding the interest of inventors in the same. It is also proposed to issue licences to citizens and corporations of the United States who desire to use any patent or copyright granted to an alien enemy, provided that the public welfare is served thereby. The Federal Trade Commission will issue the licences.

Digitized by Google

MISCELLANEOUS.

British Westinghouse Employees' War Relief Fund.—The accounts of this fund for the period from Aug. 22, 1914, to June 30, 1917, show total receipts of £43,093.

Of this amount, £29,102 has been contributed by the employees, and £13,990 by the Company. £25,835 has been paid to dependents, and £11,678 set aside for a disablement and dependents' fund, while over £2,080 has been spent in donations to local and national funds, Christmas gifts and payment to Red Cross workers. The number of families in receipt of relief is 718, and the number of employees who have joined His Majesty's Forces, 2,702.

Cornish Wolfram.—The General Electric Co. (Ltd.) disclaims any knowledge of the United Cornish Wolfram Properties (Ltd.) or of Mr. H. Greig, who has issued a circular offering for sale shares in the latter company.

Fire.—A fire occurred early on Tuesday morning on the premises of Messrs. Birdsbury & Co., electric light fittings manufacturers, Woodcock-street, Birmingham.

German Economics.—It is reported that an Imperial Ministry of Economics (Reichswirtschaftsamt) has been formed in Germany, and that the Department will take over the functions of the Ministry of the Interior so far as they relate to trade, economics and social questions, each of these three sections being placed under an under-secretary.

A census was to be taken on Aug. 15 of all industrial and trade establishments throughout the German Empire. The object of this census is stated to be the collection of statistical data considered necessary for the successful economic prosecution of the war, and to facilitate the tansition of the German economic system from war to peace conditions. The census was to include all Germans engaged in industry, whether as manufacturers, independent master craftsmen, tradesmen or home industrial workers, and was to be carried out through municipal and communal authorities.

Municipal Employes' Wages.—Nottingham Council on Monday referred to the Committee of chairmen and vice-chairmen an application for increase of pay for all men women and boys employed in the Corporation's departments of 1s. 6d. per day or shift or 2d. per hour.

The Deputy Town Clerk said the concession, if granted, would increase the expenditure of the electricity department by £3,300, the tramways department by £13,774 and the whole of the departments by £62,791.

Municipalities and War Bonuses.—A conference of representatives of North East Coast municipalities was held at Newcastle last week to discuss the subject of bonuses for municipal employés.

The Chairman (Councillor Gregg) said he thought a check should be put to the practice of using a grant made by one municipality as an argument to compel another to do likewise. The opinion of the meeting was that a joint representative committee should be formed, to which any application in connection with wages should be referred, and before which the men's representatives could state their case.

The meeting was adjourned, and other municipalities are to be asked whether they are in favour of the formation of such a committee.

Rubber Share Handbook.—From the publishing office of "The Financier and Bullionist" (Dean-street, Fetter-lane, E.C.) we have received a copy of the 14th edition of the "Financier Rubber Share Handbook."

It appears to be a good and carefully compiled record of the financial position and output of rubber of companies and estates. The interim and final dividends declared in April and May, 1917, a table of rubber outputs and a list of directors are included. The price of this useful reference book (including postage) is 4s. 4d.

Trades Union Congress.—The forty-ninth annual meeting of the Trades Union Congress was opened at Blackpool on Monday. The 695 delegates are said to represent over three million workers.

Mr. John Hill, in his presidential address, said something more than resolutions were required to obtain reforms. The promotion of Bills in a House of Representatives was also not a hopeful occupation. The recording of their resolutions in the statutes of the realm could not be accomplished by revolution. That might replace one set of autocrats by another. They must agitate, educate and organise. Their committee had held joint meetings with representatives of the co-operative movement, and they had arrived at a working agreement, the bases of which were that every trade unionist should be a co-operator, and every co-operator should be a trade unionist, that the co-operative side of the movement would be the bankers for the industrial side in times of prosperity, and lend money to it in times of adversity. Discontent in the workshops assumed alarming proportions this year. The Commissions of Inquiry paid tributes to the loyalty of the workers. It would be their duty to see that the promises of the Minister of Munitions and of Mr. Barnes (on behalf of the War Council) were carried out. The best scheme of reconstruction would be one of their own devising—a strong and intelligent trade unionism linked in their political arm, the Labour Party.

International Relations.—Could the destruction of German militarism by the substitution of German democracy be accomplished by military means? Mr. Gerard had said there was no symptom of such a change in Germany.

Old Age Pensions.—A motion was proposed by Mr. A. Law that the Parliamentary Committee promote legislation to secure that trade-union and friendly society benefits should not be taken into account in assessing the income of applicants for old age pensions, and this was carried.

Widows' Pensions.—The meeting also passed a resolution, moved by Mr. H. Elvin, urging that the gratuities given to widows of soldiers be abolished, and adequate pensions be substituted, and that the present scale of pensions should be improved.

Mr. John Hodge, M.P. (Minister of Pensions), said he had already obtained the sanction of the Chancellor of the Exchequer to an extension of the regulation relative to pensions, which enabled totally disabled men to receive up to 50s. per week (according to the amount of their previous earnings), or up to £3. 15s. if their previous earnings were from 50s. to £5.

Railwaymen's Demands.—On Tuesday after some discussion it was resolved to leave to the Parliamentary Committee the subject of the locomotive engineman's and fireman's demand for an eight-hour day.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during July, 1917, and (*b*) the aggregate figures from Jan. 1 to July 31, with increase or decrease compared with corresponding periods of 1916 :—

Electrical machinery, (*a*) £118,773 (increase £34,027), (*b*) £848,930 (increase £113,578); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £29,34. (increase £12,555), (*b*) £151,895 (increase £32,753); and electrical machinery unenumerated, (*a*) £89,425 (increase £21,472), (*b*) £697,035 (increase £80,825); telegraph and telephone cables other than submarine, (*a*) £3,427 (increase £2,279), (*b*) £49,280 (decrease £4,054); telegraph and telephone apparatus, (*a*) £1,788 (decrease £2,722), (*b*) £19,385 (decrease £179,844); other electrical wires and cables, rubber insulated, (*a*) £2,670 (decrease £9,876), (*b*) £28,725 (decrease £48,671); with other insulations, (*a*) £1,352 (decrease £154), (*b*) £6,932 (increase £1,715); carbons, (*a*) £2,294 (decrease £4,022); (*b*) £51,190 (decrease £3,559); glow lamps, (*a*) £3,035 (decrease £24,593), (*b*) £64,842 (decrease £96,842); arc lamps and electric searchlights, (*a*) nil, (*b*) £38 (increase £38); parts of arc lamps and searchlights (other than carbons), (*a*) £5,484 (decrease £3,981), (*b*) £69,004 (increase £11,373); primary and secondary batteries, (*a*) £24,048 (increase £9,619), (*b*) £188,687 (increase £73,350); meters and measuring instruments, (*a*) £5,540 (decrease £1,356), (*b*) £21,907 (decrease £3,001); switchboards, (*a*) £434 (increase £434), (*b*) £481 (increase £224); electrical goods and apparatus unenumerated, (*a*) £49,896 (increase £5,362), (*b*) £308,506 (increase £109,509). Total of electrical goods and apparatus other than machinery and uninsulated wire,) £99,968 (decrease £29,010), (*b*) £808,977 (decrease £139,782).

Exports.—The exports of electrical machinery, material, &c., (*a*) during July, 1917, and (*b*) from Jan. 1 to July 31, with increase or decrease compared with corresponding periods of 1916, were as follows :—

Electrical machinery, (*a*) £147,407 (increase £9,536), (*b*) £869,885 (increase £84,127); including railway and tramway motors, (*a*) £6,555 (increase £2,957), (*b*) £18,243 (decrease £2,382); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £78,227 (decrease £8,067), (*b*) £512,512 (increase £82,294); and electrical machinery unenumerated, (*a*) £62,625 (increase £14,686), (*b*) £339,130 (increase £41,215); telegraph and telephone cables, submarine, (*a*) nil (decrease £31,737), (*b*) £113,541 (decrease £140,673); other than submarine, (*a*) £73,521 (increase £34,056), (*b*) £492,120 (increase £170,967); telegraph and telephone apparatus, (*a*) £56,668 (increase £36,150), (*b*) £151,985 (decrease £754); other electrical wires and cables, rubber insulated, (*a*) £5,694 (decrease £31,861), (*b*) £159,597 (decrease £131,751); with other insulation, (*a*) £18,655 (decrease £48,498), (*b*) £199,556 (decrease £295,909); carbons, (*a*) £1,190 (decrease £266), (*b*) £15,881 (increase £9,686); glow lamps, (*a*) £10,101 (decrease £5,172), (*b*) £81,674 (decrease £21,579); arc lamps and searchlights, (*a*) £60 (decrease £113), (*b*) £11,430 (increase £5,598); parts of arc lamps and searchlights (other than carbons), (*a*) £15,196 (increase, £13,981), (*b*) £45,770 (increase £34,374); primary and secondary batteries, (*a*) £6,008 (decrease £22,207), (*b*) £93,071 (decrease £64,796); meters and measuring implements, (*a*) £17,406 (decrease £7,130), (*b*) £81,990 (increase £39,219); transformers, (*a*) £6,275 (decrease £3,094), (*b*) £43,565 (decrease £13,517); switchboards, (*a*) £1,933 (decrease £3,531), (*b*) £21,580 (decrease £1,261); electrical goods and apparatus unenumerated, (*a*) £34,225 (decrease £33,603), (*b*) £383,067 (increase £10,571). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £246,932 (decrease £103,035), (*b*) £1,894,827 (decrease £492,263).

EDUCATIONAL.

University College, London.—The examination for the Goldsmid Engineering Entrance Scholarship (value £30 a year for three years) takes place in September. Particulars from the Secretary not later than Sept. 11th.

University of Edinburgh.—The next session opens on Oct. 9. The preliminary or entrance examination is held in September. There are complete courses of instruction in civil, mechanical and electrical engineering, qualifying for the degree of S.Sc. in engineering, and extending over three years. Particulars of examinations, scholarships, &c., from the Matriculation Office, the University, Edinburgh.

Armstrong College, Newcastle-on-Tyne.—The session 1917-18 will commence on Sept. 24. Full courses leading to the degree of B.Sc. in engineering are provided in mechanical, marine, civil and electrical engineering, naval architecture, mining and metallurgy, &c. Particulars can be obtained from the secretary, Mr. F. H. Pruen, M.A.

City and Guilds Technical College, Finsbury.—The next entrance examination will be held on Sept. 18. The training is adapted to the needs of pupils from secondary schools above the age of 15 and men who, having served a pupilage or apprenticeship in works, desire to go through a more systematic training. There are engineering, electrical, physical and chemical laboratories and dynamo rooms. The professor of electrical engineering is Prof. W. H. Eccles, D.Sc., A.R.C.S., M.I.M.E. Programmes may be obtained from the Registrar of the College, Leonard-street, Finsbury, E.C.

Digitized by Google

Manchester Municipal School of Technology, University of Manchester.—At this school there are courses leading to the Manchester University degrees (B.Sc.Tech. and M.Sc.Tech.) in the Faculty of Technology in the departments of mechanical, electrical and sanitary engineering, chemical industries, textile industries, printing and photographic technology and architecture. Prospectuses may be obtained from the Registrar. There are extensive laboratories and workshops equipped with modern machinery and apparatus.

Manchester High School of Commerce.—Manchester Education Committee have decided to open on Oct. 1 a high school of commerce at Danlee-buildings, Spring-gardens, Manchester, with full and part-time day courses in higher commercial work and modern languages, for men, women and young persons, with sound general education. Particulars can be obtained from the Principal.

South-Western Polytechnic Institute.—Complete three years' day courses, leading to a diploma or university degree in electrical engineering, are provided at this institute. There is also a four years' evening course suitable for electrical engineering and electrical installation examinations of the City and Guilds' Institute, commencing with the next session on Sept. 24. Particulars may be obtained from the secretary, Manresa-road, Chelsea, S.W. 3.

Training of Munition Workers.—In a recent report of the Education Committee of the London County Council particulars were given of the work done in the manufacture of munitions and the training of munition workers.

The total staff in shops now engaged on the manufacture of munitions is 205. The output of gauges during the first year's work up to July 1, 1916, was 18,091; during the second year's work up to June 30, 1917, the output was 30,469; a total of 48,560 in two years. In addition a quantity of work of lesser importance has been undertaken. During the second year the character of the manufactures undertaken increased very greatly in difficulty, and special gauges of considerable complexity had been satisfactorily completed in quantity. The staff as a whole have been working from 64 to 74 hours per week for the past year, showing a record of continuous steady work comparable with any munitions organisation.

During the two years ended June 30, 1917, 8,089 students had been under training in the various centres, of whom 6,088 had been certificated on satisfactorily completing their training; 5,751 of these are known to have obtained employment on work of national importance. The main centres at Brixton and Shoreditch had gradually been equipped with modern machine tools, some of these being lent by engineering firms. The value of the machinery and equipment installed is about £10,000. The training of gauge-makers has also been carried on at the Goldsmiths' College and the South-western Polytechnic in conjunction with the manufacturing operations. The demand in this direction appears for the time being to have been largely met, although the courses are still in operation. The total staff engaged on training is 95.

Workmen and the Education Bill.—Mr. Fisher's new Education Bill was considered on Saturday afternoon at a meeting of the Workers' Educational Association (Yorkshire District) in Leeds.

A resolution was passed that this meeting considers that while the Education Bill, 1917, represents a considerable advance upon our pre-war educational standards, it falls far short of the possibilities and needs of the period after the war.

Mr. LAWRENCE (Chesterfield) said it should be called a Technical Education Bill.

Mr. POPPLESTONE considered that the Bill was of enormous value.

The Chairman (Mr. A. GREENWOOD) said that, measured by pre-war standards, the Bill did represent a considerable advance. But, viewed in relation to the fact that during the war this country had lived through two generations, it was a mockery. It did not admit a new place in the national life for the working classes. It continued to treat them as an inferior race, otherwise there would not be the clause which would put the mass of the workers in a position of attending sham schools for eight hours a week whilst the well-to-do attended full time. He moved a resolution (which was passed) containing the following, amongst other clauses:—We are of the opinion that the proposals for continuation education are inadequate and unsatisfactory, as we consider that continuation education should be regarded as of the same type as full-time secondary education, and as such should be legislated for alongside full-time secondary education. We strenuously oppose the exemption from attendance at continuation schools given by the Bill to young people above the age of 16 who have passed a matriculation examination or satisfied the Board of Education that they have been under suitable and efficient full-time instruction up to the age of 16, realising that such exemption will result in preferential treatment in industry of the child of the relatively well-to-do over the child of the worker. We offer our uncompromising opposition to any attempt to secure the recognition of works schools as places of continuation education within the meaning of the Bill. The employment of children for profit or wages during the years of full-time school attendance should be prohibited. We regret the permissive character of most of the clauses dealing with the promotion of physical well-being.

Mr. CHURWELL (Keighley) thought they would be well advised to accept the Bill as an instalment.

Mr. SIMPSON (Sheffield) urged that they should endeavour to strengthen Mr. Fisher's hands in getting his Bill through the House of Commons.

TENDERS INVITED AND ACCEPTED.

Cables, &c.

DUBLIN Electricity Supply Committee also require tenders by noon, Sept. 11th, for one year's supply (or supply and laying) of extra high-pressure and low-pressure cables, troughing, bends, &c., and supply (or supply and erection) of section pillars. Specification, &c., from the City Electrical Engineer.

Electrical Stores.

STOCKTON-ON-TEES Corporation require tenders by Sept. 10 for six months' supply of stores for the electricity department. Forms of tender from the Electrical Engineer.

WESTMINSTER Guardians require tenders by noon Sept. 19 for six months' supply of electric lamps, fittings, &c., and engineers' sundries. Forms of tender from the Clerk, Princes-row, Buckingham Palace-road, London, S.W. 1.

Internal Telephones.

MANCHESTER Guardians require tenders by Sept. 17 for the installation of internal Telephones at their offices, All Saints', Manchester.

Meters.

DUBLIN Electricity Supply Committee invite tenders for single-phase and three-phase meters for one year. Tenders to Chairman of Committee by noon Sept. 11.

Rotary Converter.

BERMONDSEY (London) Borough Council invite tenders for a 500 kw. rotary converter. Specifications from the borough electrical engineer, and tenders by noon Sept. 7 to the town clerk, Town Hall, Bermondsey, S.E.

Coal Bunker.

BOOTLE Corporation invite designs and tenders for erection of an Overhead Coal Bunker at Marsh-lane generating station (for at least 400 tons of coal). Particulars from the Borough Engineer. Tenders to the Town Clerk by noon Sept. 12.

SALFORD.—The Corporation has accepted the following tenders:—Edison Accumulators (Ltd.), 2-ton electric vehicle with automatic electric tipping body, £1,123; W. T. Glover & Co., low-tension, paper insulated, lead covered cable, £176. 12s. 6d.; British Westinghouse Electric & Mfg. Co., 300 kw. rotary converter set, £1,535; switchgear, £551; Ferranti (Ltd.), 250 k.v.a., 3-phase, oil cooled power transformer, £274. 10s.

BALLYCLARE.—The Council has accepted the tender of Curran Bros. for lighting the district for three years at the following rates per annum:—Carbon filament lamps, 8 c.p., £1. 13s. each, 16 c.p., £2 5s.; metal filament lamps, 25 c.p., £1. 13s., 50 c.p., £2. 5s., 100 c.p., £3. 5s.

MANCHESTER.—The Corporation has accepted the following tenders: Babcock & Wilcox, superheater tubes, &c., for Bloom-street electricity works boilers; Lea Recorder Co., Lea recorders.

APPOINTMENTS VACANT AND FILLED.

London County Council invites applications for the position of charge shift engineer at their East Greenwich generating station. Commencing salary £250, rising by £10 a year to £300. Applications, on official form to be obtained from the Clerk of the Council, Council Hall, Spring Gardens, S.W.1, must be in by 1 p.m. of Sept. 24.

An assistant mains superintendent is required for Darlington electricity department. Salary, including bonus, £2. 15s. per week. Applications to the Borough Electrical Engineer by Sept. 10.

Mr. W. Brew, lecturer in electrical engineering at Belfast Municipal Technical Institute, has been appointed head of the electrical department of Birmingham Municipal Technical School.

BUSINESS ITEMS.

The offices of the Brush Electrical Engineering Co. have been removed from 1, Kingsway to Maxwell House, 11, Arundel street, London, W.C. 2. (Telegrams: Magneto, Estrand; Telephone: Central 415.)

The Cowper-Coles Aircraft Co. informs us that a plant of considerable size is being erected in the south of England for making shell bands by the Cowper-Coles centrifugal copper process.

"Wireless World."—In consequence of increased cost of production, the price of the "Wireless World" (issued by the Wireless Press, Ltd., Marconi House, London, W.C.) will be 7d., instead of 6d. as heretofore.

CATALOGUES, &c.

PNEUMATIC PAINTING EQUIPMENT.—The Spray Engineering Co. has sent us a pamphlet illustrating and describing the latest type of the Spraco pneumatic painting equipment. Copies of the bulletin can be obtained from the Company 93, Federal-street, Boston, Mass.

Digitized by Google

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Aberdeen.—The accounts of the electricity department show a net deficit for the past year of £345 (against £9,137 for the previous year).

Income was £76,369 (increase £496), and total working expenses were £47,215 (increase £8,035). Gross profit was £29,153 (decrease £7,539). The reserve fund now stands at £39,304.

Aylesbury.—The accounts of the electricity department for the year ended March 31 show total capital expenditure £21,539 (increase £1,971), of which £2,066 has been repaid.

Revenue was £3,716 and working and general expenses were £2,206, leaving gross profit £1,510. Interest and income tax required £983 and redemption £1,284, the net result being a deficit of £758.

Bradford.—The accounts of the electricity department for the year ended March 31 show gross capital expenditure £1,054,574 (increase £63,709), of which £542,432 is outstanding.

Revenue was £200,171 (compared with £167,177 in previous year) and working expenses were £114,029 (£87,064). Interest required £36,231 (£29,049) and sinking fund £38,099 (£35,075), leaving net profit £11,812 (£15,989), of which £3,858 (£3,605) is put to depreciation, &c., account, including £253 for battery at Sunbridge-road, and £7,954 contributed to capital outlay. Total income averaged 1·043d. per unit sold and expenses were 0·593d., or 0·980d. including capital and all other charges. Consumers increased from 4,859 to 4,958.

George Town (Penang).—The report of the electricity department for 1916 states the total capital expenditure at the end of the year was $1,031,418.

The year's revenue was $335,611, compared with $304,193 in 1951, and working and general expenses were $134,472 ($124,381), leaving as gross profit $201,139, and a net profit, after providing for capital charges, depreciation and reserve ($103,435), of $97,703 (=9·5 per cent. on the expended capital). Units sold were 1,697,619.

The engineer and manager (Mr. O. V. Thomas) says it would be proper to apply the profits to the reduction of charges for current, but, in view of the fact that any reduction in charges would be followed by an increase in the applications for supply and hasten the time when extensions of plant, &c., would be imperatively needed, it has been decided to make no charge until it is possible to obtain the material for extensions. Mr. E. S. Haslam, the assistant engineer, is still serving with H.M. Forces, and Mr. C. C. Rogers continues to act as assistant engineer.

The total capital expenditure on the tramways stands at $572,243. The year's revenue was $151,408 (against $141,944 in 1915) and operating costs were $91,735 ($95,807), leaving gross profit $59,672 ($46,136). Capital charges, depreciation and reserve required $54,049, and the net profit was $5,622 (about equal to the deficit on the previous year). Traffic revenue was 30·27 cents (28·23 cents) per car mile, and operating costs were 18·40 cents (19·05 cents). Passengers carried were 5,560,398 (5,177,874), car miles run 498,570 (502,731, and units used 251,500 (298,096).

Glasgow.—The accounts of the electricity supply department for the year ended May 31, 1917, show gross capital expenditure £2,835,297 (increase £199,145), of which £741,439 has been redeemed.

Revenue was £580,433 (compared with £530,720 in previous year), expenditure was £404,404 (£322,651), leaving gross profit £176,029 (£208,068). Depreciation required £55,606 (£58,104), interest £91,306 (£79,183), instalments of loans £1,532 (£1,480) and sinking fund £66,250 (£63,981). £38,666 to meet the net deficit has been transferred from reserve. Last year's net surplus was £5,317. Average price received was 0·975d. (1·108d.) per unit, and total cost, including capital and special charges, was 0·9578d. (0·9942d.). Units generated were 162,398,668 (132,364,922) and sold 141,193,627 (112,794,461). Consumers increased from 33,605 to 34,724.

The Committee on Electricity state in their report that the increase of £81,752 in working expenses is principally due (apart from the larger output) to the greater amounts paid for coal materials, wages, allowances to employés on active service, interest and sinking fund. The Committee recommends increases in charges for current for the current year. Amongst the rates in the new tariff are 4½d. flat rate for domestic consumers, churches, &c., from ¾d. to 2d. for power, and from 1d. to 1½d. for heating. Motors connected are 12,401 (97,733 H.P.), compared with 11,472 (84,744 H.P.) last year. Maximum load on the stations was 49,185 kw. (45,880 kw.).

Poplar (London).—In the annual report of this Borough for 1916 it is stated that at the seven depots the electrolytic fluid was still in great demand by the public.

The total output of the fluid during the year was 26,790 gallons, and this was broken down to 53,580 gallons and distributed. Since the beginning of August, 1914, the fluid has been manufactured of greater strength, being afterwards broken down to half strength for distribution. The cost of material in manufacturing the 26,790 gallons of the electrolytic fluid was as follows: Electricity, 6,250 units at 1½d. (with 10 per cent. advance) per unit, £40. 3s. 1d.; chloride of magnesium (4 tons 10 cwt.), £47. 14s.; salt, 4 tons 15 cwt, £11. 8s.; caustic soda, £12. 12s.; and water, £2. 10s.; making the total cost £114 7s. 1d., plus £1. 0s. 6d. for 164 units for the electric motor for stirring. The bottles, corks and labels cost £30. 17s. 6d. Since the installation of the plant 11 years ago 445,569 gallons of fluid have been manufactured, at a cost for electricity of £490. 14s. 2d., and materials of £455. 13s. 2d., about ½d. per gallon. Previous to the war the cost was under ½d. per gallon; but even with the strong fluid which at present is being made, and is broken down, the cost is still under ½d. per gallon when the gallons are reckoned in bulk. The public health department is not only furnished with the disinfectant and the various institutions of the Council (the public baths, &c.), but the institutions of the managers of the sick asylum and of the Board of Guardians (within and without the borough) are supplied with an unlimited quantity free. For the fluid supplied to the works department a charge of 1d. per gallon is made; the public health department is credited with this amount although no actual monetary transaction takes place. From October, 1915, for electrolytic disinfectant supplied to manufacturers and trading concerns, a charge of 8d. per gallon is to be made through the electricity department, the electricity undertaking being allowed an amount of 10 per cent. for establishment charges.

Wolverhampton.—The accounts of the tramways department for the year ended March 31 show total capital expenditure £294,280, sinking fund amounts to £70,564 and reserve and renewals fund to £56,645.

Revenue was £65,846 (against £59,111 in previous year) and working expenses were £38,599 (£33,155). Interest required £5,768, repayment of capital £6,029, and income tax £743 (£519), leaving net balance £14,997 (tramways £13,641 and motor char-a-bancs £1,356), of which £234 (£1,685) has been contributed for additions and improvements, £8,183 (£2,477) placed to maintenance and repairs suspense account and £6,580 (£4,018) contributed in aid of rates. Total revenue per car-mile was 13·596d. (12·265d.) and working expenses including power were 7·97d. (6·88d.), and war allowances 0·22d. (0·22d.). Average fare charged per mile was 0·866d. Passengers were 14,913,787, car-miles 1,162,269 and units used 1,854,828.

MORTGAGES AND CHARGES.

A. J. WAKELIN (LTD.)—Memorandum of satisfaction in full on Aug. 29, 1917, of debentures dated May 22, 1914, and July 31, 1916, securing £500 has been filed.

ELECTRIC HOLDINGS (LTD.)—Trust deed dated Aug. 22, 1917, to secure £1,243,300 10-year prior lien stock, constituting a first charge on £675,000 4 per cent. debenture stock, 313,997 preference shares of £2 each, 54,121 ordinary shares and 500,000 deferred shares of 1s. each, of the British Westinghouse Electric & Mfg. Co. (Ltd.), and a floating charge on the company's undertaking and general assets. Trustees: City Safe deposit & Agency Co. (Ltd.).

LANCASHIRE ELECTRICAL ENGINEERING CO. (LTD.)—Memorandum of satisfaction in full on July 27, 1917, of charge dated March 20, 1917, securing the sums owing on company's account with Union Bank of Manchester.

TREBURLAND WOLFRAM & TIN CO. (LTD.)—Charge on the Company's undertaking and property, present and future, including uncalled capital, dated Aug. 17, 1917, to secure all moneys which Petersen & Co. shall provide for the working and development of the Treburland Mine, stamped to cover £5,200.

CITY NOTES.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—A quarterly dividend of 1½ per cent. on the fully-paid cumulative preference shares will be payable on Oct. 1.

BRITISH INSULATED & HELSBY CABLES (LTD.)—Meetings of the ordinary and preference shareholders will be held on the 10th inst. to consider a proposal to divide both classes of shares into £1 shares.

CANADIAN GENERAL ELECTRIC CO.—A quarterly dividend of 2 per cent. (at the rate of 8 per cent. per annum) has been declared on the common stock for the quarter ended Sept. 30.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The following dividends will be payable on Sept. 24th on account of the year ending Dec. 31st next: 6s. per share on the preference and 6s. per share on the ordinary shares.

CLYDE VALLEY ELECTRICAL POWER CO. (LTD.)—The directors announce an interim dividend of 1½ per cent. actual on the ordinary shares, tax free.

DAVIS & TIMMINS (LTD.)—An interim dividend for the half-year at the rate of 6 per cent. per annum (7½d. per share), tax free, has been declared on the ordinary shares.

LONDON ELECTRIC SUPPLY CORPN. (LTD.)—The directors announce that, for reasons entirely attributable to the war, they have deemed it advisable not to distribute a dividend on the preference shares, but to carry forward the profit earned in the half-year ended June 30 last.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—This company is offering 250,000 new £1 shares to the shareholders at £1. 15s. each. Applications are to be made by the 14th inst.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO.—An interim dividend of 2½ per cent. on the ordinary shares, less tax, has been declared.

Digitized by Google

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—Petrol is nearly four "bob" a gallon, and Edison is too busy trying to stop the war by electricity to worry about "Electrics!" Ah! the nickel-irony of it!

* * * *

A poetic correspondent says the advance in petrol prices and the use of coal gas on motor cars and motor cycles have constrained him to muse thus:—

Mary, Mary, quite contrary,
How does your motor car go?
On tins of Shell and lots of smell
And gas bags all in a row.

* * * *

The electrical engineers who are among the deserving recipients of one or other classes of the New War Orders will probably find that the use of this new "handle" to their names will be confused with the "letters" they now use as members of the engineering Institutions. "G.B.E." "K.B.E.," "C.B.E.," "O.B.E.," and M.B.E." will not go very well with "M.I.C.E.," "M.I.E.E.," "M.I.M.E.," &c. Folk will say this man is all "E's," when, as a fact, he will have been a hard worker every day of his life!

* * * *

A Round Table reader has asked me a plain straightforward question:—"Can an electrical engineer be a pacifist (by that he means, a stop-the-war-now-at-any-price-ist) and still remain an electrical engineer?" I should say "Certainly not," and my reason is that the electrical industry is contributing as much as (and, personally, I would say more than) any other industry towards the prosecution of the war, and this fact persuades me that its members are at one with the country in its determination to carry the war to no uncertain conclusion. My correspondent sends me a copy of a sixpenny brochure, entitled "The Sword or the Cross. How to End the War," by E. Cecil Beman, which seems to have inspired the question printed above. If, as he informs me, the author of this piece of pacifist literature is an electrical engineer still engaged in business, and much of it directly connected with the war, it were better that he had kept silence. However, I will send this "Beman-esque" view of the war to an electrical engineer friend of mine at the front, and see what he thinks of it!

* * * *

At the risk of boring Round Table readers, I quote one passage from Mr. Beman's effort:—

"In imagination I see the figure of a man in a front-line trench. He is dressed in the regulation khaki, with rifle, bayonet and full fighting equipment. Of all the belligerents he is the most bellicose. With a shout of defiance, he and his companions are over the parapet. *He has thrown his hand-grenade* with unerring accuracy, and the result has exceeded the most sanguine expectations. The air is filled with the groans and anguish of the dying. An expression of righteous indignation is on his face. Flushed with excitement and elated by his success, he belabours the loathsome Huns with the butt end of the rifle clasped firmly *in his left hand, while with the right* he makes thrust after thrust with the trusty bayonet while each quivering body gives up the ghost."

The italics are mine, and they would seem to indicate that Mr. Beman is not even a member of the Volunteer Force!

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, September 4, 1880.]

ELECTRICITY AND WAR.—Experiments are, I understand, being tried at Plymouth with an electrical range-finder, the results of which will be known very shortly, and are looked forward to with considerable interest among military circles.

ANOTHER TELEPHONE OUTRAGE.—Jones (telephoning wife): "My dear, Mr. Skid will be with us at dinner to-day." (To Skid): "Now, Skid, you can converse with my wife through the telephone, if you wish." Mr. Skid approaches the instrument, when both hear very distinctly: "You tell old Skid that we don't keep a hotel on washdays." Mr. Skid dined at a restaurant.—"The Operator."

GAS CARBON FOR ELECTRODES.—It is not generally known that the first to find out the exceptional advantages of carbon cut from the retorts of a gasworks in producing the electric light was Mr. Golding Bird. In a letter to the "Philosophical Magazine" for January, 1838, describing his new induction coil, he expressly states that he gets the most brilliant sparks from electrodes of this material.

THE POST OFFICE AND FEMALE CLERKS.—The Postmaster-General announces that the competitive examinations for appointments in the various branches of the Post Office will in future be thrown open to females. The telegraph service is not specifically mentioned, but we apprehend that it is included in this philanthropic scheme, and that an accession to the number of female telegraphists may consequently be anticipated.

Improved Motor Ambulances.—Two new types of motor ambulance for serious cases have been recently designed by the Motor Ambulance Department of the Joint War Committee of the British Red Cross Society and the Order of St. John, and have been dispatched oversea for trial.

One of the new vehicles is a single-bed ambulance. The body is light and airy with folding rear doors, and an electric radiant heater is used to maintain the necessary temperature. The other vehicle is a special two-bed ambulance. The body is built with duplex panels, between which is an insulating material. Heating is provided by electric foot-warmers, the current for which is supplied by the regular lighting system on the car and by pipes through which the whole of the exhaust of the engine can be taken. The car is scientifically ventilated, and is lit by electricity and by windows and skylights, the windows being duplex like the panelling.

Imperial Commerce.—The Canadian Trade Commission, which was appointed in 1916 to inquire into the prospects for Canadian trade with European countries has issued its report, and recommends that the Government should take steps to improve the ocean transportation system between Canada and Great Britain, France and Italy, and that Canada's resources should be systematically advertised abroad.

The Commissioners, who personally investigated trade conditions in the countries mentioned, believe that a very large trade between Canada and Great Britain can be developed, and that after the war the trade with France will undoubtedly increase. Good openings also will be found in Italy and Russia. They found in the countries visited an impression that a preferential tariff should be created by the Allies for one another, an intermediate tariff for neutral countries, and that enemy countries should be penalised as far as possible by a tariff wall in order to restrain unfair competition. Among the courses advocated by the Commission are a study of the question of transportation of Canadian grain and other products and encouragement of shipbuilding in Canada.

Canadian Nickel Industry.—In connection with the nickel, smelting and refining plant which is being erected at Sudbury, Northern Ontario, by the British-America Nickel Corpn., it is stated that the undertaking is controlled by the British Government. Mr. Alan Anderson, Public Trustee for Great Britain, holds $14,500,000 of the $20,000,000 of issued capital stock, and also half of the $6,000,000 first mortgage bonds.

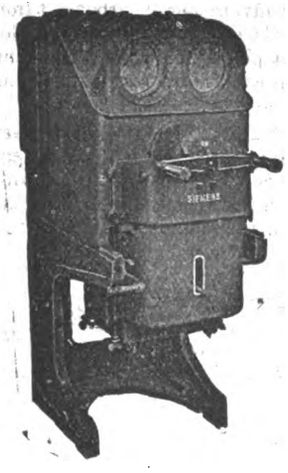
Norwegian interests own $1,000,000 stock, and the remainder is held in Canada. Within two years' time the corporation expects to be producing 6,000 tons of refined nickel yearly. Under a long-term contract the British Government will purchase the output of the corporation to the limit of its requirements. Any surplus will be sold under strict control of the Imperial authorities. The plant will be located 4½ miles north-west of Sudbury and close to the most important mine in the possession of the company. Exclusive rights for Canada and the United States to the Hybinette electrolytic process of refining, which is used in Norway and controlled by the Kristianssands Company, have been purchased. By the Hybinette treatment the ore will be smelted to an 80 per cent. matte, which will then be refined by the electrolytic method. The International Nickel Co. is building a $4,000,000 refinery at Port Colborne, Ont., and it is expected that the plant will be ready for operation by the end of the year. A subsidiary company—the International Nickel Co. of Canada (Ltd.)—has been incorporated to operate the Ontario refining works.

L.P.S. INSULATING MATERIALS.
INSULATING VARNISHED
Silk, Cloth, Linen, Paper and Tapes (Straight and Bias Cut).
COTTON and SILK TAPES and RIBBONS of every description.
LEATHEROID AND PRESSPAHN.
THE L.P.S. ELECTRICAL COMPANY,
14, Howick Place, Westminster, London, S.W.1.
Telephone: Victoria 7346. Telegrams: "Engineyor, Sowest, London."

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 100, WARDOUR STREET, W.
"Gosfiplat, Ox., London." 4746 Gerrard.

Digitized by Google

SIEMENS



IRONCLAD
SWITCHGEAR
FOR ALL
PURPOSES

Control Pillars
Distribution Boards
Main Switchboards

Write for particulars to —

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350 Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

FOR
High and Low Tension
SWITCHGEAR
THE
NEW SWITCHGEAR CONSTRUCTION CO., Ltd.
SUTTON, SURREY, ENGLAND.
ABC Code 5th Edition. Telephone: Sutton 773.

Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE
Brass & Copper
Tubes and Sheets.
BRASS CONDENSER
TUBES FOR STANDARD
SHIPS, &c.
TRADE MARK.
SEA-CLIFF
CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.

STEEL WORKS ELECTRIFICATION. DIRECT DRIVE OF 20-INCH BAR MILL.

British steel manufacturers having been under the imperative necessity of increasing their output to a point which in pre-war days would have been deemed impossible, have resorted to electrification in all their departments.

For no class of work has the demand been keener than for rolling mill motors. In a new extension of Messrs. Johnson's Iron & Steel Works,

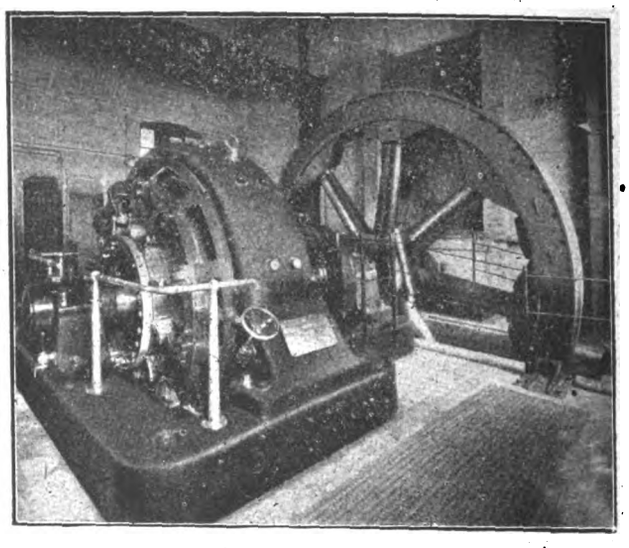


FIG. 1.

West Bromwich, there has recently been laid down a new 20 in. two-high bar mill which embodies the latest improvements in the electric driving of rolling mills. The mill consists at present of one stand of rolls (eventually to be increased to two) for dealing with ball furnace iron and steel blooms, and is driven direct by a C.C. Witton motor (*see* Fig. 1) without gear or ropes. The motor drives the mill direct and a flywheel is interposed between the motor and the mill. This motor has an output of

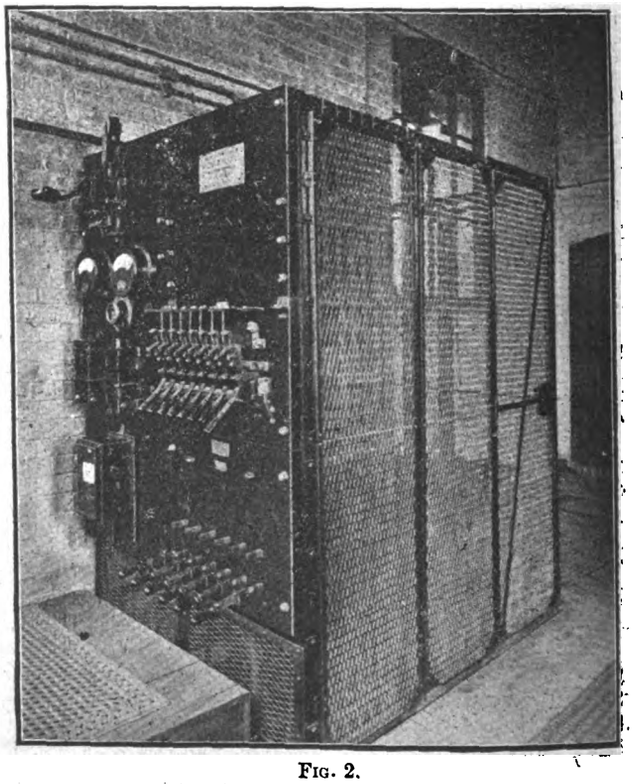


FIG. 2.

300 B.H.P. on continuous rating at 52 revs. per min., and has an overload capacity of 100 per cent. for short periods. It is designed for speed adjustment by shunt regulation from normal speed up to 100 revs. per min. on light load, and is compound-wound in order to give a drop in speed of about 20 per cent. between light-load and full-load, thereby enabling the flywheel to take a share of the load during heavy passes. In order to accommodate the motor to the particular requirements of

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

HAVE YOU OVERLOOKED THE FACT THAT, AS SHOWN IN THE ADJOINING LIST, WE ARE MANUFACTURERS OF

COTTON COVERED WIRES?

Let us have your enquiries at our Prescot Works.

BRITISH INSULATED & HELSBY CABLES. LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED **SECOND HAND**

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Vicmaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.
ELECTRICAL MACHINERY
Engineers, Edinburgh.
See our Illustrated Advt. last week.

Digitized by Google

various classes of work, a diverter is provided on the switch panel, enabling the amount of compounding to be easily varied. In this way the drop in speed of the motor can be adjusted and the flywheel can be called upon for a heavier or lighter amount of work.

The motor shaft runs in two pedestal bearings, being connected by a flexible coupling to the flywheel. The flywheel shaft also runs in two pedestal bearings, one of which is carried on an extension of the motor bedplate. The flywheel is 18 ft. in diameter, and weighs about 20 tons. It is equipped with a band-brake operating on the lower half, by means of which the mill can be brought rapidly to rest. The mill is driven from the flywheel shaft by means of a wobbler and disconnecting coupling.

A wood paved motor house encloses the motor, switchgear, flywheel, with its bearings, and overhead travelling crane, the crane rails being continued so that the crane can also travel outside over the mill housings, for which purpose the portion of the steel partition at the crane level is arranged to swing open. Two doors completely enclose the electrical plant from the dust of the mill (as shown in Fig. 2).

The motor is controlled by a switch panel fitted with expanded metal sides and door. This panel comprises a double-pole main switch, circuit-breaker, ammeter, voltmeter, kelvin (watt-hour) meter, speed regulator, diverter for carrying the compounding, and multiple switch starter with grid resistances. The apparatus is interlocked by means of the special G.E.C. arrangement for rolling mills which ensures the motor being started with full field and the switches operated in the correct sequence. By the same device the circuit-breaker is prevented from being closed should the starter have been left in the running position.

The power for driving the motor is supplied by the West Bromwich Corporation electricity department. The electrical plant and flywheel were supplied by the General Electric Co., Witton, Birmingham, and London, to the specification of the consulting engineers, Messrs. Walter Dixon & Co., 38, Bath-street, Glasgow.

Indebtedness is expressed to Messrs. Johnson for permission to take the accompanying photographs, and to publish this description.

AN IMPROVED TYPE OF TRAMCAR.

In the recently published annual report of the general manager of the Southampton Municipal Tramways (Mr. W. T. Robson) it is stated that a car embodying many new features was built during the summer, and would serve as a useful experiment in indicating the type of vehicle most suitable for adoption when new rolling stock becomes once more obtainable. One of the greatest improvements which could be effected in the department in the future was the adoption of a modern type of motor which, by its improved design, practically did away with the constant maintenance work necessary to keep the older type of motor in successful operation. After 17 years' constant running the original small motors might be safely considered to have had their adequate life, and the conversion to the modern type would be another of the things to look forward to when normal conditions again prevail. In the new experimental tramcar, Mr. Robson appears to have put into practice the views on rolling stock expressed by him at the 1916 conference of the Tramways and Light Railways Association. The car is of the four-wheeled double-deck type, with roof cover and open canopies. The front platform near side exit is included in the design, the staircase being so arranged that passengers can make use of this exit. It is closed when required by a hinged bar. Cross seats are employed in both lower and upper saloons, and only three passengers can sit abreast; thus there are more roomy seats and a wider gangway. The canopy seat consists entirely of cane, curved to the same radius as the canopy rails, and is thoroughly comfortable. The seating capacity on the lower saloon is 21, on the upper 28, and on the canopies 10, a total of 59. The length over all is 30 ft. 6 in. and the length of platforms 5 ft. 11 in.; the wheel-base is 7 ft. 6 in.; the width over pillars (lower deck) 6 ft. 10½ in., and upper deck 7 ft. The height of sill from ground is 2 ft. 8 in., and the height inside lower saloon is 6 ft. 6 in. The total height above rails is 15 ft. 11 in., and the width of the doors is 1 ft. 11 in. The floor framing is of oak. The platform floors are supported on steel angle bars, to which are secured ash end-bars. The floor is of ⅞ in. red pine boards, with 2½ in. oak wearing slats. The body framing is of teak, oak and pitch pine, and the panels above and below the fender rail are of mahogany. The roof frame is of ash stiffened with steel. Three-ply maple veneer is used for the ceiling, with a light inner roof abode of canary whitewood ½ in. thick, covered with cotton duck. The upper deck is of ⅞ in. pitch pine boards laid on ash bearings. The small ventilating sashes above the windows open outwards. The interior finish is in mahogany framing. Ceiling joints are covered by plain rounded mouldings, and a plain hollow cornice above the windows finishes the ceiling. The seating is rattan. The pillars, longitudinal rails and end framing of the top cover are of teak; the side panels are of mahogany ½ in. thick, and the joints are also covered by moulds. The windows are mounted on lazy-tongs balancing

FERRY
FERROZOID
CONSTANTAN
CHRONIC
WRITE FOR PARTICULARS OF FOURTEEN GRADES OF
British-Made Resistance Materials
TO:—
MAKERS:
HENRY WIGGIN & CO., Ltd.
George Street, Birmingham.
TELEPHONE: 6400 CENTRAL.
GRAMS: "WIGGIN BIRMINGHAM."
AGENT:
LIONEL ROBINSON,
3, Staple Inn, London, W.C.
TELEPHONE: 6323 HOLBORN.
GRAMS: "FERRYDOM, LONDON."

Digitized by Google

REYROLLE'S
SIX SPECIAL LINES.

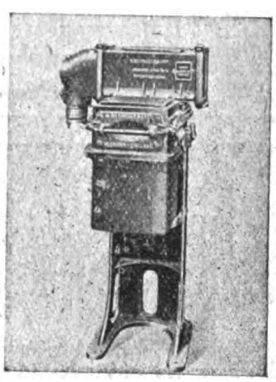
(1) 500-v. IRONCLAD **SWITCH FUSES.**

(As illustration.)

50 and 100 amps. capacities.
Deals satisfactorily with short circuits.
Fireproof Linings.
Easy and safe for re-wiring.
No costly refills required.
Ordinary fuse wire used.

(2) **MOTOR STARTERS.** Drum Type with Free Handle Circuit Breaker (interlocked), also Lever Type.

(3) **WALL PLUGS.** W.T., for outside use, as supplied to Admiralty, and Dustproof, for Works use.



(4) **H.T. ARMOURCLAD SWITCHGEAR.**

(5) **MINING SWITCHGEAR.** ⟶

(6) **PROTECTIVE DEVICES,** to isolate faulty sections on Power Supply Systems without interruption of supply through Sound Sections.

A. REYROLLE & CO., LTD.

HEBBURN-ON-TYNE.

Digitized by Google

THEIR lasting qualities, and the fact that they retain to the end their initial brilliance, make them equally suitable for Street Lighting, Factory Lighting, Train Lighting, the Hotel or the Home.

For Street Lighting

POPE

ELASTA

(British Made)

WIRE LAMPS

Strong Brilliant Economical.

Advt. of Pope's Electric Lamp Co., Ltd., Hythe Road, Willesden, N.W. 10.

EVERY INSTALLATION ENGINEER

Should join his Trade Protection Organisation,

THE ELECTRICAL CONTRACTORS' ASSOCIATION

(Incorporated)

Inquiries cordially invited by the Secretary—

L. G. TATE, 20, Bucklersbury, LONDON, E.C.

GENUINE

M & M VULCANISED FIBRE.

MOSSES & MITCHELL. 122 & 124, GOLDEN LANE. LONDON, E.C.

INSULATION BEADS

AMPLE STOCKS

BOLDER-HARRIDEN, LTD.

gear, and the ventilation sashes are similar to those in the lower saloon. Ash roof ribs strengthened with steel are employed, and are boarded outside with ⅞ in. pitch pine boards. The inside boarding consists of narrow matching of Sequoi and pitch pine. The end panels are of teak. Errol wood and pitch pine slats are used for the seats, and the backs are framed with maple veneer panels.

ELECTRIC TRUCK SERVICE IN CHICAGO.

The Commonwealth Edison Co. of Chicago recently adopted an interesting scheme for promoting the use of commercial electric trucks.

After investigating the cost of operating electric trucks, the company now offer a complete garage and maintenance service for commercial electric vehicles at specific rates per annum on long term contracts. The service would be so comprehensive as to cover all the doubtful elements of transportation expense, and enable any customer to determine in advance what it would cost him per year to operate any size fleet of electric trucks. The proposed service will cover the ordinary garaging or storage, including the cleaning and care of vehicles; it will include the supply of energy for charging the battery, and it will provide for the maintenance or upkeep of the wearing parts of the vehicle, including tyres, battery and mechanical parts. This maintenance will cover minor repairs as well as the renewal of tyres and battery when worn out, the painting of the body at specified intervals, &c. The owner of the vehicle pays the driver's wages, insurance and the cost of damage by accidents.

New trucks only will be accepted for the service. The rate for each size, equipped with standard battery, will be a flat figure per annum payable monthly. Trucks equipped with batteries of sizes larger than the standard will be charged for at proportionally higher rates. The working radius of the truck which the flat rate is intended to cover is that amount of service which can be procured from one charge of the battery daily. If the work to be done by the user should be greater than this, and such as to require additional charging during the day, or the use of extra batteries, the flat rate will be increased accordingly. Thus, the whole system, while based on a flat rate for minimum service, is really a measured-service scheme depending upon the requirements of the user. As the service will provide for renewal of battery, tyres and mechanical parts when worn out, the customers' vehicle will be practically as good as new at the end of the contract period, except for such depreciation as may have taken place in the non-wearing parts. The company's new service station, which is close to the trucking centre, just west of the main business district, will render service to 100 electric trucks, but additional space can be readily provided in the same neighbourhood. The company employ a specially qualified staff for the development and conduct of the service. Salesmen, supplemented by transportation engineering service, will be able to present to prospective customers having large horse-truck equipments facts and figures which will satisfy them as to their present expense, and will subsequently present statements which will prove the reduced expense to be effected by substituting electric trucks for these horse equipments.

LOW POWER RATES IN CALIFORNIA.

The California Railroad Commission has recently instituted an investigation into the rates and practices of the Great Western and the Sierra & San Francisco Power Companies and the Pacific Gas & Electric Co.

The electrical plant of the Pacific Electro Metals Company was organised for the purpose of operating a $500,000 plant for the reduction and refining of metals on San Francisco Bay. Complaint was made to the Commission that when the power companies were asked for rates for 9,380 H.P. two companies quoted $36 per horse-power-year and one $40 per horse-power-year. The Electro Metals Co. asserted that a rate of $15 is sufficient for that class of business. The power companies contended that the commission had no jurisdiction to hear the proceedings because the plaints were not signed by the proper Governmental authorities or by 25 prospective purchasers of electricity, as required by the Public Utilities Act. The Electro Metals Co. replied that it could not secure the signatures of the Governmental authorities in the county where it intended to locate its plant because it was unable to decide upon the location until the Commission established reasonable rates for the electricity required, and further that there were not 25 prospective consumers who would require electricity in the same quantity.

BASTIAN METERS FOR DIRECT CURRENT ONLY.

Made in ENGLAND with

BRITISH CAPITAL and BRITISH LABOUR.

THE BASTIAN METER COMPANY, LTD., BARTHOLOMEW WORKS, KENTISH TOWN, N.W.

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,052. [Vol. LXXIX. No. 24] FRIDAY, SEPTEMBER 14, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 919
Arrangements for the Week 921
The High-Tension Magneto with Special Reference to the Ignition of Aeroplane Engines. By A. P. Young. Illustrated 922
Electricity Supply at Redditch. Illustrated 925
Repetitions of E.M.F. in Armature Windings. By C. C. Hawkins. Illustrated.—*Concluded* 928
Conference of Indian Electrical Inspectors 930
The Detection of Submarines 931
THINGS WE DO NOT KNOW 932
REVIEWS 932
Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1916-17.—*Concluded* 936
CORRESPONDENCE 937
The Protection of Cables Against Electrolysis 938
Totally Enclosed Industrial Switchgear. Illustrated 939
B.T.-H. Truck-Type Ironclad Switchgear. Illustrated 939
Electro-Tanning 940
Patent Record 940
Volunteer Notices 940
COMMERCIAL AND INDUSTRIAL SECTION 943
Electricity Supply 944
Tenders Invited and Accepted 947
Financial Matters 948

NOTES.

The British Magneto.

THE importance of the magneto as an accessory to the petrol engine cannot be over-estimated. It is a device which has proved itself to be so convenient in the running of motor cars that battery ignition in this country has been practically ousted. Curiously enough, the tendency is all the other way in the United States, possibly due to the fact that if a battery is to be used for an electric starter it may as well be used for ignition also. Be this as it may, the magneto is certainly a convenient device on the car, and is almost essential for the aeroplane, owing to the fact that it is simply a mechanical adjunct requiring no attention, and is more hardy than the ignition accumulator. Although it will be admitted that the magneto is important, this industry, like many others, was allowed to pass into German hands before the war. Consequently, when the war broke out, we found ourselves in a very unenviable position in regard to this part of a very necessary equipment. It became imperative, therefore, that British manufacturers should take the matter in hand, and, with this object in view, a proper understanding of the phenomena involved is a first step. In THE ELECTRICIAN a year ago last March we published an analysis by Mr. ARMAGNAT, in which the action of the magneto was clearly set out. A further analysis has been given recently by Mr. A. P. YOUNG in a Paper read before the Aeronautical Society, and the first part of an abstract of this Paper will be found on another page.

The Present Position.

WE are glad to learn from this Paper that the magneto industry is now in a flourishing condition. The British Ignition Apparatus Association is at the moment supported by ten British magneto manufacturers, who have, during the period of war, supplied to the Government for all purposes not less than 200,000 magnetos. We believe it is recognised that the British magneto is no longer inferior to those which used to be produced in Germany; in fact, Mr. YOUNG makes the statement that recent developments have resulted in the production of new types of magnetos which will prove to be vastly superior to anything turned out by Germany in the past. This result must be regarded as exceedingly satisfactory, and only serves to show that our manufacturers, if they will but exert themselves, are capable of making articles which are in every respect as good as those obtained elsewhere, and in many cases very much better.

Problems of Interlinking.

ELSEWHERE we publish a description of the alterations which were rendered necessary to the electricity works of Redditch to enable this station to develop the power load under proper conditions. This work is of interest, not so much on account of the size of the station, which is comparatively small, but by reason of the fact that in the alterations many of the difficulties were encountered which arise in the problem of interlinking one station with another. When differences of frequency and differences of system are involved there is considerable complication in the interchange of power from one station to another, and, unfortunately, these conditions are found here and there throughout the country. Many of the older stations, more particularly those which have grown but slowly, started with single-phase current and still retain this feature. There is often a further complication of a frequency which is no longer in common use. In the distribution network a change of system is a difficult matter, more particularly if there are many power consumers. It may, therefore, become necessary to maintain an out-of-date system from the point of view of distribution, and to make extensions on mort modern lines. In the case of a generating station there is noe quite the same limitation, although the natural tendency is to retain the old plant as far as possible. From this point of view it may be questioned, in considering interlinking, which is now so much to the fore, whether in many cases it would not be better to make a clean sweep and to convert some of the older stations into sub-stations taking a bulk supply, rather than adopt the expedient of interlinking. This, of course, involves a much larger capital expenditure; but the saving that may be effected by means of large power stations giving a bulk supply, as distinct from linking up old stations and retaining inefficient plant, is very material. On that account the Government, in the national interest, might be well advised in many cases to shoulder the financial liability of such changes, or to provide capital on such generous terms that it would pay an undertaking to make the most drastic changes.

The Society of Glass Technology.

AMONG the various special associations and societies that have been formed since the outbreak of war special interest attaches to the Society of Glass Technology, which has its headquarters at Sheffield University. In view of the large number of existing scientific and technical organisations, one is rather inclined to deprecate the undue multiplication of separate societies, unless they fill an obvious need. But there seems no doubt that the Society of Optical Glass Technology

Digitized by Google

has a well-defined sphere, and a most useful purpose to fulfil. Glass manufacture, especially in its finer and more scientific aspects, is generally recognised to be a subject on which study and fuller information are badly needed. Everyone is aware of the deficiencies in regard to optical and other special glasses experienced at the outbreak of war, though fortunately a great deal of useful scientific work has since been done in this field, and the deficiency we hope and believe is being made good. In attacking this subject the co-operation of the glass manufacturer and the experts concerned with its practical use in various forms, is highly necessary. We are, therefore, glad to observe that the Society has amongst its supporters leading manufacturers, professors, experts associated with Government departments and others concerned with the optical properties of glass. The first issue of the "Transactions" of the Society is a very creditable production, containing contributions on British glass sands, the annealing of glass, glass furnaces on the Continent, and other subjects of great technical importance. Another good feature is the collection of a series of abstracts of current Papers and articles on glass technology. The society starts under promising conditions, and is fortunate in having as its secretary and editor Dr. W. E. S. TURNER, of Sheffield University, where a special experimental department of glass technology has recently been established. The President for the current year is Mr. W. F. J. WOOD, B.Sc.

Charging Stations.

WE are glad to note that the Chief Commissioner of Police has issued a circular letter to the local authorities in the Metropolitan Police area inviting suggestions on the question of providing charging stations for water, gas, electricity, petrol and coal for mechanical vehicles. This is certainly a step in the right direction. Sometimes considerable difficulty is experienced by drivers in obtaining necessary supplies, and this was particularly the case in regard to electric vehicles until the matter was taken energetically in hand by the Electric Vehicle Committee. Now it is possible in many districts to obtain a re-charge of the batteries of such vehicles easily and at a reasonable cost. Nevertheless, it would be better if charging stations were available at which all commodities could be obtained at any hour of the day and night. In a scheme of this kind there is little question that the local authority is the most suitable body to take the matter in hand, and this applies not merely to the London area, but to the provinces also. As far as electric vehicles are concerned, electricity supply is in the hands of municipalities in so many parts of the country that there should be no difficulty in arranging the desired facilities. The suggestion is likely to lead to the establishment of charging stations at more than one point in a town, instead of making it necessary for the driver to take his vehicle to the generating station, which, as likely as not, is in an inconvenient quarter, and thus we shall doubtless see an easier time before the electric vehicle.

Linking-up in London.—The Borough Councils of Battersea, Fulham and Hammersmith have agreed to submit to arbitration the question of the apportioning of the cost of the projected linking-up of the three electricity generating stations.

Ramsay Memorial Fund.—Señor Augusto Villanueva, Banco de Chile, Santiago de Chile, has accepted the position of representative and corresponding member of the Ramsay Memorial Committee for Chile, and is taking steps to promote the objects of the memorial in Chile by the formation of a local committee and in other ways. The Ramsay Memorial Fund now amounts to £21,428. 11s. 6d. Further donations may be sent to the honorary treasurers, Lord Glenconner and Prof. Collie, at University College, Gower-street, London, W.C.1.

Purchase and Use of Coal for Domestic Heating.—We have received a copy of Circular No. 4 of the Engineering Experiment Station of the University of Illinois dealing with this subject. The object of the circular is to acquaint the householder with the essential properties of the fuel he buys, to inform him as to the processes which take place in his furnace, and to suggest the means which he may employ to obtain the greatest possible amount of heat in return for the money he pays. The directions have reference particularly to boilers and air heaters, such as are used for central heating, and are more commonly adopted in America than in this country. The pamphlet is well written and clearly illustrated. It will serve to point out the sources of waste commonly found, and give the householder a clearer idea of how he should buy his coal and how he should burn it economically.

The United States Engineering Council.—The first meeting of the Engineering Council, formed in the United States to promote co-operation with the Government in connection with the war, took place on June 27. The Council is composed of five members from each of the four founder societies and four from the United Engineering Society. At the organising meeting the following officers were elected:—*President*, I. N. Hollis; *Vice-Presidents*, H. W. Buck and George F. Swain; *Secretary*, Calvert Townley; *Executive Committee*, the four officers named, L. Parke Channing and D. S. Jacobus. At their first meeting the Council discussed general procedure, and a resolution was passed expressing the unanimous desire to assist the Government and instructing the executive committee to co-operate with the Government in procuring the services of engineers. A committee consisting of H. W. Buck, A. M. Greene, Jr., and Edmund B. Kirby was appointed to consider the best means of utilising the inventive ability of members of the founders' societies.

The Colouring of Arc Lamp Globes.—The purple colouring of arc lamps globe in course of use is discussed by Mr. M. Luckiesh in the "General Electric Review" (U.S.A.). This coloration may be due to chemical changes by sunlight, or ultra-violet rays emitted by the illuminant within the globe; glass exposed to sunlight or X-rays frequently tends to become coloured due to the presence of manganese, sodium, potash and other ingredients. The glass commonly used for arc lamp globes is greenish in tint owing to the presence of a small proportion of iron oxide. Manganese is sometimes added to neutralise this tint. But it is to be noted that the absorptions due to the purple colour of manganese and the greenish tint due to iron are additive. The resulting glass is "whiter" as regards colour but less transparent, and the amount of light absorbed may amount to 10 per cent. Moreover, the deepening of the purple coloration of manganese, owing to chemical changes induced by light, gives rise to a still deeper colour and a considerably increased absorption which may ultimately be double that originally characteristic of the glass. Mr. Luckiesh is therefore inclined to suggest that manganese should not be used in globes for street lighting. This would mean a slightly greenish tint, but a considerably smaller absorption.

The British Control of Cables.—The revelations of the action of Sweden in having allowed Germany to make use of her diplomatic cable service to direct the submarine campaign will, no doubt, lead to curtailment or very much stricter supervision of cable facilities for neutrals. It is, perhaps, not generally known how completely the cables of the world are in the hands of the Allies. It is pointed out in "The Times," that this refers not only to communication between Germany and her Allies, but between all the adjacent neutral countries and the United States, South America and Asia. Most German cables landed on our own east coast; others ran to the Azores and thence to New York, to Teneriffe and thence to the German Cameroon and Pernambuco in Brazil; and to Vigo in Spain. None of these have been available to Germany since August, 1914. Similarly, telegraphic communication is cut off on Germany's eastern Russian frontier, and on the

Digitized by Google

French and Italian sides, and even messages to Switzerland must emerge through the Allied countries. Even from Greece or Turkey Germany could only get in touch with the Atlantic through British cables. In the case of the small Northern lands the way is also blocked, for the cables from Holland, Denmark, Sweden and Norway (with one exception, that goes to France) all come to England. Legally we have an absolutely free hand in the checking or control of cable messages, and no doubt this right will be much more firmly applied in the future.

The Absorption of X-Rays.—The absorption of X-rays is the subject of a communication by Dr. T. E. Auren, in the "Philosophical Magazine" for June. The co-efficient for the absorption is found by the formula :—$I=I_0e^{-\mu d}$, where I_0 is the intensity of the incident rays, I that of the transmitted rays, and d the thickness of the sheet of a definite material. There are various experimental difficulties which render the determinations up to the present date rather uncertain. The ratio of the absorption coefficients of two materials is now known to be constant in the case of rays of widely different wave-lengths. Nowadays the ratio is commonly expressed by the mass absorption coefficient μ/σ, which is obtained by dividing the absorption coefficients by the density σ of the absorbing material. It has also been suggested that the ratio of the absorption coefficients of two materials might be expressed by the fourth power of the atomic numbers of the respective elements. The author calculates out ratios for various metals, the agreement being on the whole good, though it appears that in certain cases the relation between the coefficient and the wave-length is not a constant one. In the latter part of the paper Dr. Auren obtains the ratio of the atomic and molecular absorption coefficients (denoted respectively by *X.a.k.* and *X.m.k.*) for a variety of materials. It is assumed that the absorption of a solution is additively determined by the absorption of the constituent atoms. The values of *X.a.k.* are plotted against the atomic number, and there is evidence that a simple relation between these quantities exists. Nevertheless it now appears that the relation of Bragg and Pierce, namely, that the atomic absorption coefficient is proportional to the fourth power of the atomic number, cannot hold.

The Sound of Explosions.—It has long been known that areas of silence occur in the case of big explosions or other loud noises capable of being heard at a considerable distance. This effect has been recorded in connection with volcanic eruptions in Japan, and the present war has afforded a number of opportunities of testing theories on the subject. The transmission of sound following the great explosion of a munition factory in London on Jan. 19th of this year, has been investigated by Dr. C. Davison, who gives a summary of his conclusions in the "Quarterly Review." Dr. Davison maps out a quite distinct area in and around London, where the sound was very loud, an outer band of silence, and then a second more distant area where the sound was also quite audible, though less violent than in the inner area. It is curious to observe, however, that there were one or two spots in the area of silence where the sound was apparently heard. Another curious circumstance is that while observers in and around London were only conscious of a single loud detonation, in the outer area observers refer to the sound as consisting of two, three and even four distinct reports. The problem of the area of silence has been much discussed, and theories of the bending of the sound wave have been evolved, based on the course of the upper wind currents. The wind also appears to be a determining factor in the irregular nature of the zones of audibility. A number of letters have appeared in "The Times" in support of the contention that intervening hills and mounds have also an important effect, the sound apparently travelling with special ease along certain strata in the earth. It appears to be a common experience that distant sounds are readily heard below the level of the earth, and evidence of this is afforded by the experience of a grave-digger who declares that the guns of Flanders are often audible to him when working a few feet below the earth, when at the surface they cannot be distinguished. Another circumstance of interest recorded in connection with the big explosion of January last is the fact of inaudible air-waves, which are perceived by various phenomena such as rattling of windows, disturbance of foliage, &c., being noted independently of the sound. In the distant zone of audibility these waves commonly arrived an appreciable time before the sound, whereas in the region near to the explosion they occurred simultaneously with the sound, or even followed it.

OBITUARY.

PROF. ADOLF VON BAEYER.—Prof. Adolf von Baeyer has just died in Munich in his 82nd year.

He helped in a marked degree to assure the position which Germany held before the war in chemical industry. As a result of establishing the constitution of indigo he was able in 1870 to show its synthesis, and later he devised a second synthesis starting from toluene, which had some success. His patents were acquired in 1880 by the Badische Anilin und Soda Fabrik and the Hoechst Farbwerke. He was a pupil of Bunsen at Heidelberg, and he spent some years at Berlin as a privat dozent. In 1872 he was called to Strassburg as Professor of Chemistry and director of the new chemical laboratories, in which many famous chemists studied, including Emil Fischer, C. Graebe, C. Liebermann and Victor Meyer. In 1875 he succeeded to Liebig's chair in Munich, where he built the new Chemisches Institut, in which organic chemists of all nationalities have received their training.

DEATHS ON ACTIVE SERVICE.—The following deaths are reported :—

Sec.-Lieut. O. L. Strong (Somerset L. I.), aged 22, who died on Aug. 6 of shell wounds received on the previous day, was a student in chemistry at the Imperial College of Science and Technology until the outbreak of war.

Rfmn. John Dynes (17th R. Irish Rifles), formerly a motorman on the Belfast tramways, reported missing on July 1, 1916, is now reported as killed on that date.

Pte. J. Kinsey (K.O. Lancaster Regt.), formerly employed in the Blackburn electricity works, has died of wounds.

Signaller L. Foster (Warwickshire Regt.), formerly employed in the Bolton tramway offices, has been killed in action.

Gunner J. R. Morris (R.F.A.), a Burnley tramway employee, has been killed in action.

The death in action of Pte. J. Gillibrand (Loyal North Lancasters), formerly employed by the United Electric Car Co., is reported.

PERSONAL.

Sir Oswyn A. R. Murray, K.C.B., has been appointed Permanent Secretary of the Admiralty, Mr. Chas. Walker, C.B., succeeding him as Assistant Secretary.

WAR HONOURS.—The following honours have been conferred :—

Lieut.-Col. G. G. Ewer (Essex Regt.), sales manager of Stepney (London) Borough Council's electricity department, has been awarded the D.S.O. He is now serving with the Egyptian Expeditionary Force.

Corp. Francis Hirst (R.F.A.), formerly an electrician in the Blackpool Corporation tramways department, has been awarded the D.C.M.

WAR CASUALTIES.—The following casualties are reported :—

Lieut. Fred. Harris, of Liegh, Lancs, formerly an electrical engineer, has had the misfortune to lose his left arm and right leg. He joined the Army nearly three years ago and has recently been serving with the Tanks.

Sgt. F. Hibbard (R.F.A.), formerly in the India Rubber Co.'s general offices, was wounded on Aug. 17.

Pte. D. Clark (Loyal North Lancasters), formerly in the Darwen tramway offices, is suffering from shrapnel wounds.

ARRANGEMENTS FOR THE WEEK.

MUNICIPAL TRAMWAYS ASSOCIATION.

Thursday, Sept. 20th.

10.45 a.m. At Savoy Hydro, North Shore, Blackpool. Presidential Address by Mr. H. Mozley. Paper to be read on "Notes on Tramway Finance," by Messrs. J. Barnard, G. W. Holford and P. Priestly. Discussion on "Rule of Footpath," to be introduced by Mr. J. Dalrymple.

2.15 p.m. Paper to be read on "Differentiation in Fares for Workmen and other Passengers on Tramways," by Mr. W Murray. Discussion on "Development of Tramways," to be introduced by Mr. A. Ellis.

Friday, Sept. 21st.

11 a.m. Annual General Meeting.

Digitized by Google

THE HIGH-TENSION MAGNETO WITH SPECIAL REFERENCE TO THE IGNITION OF AEROPLANE ENGINES.*

BY A. P. YOUNG.

In 1915 the author delivered to one of the largest engineering societies in the Midlands a lecture† on "The High-tension Magneto." The present Paper is a continuation of the earlier one, but includes special reference to the high-tension aeroplane type of magneto.

The degree of success achieved in the development of the combustion motor has at all stages been primarily dependent upon the efficiency of the ignition system used. It is fundamentally true to say that the most perfect engine mechanism is of little use if the ignition system be faulty.

During the last two decades we have witnessed the birth and development of high-tension ignition in the form of the magneto. The efficiency and flexibility of this system, enabling one magneto to cope with almost any number of cylinders, is primarily responsible for the enormous developments in the application of the petrol motor

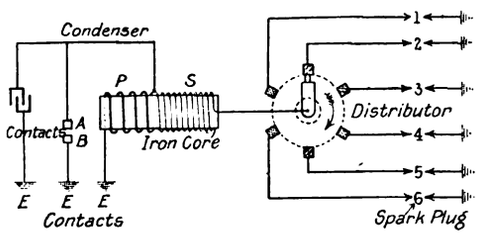


FIG. 1.

NOTE.—For convenience, a six-cylinder distributor is illustrated. In general, the number of distributor segments is equal to the number of cylinders.

to industrial and war purposes. Without the high-tension magneto the aeroplane would never have reached its present high state of development, and it is reasonable to assume that the whole course of the present disastrous war would have been different and much less in our favour.

Prior to the outbreak of war the number of high-tension magnetos being produced in this country formed a negligible proportion of the total number being used for a variety of purposes. Through laxity on our part this most vital "key" industry was allowed to develop in Germany, but the war has taught us a lesson in this respect.

The British Ignition Apparatus Association is at the moment supported by 10 British magneto manufacturers, who have during the period of the war supplied to the Government for war purposes, and chiefly for aeroplanes, no less than 200,000 magnetos. Furthermore, the British magneto as at present constructed is the equal of the pre-war Bosch magneto emanating from Stuttgart, and I can further state, from first-hand knowledge, that certain developments now taking place will result in the British manufacturers producing new types of magnetos that will prove to be vastly superior to anything turned out by Germany in the past.

All electrical systems of ignition are direct descendants of Faraday's great discovery of electromagnetic induction made in 1831, when for the first time in the world's history he succeeded in producing a spark by electromagnetic means.

The first system of electric ignition ever used was devised by Lenoir‡ in 1860. He utilised the high-tension spark of a Ruhmkorff coil for ignition purposes, employing a high-tension distributor for connecting the secondary winding first to one plug and then to the other. The modern battery system of ignition now used most extensively in America is strikingly similar to the old Lenoir system, even to the detail of introducing an extremely small air-gap between the rotating metal brush and the distributor segment, a method of distribution that is now being followed on magnetos. Lenoir was also the inventor of the spark plug, which had all the features of the modern spark plug

Marcus appears to have been the first man to construct a magneto for ignition purposes. His was a low-tension machine, having the now familiar form of H armature, the current induced in the winding being broken at predetermined times in the cylinder by a system of cams and levers.

In 1898 Simms and Bosch developed a low-tension magneto, using a fixed H armature and rotating segments for producing the necessary flux changes in the armature core. Subsequently, by the addition of a secondary winding on the same armature core, a high-tension magneto was evolved. Later on I shall describe in detail a magneto of this type which is being built in large quantities for aeroplane work.

The Bosch Company, of Stuttgart, Germany, must receive the credit of having thoroughly established the fact that a high-tension magneto can be manufactured on a commercial basis, to give reliable and efficient ignition in practice. Although this important industry was allowed to develop in Germany, the modern high-tension magneto was first conceived in France by the Frenchman M. Boudeville, who unfortunately omitted to include a condenser in his scheme for eliminating sparking at the contact points.

A condenser is a vital part of every magneto. It is surprising that Boudeville should have overlooked this feature, because the idea is of French origin, the Frenchman Fizeau being the first to suggest, in 1853, connecting a condenser in parallel with the contacts on a Ruhmkorff coil, to prevent excessive sparking.

FUNDAMENTAL CONSIDERATIONS.

Any form of high-tension magneto consists of four essential parts:

1. A magnet system.
2. An iron core wound with primary and secondary.
3. A contact breaker to interrupt the primary circuit at predetermined intervals.
4. A high-tension distributor.

The arrangement of connections generally adopted is clearly illustrated in Fig. 1. The earthed primary contact (B) is actuated by some form of cam, so that the primary circuit is continually being closed and opened.

The iron core which carries the armature windings may either revolve or be fixed. In the latter case the rotor comprises certain iron masses so disposed that every 90 deg. or 180 deg. (depending upon whether the magneto is a two-spark or a four-spark), the flux flowing from the N pole of the magnet to the S pole, through the armature core, is suddenly reversed.

When the armature rotates the flux reversal occurs, except when specially-shaped poles are fitted, every 180 deg., and the magneto gives two sparks per revolution.

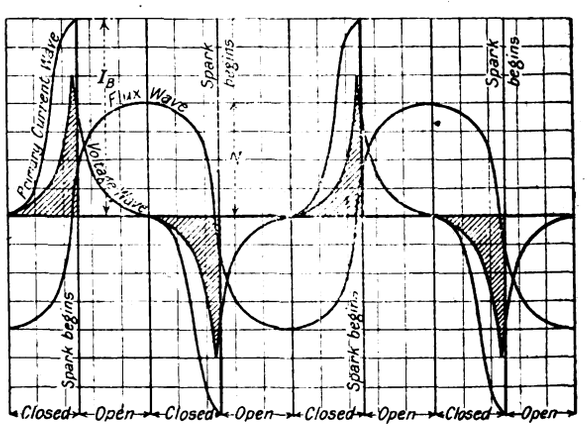


FIG. 2.—TYPICAL FLUX, VOLTAGE AND PRIMARY CURRENT WAVES FOR HIGH-TENSION MAGNETO.

Magnetos provided with stationary armatures are said to be of the inductor type. To prevent confusion we shall adopt the following nomenclature:—

1. When the rotor comprises iron segments built in the form of a sleeve, which revolves around the stationary armature, we shall call the machine a "sleeve inductor" type magneto.
2. When the rotor comprises iron masses operating in conjunction with an external armature core, we shall call the machine a "polar inductor" type magneto.
3. When the armature rotates, as is more usually the case, we shall call the machine a "rotating armature" type magneto.

We give below a description of the cycle of operations. Fig. 2 shows a typical flux wave, and the resultant open circuit voltage and primary current waves.

(a) The rapid reversals of flux in the armature core induce in both primary and secondary an alternating E.M.F., the maximum E.M.F.

* Abstract of a Paper read before the Aeronautical Society.

† Lecture delivered to the Coventry Engineering Society on January 29th, 1915, and published in the "Automobile Engineer" for March, 1915.

‡ This system is described by the Author in an Appendix to the original Paper.

Digitized by Google

being reached for any given speed, when the actual flux in the armature core is substantially zero.

(*b*) The cam operating the contact breaker lever is so designed that the primary circuit is closed during the period when the induced voltage is growing from zero to its maximum value, and for some little while afterwards, but not until the voltage has become zero again.

(*c*) During the period of closure of the primary circuit the induced current will steadily increase in value. Then at a certain instant the contacts are suddenly separated by the cam. The condenser in parallel with them ensures that there is no sparking at this instant, so consequently the rupture of the primary current is remarkably sudden.

(*d*) The sudden rupture of the primary current causes an instantaneous collapse of the magnetic field associated with it, and as this field is linked with the secondary turns a high voltage is induced in the secondary winding, providing a spark between the electrodes of

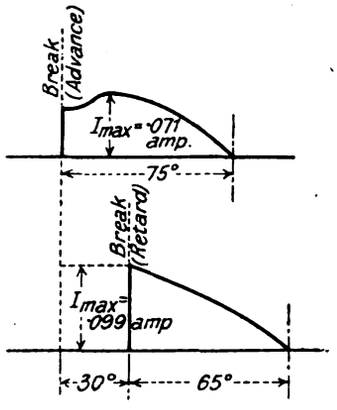


FIG. 3.
Speed = 1,200 revs. per min.

the spark plug. This spark is maintained to some extent by the voltage induced in the secondary by the continual flux change in the armature core produced by rotation during the period that the contacts remain open. (*See* Fig. 3.)

(*e*) After a certain short interval of time the cam allows the contacts to close again, and the cycle of operations (*b*) (*c*) (*d*) is repeated.

ANALYSIS OF THE WORKING OF A MAGNETO.

The factors which govern the operation characteristics of any H.T. magneto are as follows :—

Maximum value of flux through armature core = N.

Angle during which contacts remain closed (measured on revolving shaft) = θ_1.

Angle during which contacts remain open = θ_2.

$$\text{Ratio } \frac{\theta_1}{\theta_2} = k$$

No. of primary turns = S_1.
No. of secondary turns = S_2.

$$\text{Ratio} = \frac{S_2}{S_1} = k_1$$

Value of primary current at "break" = I_B.
Self-induction of primary at "break" = L.

Other things being equal, the voltage induced in the secondary winding at "break," and the amount of energy liberated in the H.T. spark, are dependent on I_B. The best results are therefore obtained when, for any speed over a very wide range, I_B corresponds to the maximum point on the primary current wave. Unfortunately, this result cannot be achieved in practice, because if I_B is a maximum at low speeds, the current broken at high speeds (for the same timing) will be less than the maximum, and *vice versa*.

Theoretically, the whole of the energy stored up in the primary winding during the periods when the contacts are closed and the primary current is creating a magnetic field should reappear in the secondary spark at "break" if there were no losses. This energy, which is stored in the primary at a low potential, is, as it were, suddenly thrust into the secondary at "break," where it reappears at a high potential. Actually, certain losses occur during the transfer, and only a portion of the energy stored magnetically (amounting to $\frac{1}{2}LI_B^2$ Joules) appears in the H.T spark. Generally speaking, about 80 per cent of this energy is available for ignition in a well-designed magneto.

The problem, then, is to determine the value of I_B. If we know the formation of either the flux or voltage wave this can be easily done. The flux wave can be deduced experimentally by a "point to point" method. A fine search coil is wound on the armature windings (or the primary may be used if the turns are known) and connected to a ballistic galvanometer. By moving the rotor through a large number of consecutive and equal angles (say 15°), noting the deflection of the galvanometer corresponding to each movement, the corresponding flux changes can be calculated and from these figures the flux wave deduced.

Having a flux wave, the E.M.F. is given by :—

$$e = \frac{-S_1}{10^8}\frac{dN}{dt} \text{ volts.} \quad \ldots\ldots\ldots (1)$$

One may also determine the E.M.F. wave on open circuit, experimentally, by using an oscillograph, and calculate the flux wave by again using the above formula in the form :—

$$N = \frac{-10^8}{S_1}\int e.dt. \quad \ldots\ldots\ldots (2)$$

The value of I_B can be determined by the graphical method.

In general, we can represent the growth of the primary current during the period when the contacts remain closed by the following fundamental formula :—

$$e = ri + L.\frac{di}{dt}$$

Where,

e = Instantaneous voltage induced in primary circuit as determined from the curve, such as that shown in Fig. 2.
i = Instantaneous value of the current in the primary. Amps.
r = Resistance of primary. Ohms.
L = Self-induction of primary at the instant under consideration. Henries.

By integrating this equation we can readily derive the approximate relation :—

$$i_{T_2} = \frac{2X + i_{T_1}(2L - rT)}{r.T + 2L} \quad \ldots\ldots\ldots (3)$$

Where

X = Area of voltage wave included between T_1 and T_2.

By using this formula and applying a point-to-point method it is a fairly easy matter to determine the primary current curve (and therefore I_B) for any type of magneto at any speed, provided that the constants of the design are known.

The factor X is proportional to the flux change in the armature core, due to rotation, that occurs in the short period of time considered. Therefore the current I_B, for any given design, is within limits proportional to the maximum armature core flux N. As the

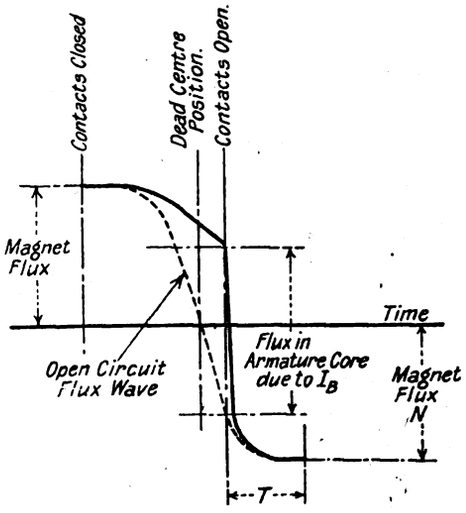


FIG. 4.—CURVES SHOWING FLUX CHANGE IN ARMATURE CORE PRIOR TO, AND IMMEDIATELY AFTER "BREAK."

NOTE.—Generally, the contacts should remain open for a period of time not less than T.

energy in the high-tension spark is proportional to $(I_B)^2$, we must conclude that the energy liberated at each discharge (that is, the intensity of the spark, but not necessarily the power of the spark to produce ignition) is proportional to the *square of the maximum value of the flux produced in the armature core on open circuit by the system of magnets used.*

THE PHENOMENA THAT OCCUR IN THE SECONDARY AT "BREAK."

(*a*) *Induced Secondary Voltage.*—Fig. 4 shows the way in which the flux flowing in the armature core and linked with the windings changes at the instant of "break." Actually, the flux reverses

Digitized by Google

its direction, because so soon as the magnetic field associated with the current I_B disappears, the magnet flux is reinstated. The effect on the secondary is equivalent to the sudden destruction of the flux associated with the current I_B.

Prior to "break" a certain amount of energy is stored in the primary winding. At the instant when the contacts separate this energy can be transferred magnetically to the secondary winding to reappear as a high-tension discharge at much higher potential.

The rate at which the secondary voltage rises, and the value of the maximum reached, are dependent on the primary current broken (I_B); on the self-induction of the primary at "break"; on the ratio of turns k_1; and on the characteristics of the magnetic circuit. It is necessary that the magnetic field created by the primary current shall instantly collapse at "break." Obviously, the rate of disappearance depends upon the characteristics of the magnetic circuit through which this magnetic field is passing. A magnetic circuit which is totally laminated will ensure a more rapid dying away of the magnetic field than will occur if there are in the magnetic circuit any solid masses in which eddy currents may be set up during the period of change.

The character of the secondary voltage wave during the period of the high-tension discharge is of considerable importance, because the maximum value reached would seem to have some influence on the power of the spark to produce ignition. Furthermore, the shape of the wave controls, to some extent, the rate at which the energy liberated in the high-tension spark is dissipated, and I hold the view that the rate of energy discharge is of more importance than the total amount of energy liberated, although the latter factor must be taken into consideration.

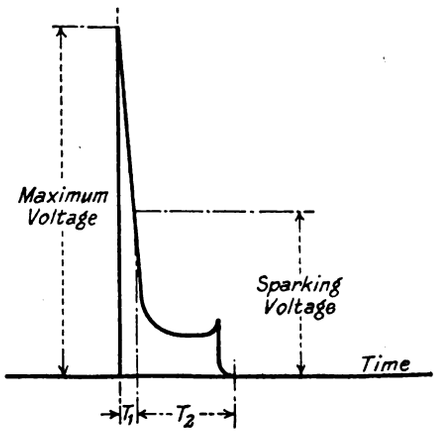


FIG. 5.

It is difficult to investigate this point quantitatively, but experiments made on magnetos, using a special valve known as a Kenotron,* indicate that the voltage rise in the primary winding at the instant of "break" is much greater than one would anticipate. Presumably a correspondingly abnormal rise of voltage occurs in the secondary at "break"—this voltage, of course, only being maintained for an infinitesimal period of time—and the curve shown in Fig. 5 represents the way in which I imagine the secondary voltage varies during the period of the high-tension spark.

I assume the voltage suddenly rises to a maximum and then suddenly falls again, the rise and fall occupying a time T_1, during which period there is no actual discharge between the electrodes, but the gases in the vicinity are being ionised preparatory to a discharge which occurs at the point "A" and is maintained during the subsequent period T_2, at the end of which the voltage has dropped away to zero. The voltage corresponding to the maximum point on the curve I will call the "maximum voltage," whereas the voltage at the beginning of the discharge period T_2 I shall call the "sparking voltage." As soon as the spark is initiated at the point "A" the discharge is maintained to some extent by the voltage induced in the secondary winding in consequence of rotation, and this voltage is virtually superimposed upon the voltage induced as a result of the collapsing of the magnetic field stored in the primary prior to break.

(*b*) *The Process of Ignition.*—The present state of our knowledge † concerning the process of ignition by means of a high-tension spark is by no means complete, but I suspect that the maximum value of the secondary voltage is a controlling factor, and it is even possible that the ionisation occurring as a result of the sudden application of an enormous voltage during the extremely small interval of time T_1 may in itself be sufficient to initiate the explosion. Ionisation in itself will produce an explosion even though no spark occurs, and superiority of the polar inductor type of magneto over the rotating armature type may be due to the fact that the secondary voltage wave is steeper and reaches a higher maximum during the interval T_1, in consequence of the armature circuit being more thoroughly laminated.

The process of ignition by high-tension spark is a subject worthy of Government research. Experiments might even be conducted with magnetos of both the polar inductor and rotating armature types, with a view to ascertaining to what extent the process of ignition is dependent upon the shape of the secondary voltage wave and whether, as suggested above, the ionisation that must occur during the initial period T_1 is a predominant factor.

(*c*) *The "Spark-Gap" type of Distributor and Brush.*—When discussing this question it is not out of place to consider what is termed the "spark-gap" form of distributor. In the ordinary type of distributor in which a carbon brush is used the carbon dust generated is liable to be ground into the brush track of the distributor, thus producing a path of low resistance between the segments, this disease being known as "tracking." This is liable to cause misfiring, because the spark, rather than discharge between the electrodes of the spark plug, will leap along the surface of the brush track.

Experiments have shown that even with a distributor that is badly tracked misfiring can be entirely eliminated if, instead of the ordinary carbon brush, a metal brush be used, this being so arranged that there is a very small air gap (about 0·01 in.) between the face of the rotating metal brush and the distributor segment. The superiority of this arrangement would seem to be due to the fact that the introduction of a small air gap in the high-tension circuit, completely insulates the secondary during the small interval of time T_1, and thus allows the voltage to rise to a very much higher maximum value than would be the case if there were any leakage paths of low resistance.

This is a further confirmation of the view that the value of the maximum value of the secondary voltage at "break" is of vital importance. The spark-gap form of distributor has been tried with considerable success on aeroplane magnetos in this country and in France, and it is used generally on all the battery ignition systems designed for automobile work in use in America.

MAGNETS—IMPORTANCE OF FLUX.

The function of the magnets is to produce and maintain, in spite of the very severe conditions under which a magneto has to operate—including severe vibration and cyclic changes in temperature—a practically constant flux in the armature core. As the energy liberated in the high-tension spark is substantially proportional to the square of this flux, the necessity for magnets of correct design and good quality is apparent.

In comparing permanent magnets of different quality, it is usual to determine the remanence (B_R) and the coercive force (C_F). These factors apply to a closed ring of the steel which is capable of being completely and uniformly magnetised. The remanence is the flux density in the steel, after the magnetising force Hmax (usually 400) has been removed, and the coercive force is the demagneti ing force that has to be subsequently applied to reduce this flux density to zero. When testing a magneto magnet the ideal "ring" condition can be approximated by bridging the poles with a soft iron keeper and suitably winding the magnet. A fundamental test of this kind is, however, attended with considerable difficulties.

It is the practice of the B. T.-H. Co., and, I believe, of most other magneto manufacturers in this country, to test every magnet by means of certain special apparatus before it is fitted to a magneto, to determine both of these factors. So far as we are conce ned, we accept only those magnets which conform with the following requirements:—

1. The product of remanence and coercive force in C.G.S. units must not be less than 580,000.
2. The actual coercive force must not be less than 55.

Experiment has shown that the active armature core flux in a magneto of given design is greatly dependent on the product of remanence and coercive force, or upon what I shall term the "magnet strength," using this expression to denote he factor $(B_R \times C_F)/10^4$. The spark energy output, being proportional to the square of the armature core flux, must in consequence be dependent on the magnet strength to a much greater degree.

The product remanence and coercive force is therefore a very important factor, and, generally speaking, it is sufficient when testing magneto magnets to measure this product only, because as a general rule a magnet which shows a product of not less than 580,000 will have a coercive force not less than 55.

From a purely mechanical standpoint, it is necessary that the pole faces, and also the edges of a magneto magnet, should be finally ground after hardening to a fairly fine degree of accuracy. It is of great importance that the ground pole faces be parallel to each other and exactly at right angles to the ground edges.

(To be continued.)

* For a detailed description of the theory and working of the Kenotron, see article in "General Electric Review" for March, 1915.

† An excellent article on "Spark Ignition," by J. D. Morgan, A.M.I.C.E., A.M.I.E.E., appeared in "Engineering" for Nov. 3, 1916. See also numerous papers by Dr. W. M. Thornton in "Proceedings," Roy. Soc. and "Phil. Mag."

Digitized by Google

ELECTRICITY SUPPLY AT REDDITCH.

Redditch is, perhaps, best known as the centre of the English needle and fish hook trade, but the establishment in recent years of large works such as those of the Birmingham Small Arms Co., the Enfield Cycle Co., and others, all now engaged almost entirely on work in connection with munitions of war, has made it an important industrial centre.

The electricity supply undertaking, which is in the hands of the local authority, has naturally felt the effect of these changes, and in a booklet which has just been issued by the Council particulars are given for the benefit of consumers and other manufacturers in the district, of the recent changes which the undertaking has undergone.

The original provisional order was granted to the Urban District Council in 1897, and a supply was first given in 1899.

As originally laid out by Mr. M. A. J. McMullen, the generating plant consisted of three Premier gas engines driving by belts on to three Johnson Phillips, single-phase 2,100-volt 66-cycle alternators, two of 100 kw. and one 35 kw. capacity, with a Dowson producer gas plant. The high-tension mains consisted of concentric paper-insulated lead-sheathed and armoured cables, the generating pressure of 2,100 volts being transformed down in a large number of public and private sub-stations to 210 volts.

At that time and for several years afterwards, the supply was used almost entirely for lighting purposes, the price for current being 5½d. per unit, but by March, 1911, the demand for energy for power purposes amounted to 603,000 units per annum, as against 172,600 units for private lighting, the motors then connected to the circuit aggregating 729 H.P.

Meantime extensions had taken place, the original gas plant being supplemented by three Willans steam sets supplied from three Babcock & Willcox boilers.

In 1913 Mr. R. N. Mayne, who had recently been appointed electrical engineer and manager, reported that radical alterations and improvements were required; and it was accordingly decided to call in expert advice.

Early in 1914, therefore, Messrs. Handcock & Dykes, of Westminster, were instructed to look carefully into the whole position and report thereon.

At that time the plant consisted of one 300 kw. single-phase Willans-Parsons steam turbine, and three Willans Central valve engines, ranging from 150 kw. down to 35 kw., coupled to the alternators originally driven by the gas engines. which latter had for various reasons been dispensed with.

Messrs. Handcock & Dykes reported that the power load had outgrown the capacity of the station, and that the plant and also the system of supply was not up to modern requirements. They recommended a drastic overhaul and extension of the station and mains, including the substitution of three-phase 50 cycles for the old single-phase 66 cycles supply, the provision of modern turbo-generating plant, and additional boiler power, the laying down of main three-phase cables, and the building of proper sub-stations in place of the existing small sub-stations below the pavements.

Whilst the report was under consideration the war broke out. It was immediately evident that large demands would be made on the undertaking for power for munitions purposes, and agreements were entered into with the Birmingham Small Arms Co. (Ltd.) and others for that purpose.

In due course a Local Government Board inquiry was held, when the recommendations of the consulting engineers were endorsed by the Board, and the Treasury, having regard to the requirements of the Ministry of Munitions, gave special permission for the necessary loans to be raised.

Specifications for the necessary works were accordingly prepared by the consulting engineers and contracts placed, it being hoped that it might be possible to get the new plant running early in 1916.

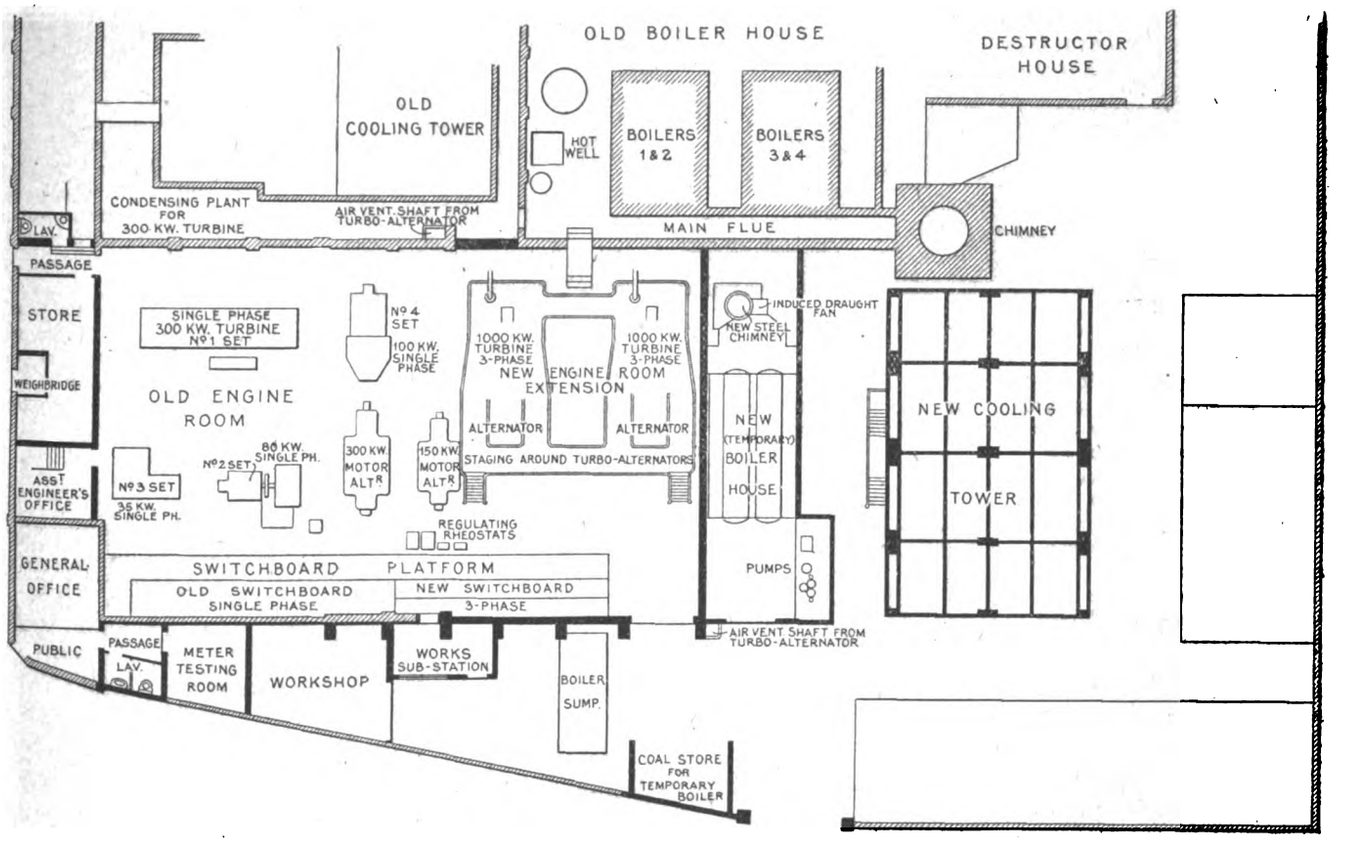


FIG. 1.—PLAN OF GENERATING STATION, SHOWING GENERAL ARRANGEMENT OF PLANT. (Shaded portions show new extensions)

Owing, however, to the pressure of Admiralty work on the chief contractors, Messrs. C. A. Parsons & Co., the new sets were not started up until September last, and the alterations and extensions being now complete we are able to give the following details of the work :—

The block plan (Fig. 1) of the works shows the addition to the engine house and the new cooling tower. Owing to the existing main flue coming close up to the old boiler house wall, now the wall between the boiler house and the extension of the engine room, the engineers decided, instead of excavating a basement for the condensing plant to put it on the ground level, and raise the turbines on concrete blocks with iron chequer plate gallery round, somewhat similar to the platform of a big vertical engine.

There is a clear passageway underneath the platform and between the concrete piers through to the boiler house, and the arrangement provides very convenient access to all the condenser auxiliaries.

The two turbo-alternators together with all accessories were supplied by Messrs. Parsons & Co. Each set is capable of giving continuously 1,000 kw. (1,300 k.v.a. on 0·75 power factor) at 3,800 volts (2,200 phase wire to neutral) and 1,500 kw. for half an hour,

Digitized by Google

with a steam pressure of 150 lb. at the stop valve, and 60°F. superheat. Each set has its own direct-coupled exciter working at 90 volts.

The ventilation of the sets is by means of motor-driven fans, a Heenan & Froude wet air filter being provided for cleaning and cooling the air, which, after passing through the machines, is carried underground through ducts to the outside of the engine room.

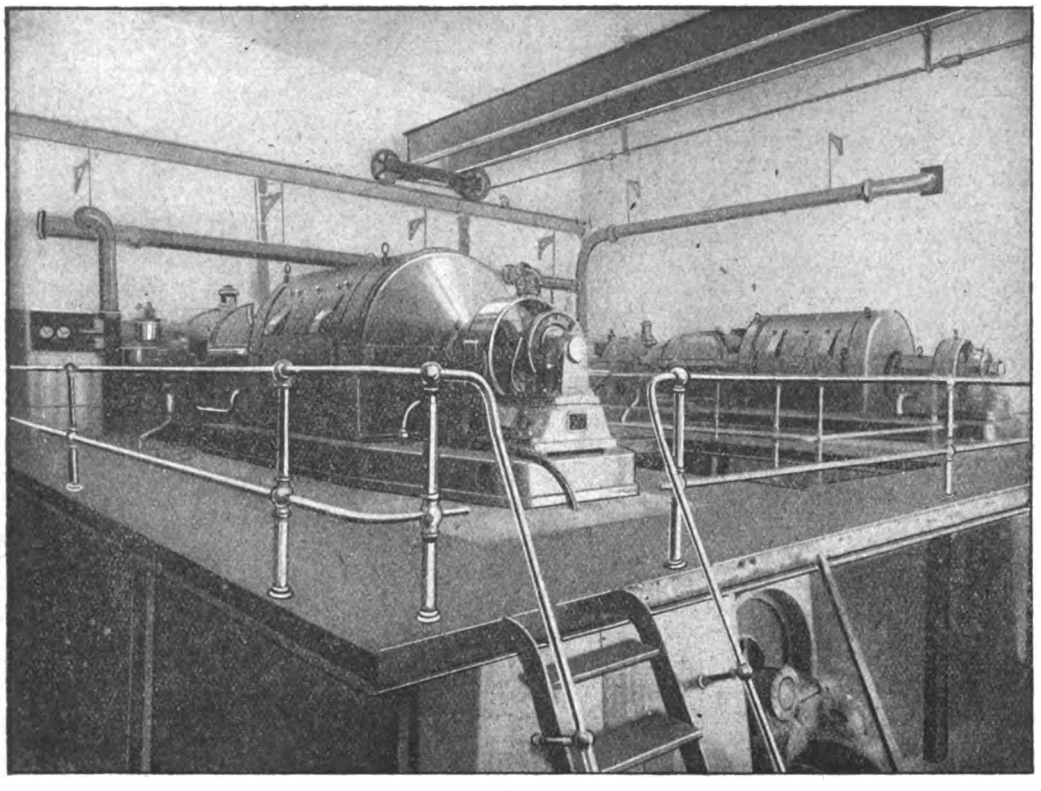


FIG. 2.—VIEW OF TURBO-ALTERNATORS.

Each turbine has its own surface condenser motor-driven centrifugal circulating pump, and throw air pump, with force pump on one end for lifting the condensed water into the hot well. A standard Lee recorder and tank is provided capable of dealing with 50,000 lb. of water per hour, so arranged that the discharge from either or both air pumps can be measured.

The guaranteed steam consumption per kilowatt-hour with 150 lb. steam, 60°F. superheat, 30° barometer, 55°F. air temperature, and 75 per cent. humidity and unity power factor were :—

Load.	Steam consumption in lb., excluding auxiliaries.	Inc. current used by all motor-driven auxiliaries.	Vacuum in inches of mercury.
Full	15·4	16·1	28·0
1¼	15·7	16·8	27·7
¾	16·0	16·9	28·2
½	17·2	18·5	28·4
¼	20·8	23·3	28·6

As the original cooling tower, in addition to being too small and not in very good repair, blocked the way for extension of the boiler house, a new cooler was ordered from the Film Cooling Towers Co. (Ltd.). This tower, of the natural draught chimney type, fitted with White's surface tension cooling laths, is capable of cooling 174,000 gallons of condensing water per hour from 95°F. to 80°F. when the temperature of the surrounding air is 55°F. (dry bulb) and the humidity 75. It stands in a reinforced concrete tank; the gross weight of the timber work is approximately 60 tons.

It being impossible to move the old cooling tower until the new one was at work the new Babcock & Willcox boiler feed-heater and pump, were put into a temporary boiler house at the end of the new engine room.

This boiler, which is capable of evaporating normally 13,000 lb. of water per hour has a separate steel chimney shaft and electrically-driven induced draught fan and will eventually be transferred into the extended boiler house which will occupy the place of the old cooling tower and the condensing plant of the 300 kw. turbo-alternator.

Although all future extensions will be by means of three-phase 50-cycles current it was not practicable to change over the whole system at once and the Electric Construction Co. have provided two reversible synchronous motor transformers of 150 kw. and 300 kw. capacity respectively, for transforming from three phase 50 periods to single phase 70 periods and vice versa.

Having regard to the lower steam consumption of the new sets the whole load of the station is as far as possible taken on them, sufficient power being transformed by the motor transformers to supply the remaining single-phase feeders.

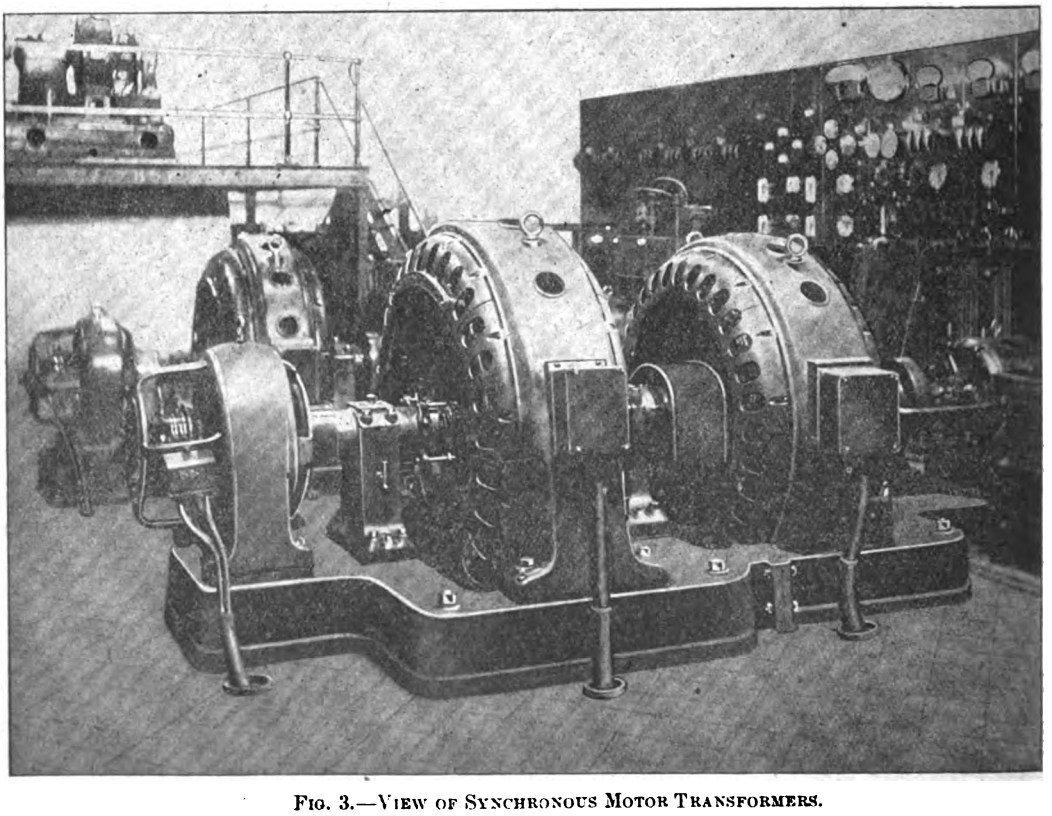


FIG. 3.—VIEW OF SYNCHRONOUS MOTOR TRANSFORMERS.

At times of full load the old single-phase sets are run as well as the new three-phase ones and the two systems are "linked up" by means of the motor transformers.

Digitized by Google

It will be noted that, although both are under one roof, there are really two distinct systems—three phase 50 cycles and single phase 70 cycles—and all the problems of "linking up" had to be provided for.

For this reason one of the machines of the motor transformer is arranged so that the stator can be rotated relatively to the other machine in order that the two sets can be paralleled on both the single and three-phase side, the two systems being "linked" together through the motor alternators.

To facilitate the paralleling of the motor-alternators also, there is a special change-over switch, by means of which the polarity of either set can be reversed.

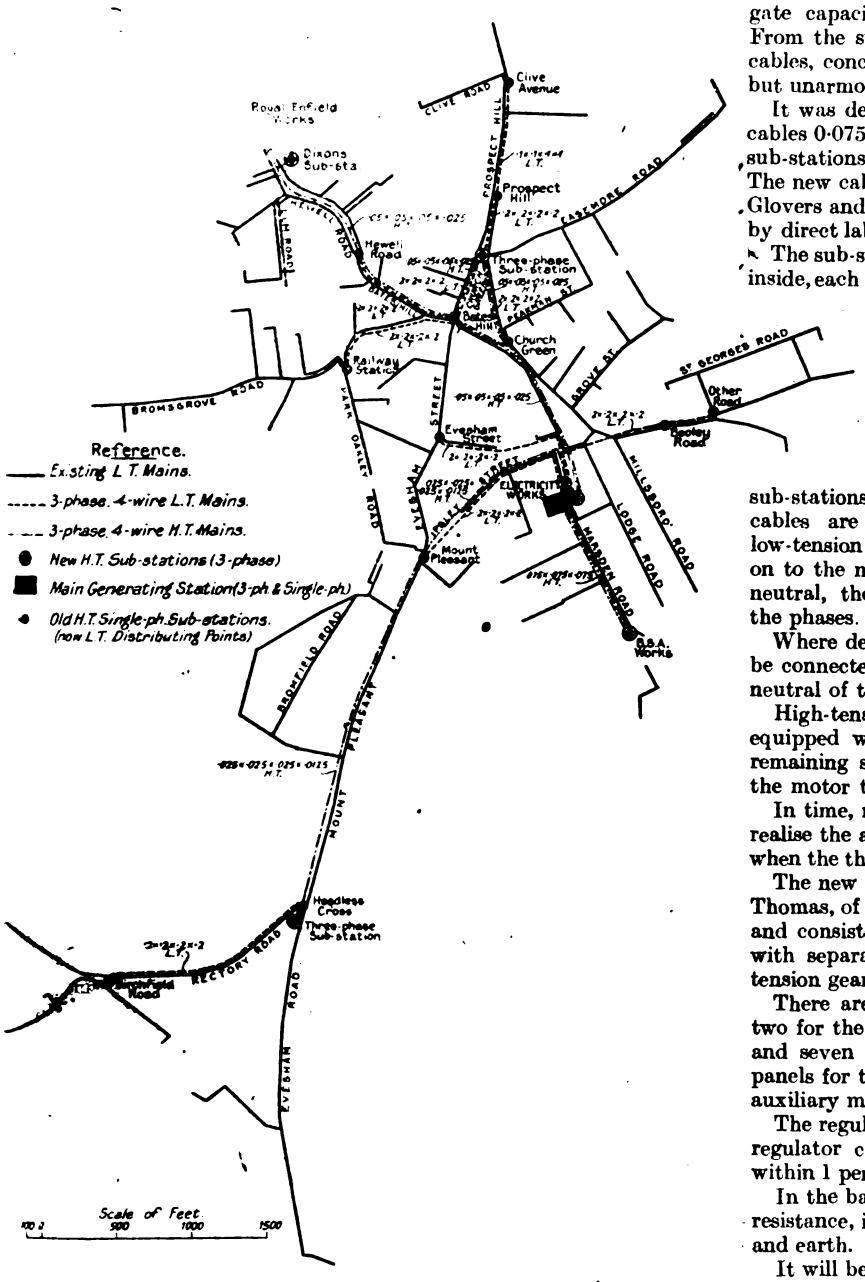


FIG. 4.—PLAN SHOWING NEW THREE-PHASE MAINS AND OLD LIGHTING DISTRIBUTORS.

(High-tension mains supplying private sub-stations are omitted.)

The question of the best way to start up the motor transformers was one which called for some little consideration.

As all the auxiliary motors of the new plant are driven by means of three-phase motors, and need to be running before the turbos can be got on load, it was finally decided that the pony motor of the 150 kw. set should be single phase, so that in the event of a shut down one of the small reciprocating single-phase alternator sets could be run up and three-phase current obtained from it by means of the motor transformer, to enable the circulating and ventilating motors of the large three-phase turbo sets to be started up.

It is interesting to notice that the single-phase pony motor of the 150 kw. set takes a starting current of 350-420 amperes at 200 volts, whilst the three-phase pony motor of the 300 kw. set requires only 70-100 per phase.

Owing to the large number of single-phase motors and transformers on the old single-phase mains, the power factor of the feeders is low, and the two synchronous motor-transformers are of considerable assistance, as, by over-exciting their fields, it is possible to reduce considerably the idle current of the turbo-alternators.

The original mains system consisted of eight high-tension single-phase, concentric, paper-insulated, lead-covered and armoured cables, laid direct in the ground, with 31 sub-stations in various parts of the town, some in underground chambers under the streets and others in different factories taking a supply for power purposes, the aggregate capacity of the sub-station transformers being 1,705 k.v.a. From the sub-stations under the streets were run nine distributor cables, concentric, diatrine, paper or other insulation, lead covered but unarmoured, laid direct in the ground.

It was decided to run out five new high-tension, four-core, feeder cables 0·075 and 0·050 per phase, and to build five new high-tension sub-stations equipped with three-phase oil-cooled transformers. The new cables, both high and low tension, were supplied by Messrs. Glovers and laid by Mr. Mayne and his chief assistant, Mr. Bush, by direct labour. Fig. 4 is a plan of the mains.

The sub-stations consist of neat brick buildings about 12 ft by 9 ft. inside, each incoming feeder being controlled by a B.T.-H., truck type, switch panel fitted with oil-break switch and overload and reverse current relays. The transformers are Ferranti oil-cooled type. From the secondaries of the transformers the current passes through B.I. & H. low-tension fuse units fixed on the ends of four-core lead-covered and armoured cables, 0·2 by 0·2 by 0·2 by 0·2 sq. in. section, which are run down the principal streets and through the old underground high-tension sub-stations. In these sub-stations, from which the high-tension cables are now withdrawn, such of the original single-phase low-tension cables as were in good condition have been connected on to the new four-core cables between the phase wires and the neutral, the load being balanced as evenly as possible between the phases.

Where desired, also, existing single-phase high-tension mains can be connected at the new sub-stations between the phase wires and neutral of the new three-phase four-wire feeders.

High-tension single-phase feeders running direct to works still equipped with single-phase motors are supplied either from the remaining single-phase machinery or from the new plant through the motor transformers.

In time, no doubt, the users of single-phase 70-period motors will realise the advantage of substituting three-phase 50-period motors, when the three-phase mains will be gradually extended.

The new main three-phase switchboard, built by Messrs. Bertram Thomas, of Manchester, lines up with the original single-phase board, and consists of enamelled slate panels carried on steel framework, with separate empire stone cubicles behind to contain the high-tension gear.

There are 13 high-tension panels, two for the turbo-alternators, two for the motor alternators, two recording and regulating panels, and seven feeder panels. In addition, there are two low-tension panels for the low-tension side of the works sub-station and for the auxiliary motors and works' lighting and power generally.

The regulating panel contains a Brown-Boveri automatic pressure regulator capable of regulating the pressure of the main turbos within 1 per cent. from 0 to full load.

In the basement below the board is a Brazil carbon powder earth resistance, in the circuit between the neutral point of the alternators and earth.

It will be seen that, as the result of the alterations, the town now possesses a power station of a most modern design, and well able to cope with all the load which the various manufacturers can put upon it. The war has shown conclusively that no manufacturer can afford to ignore the value of electrical power for driving his machinery, and in view also of the exhortation by the Coal Controller to all manufacturers to scrap their existing steam engines and take power from the local electricity works, it is safe to prophesy that the present sets will soon be loaded up.

This should have the effect of putting the financial position of the undertaking on a sound and satisfactory basis, and enable the Council to look forward with confidence and to make plans for yet further extensions which will be required in the near future. From the results so far obtained, it is evident Redditch is already able to supply at a price which compares favourably with those of many larger undertakings.

We desire to thank Messrs. Handcock & Dykes for placing information for this article at our disposal.

Digitized by Google

REPETITIONS OF E.M.F. IN ARMATURE WINDINGS.

BY C. C. HAWKINS.

(*Concluded from p.* 891.)

(B.)—MULTIPLEX WINDINGS CONSISTING OF TWO OR MORE INDEPENDENT WINDINGS.

The first question to be decided is whether there are repetitions in one of the windings considered separately. The same principles as before, *mutatis mutandis*, determine this. y_k and $N_2=n_s \cdot u_l$ must have a common factor m higher than 1, and m is now the number of independent windings; it is, of course, conceivable that each of the independent windings might itself be not merely a simplex lap or a simplex wave but multiplex, in which case m would not be identical with the number of independent windings, but this complexity is not here contemplated. The number of tours round the armature before any given one of the independent windings closes is then y_k/m, which, for example, with lap-winding=1.

Lap-winding.—The advance in slots per coil traversed is as before m/u_l, but now in contrast to the case of the single closed helix, there *may* be a common factor greater than 1 between m and u_l. This is, however, not necessarily the case, since the H.C.F. between $y_k=m$ and $n_s \cdot u_l$ may exist only between y_k and n_s.

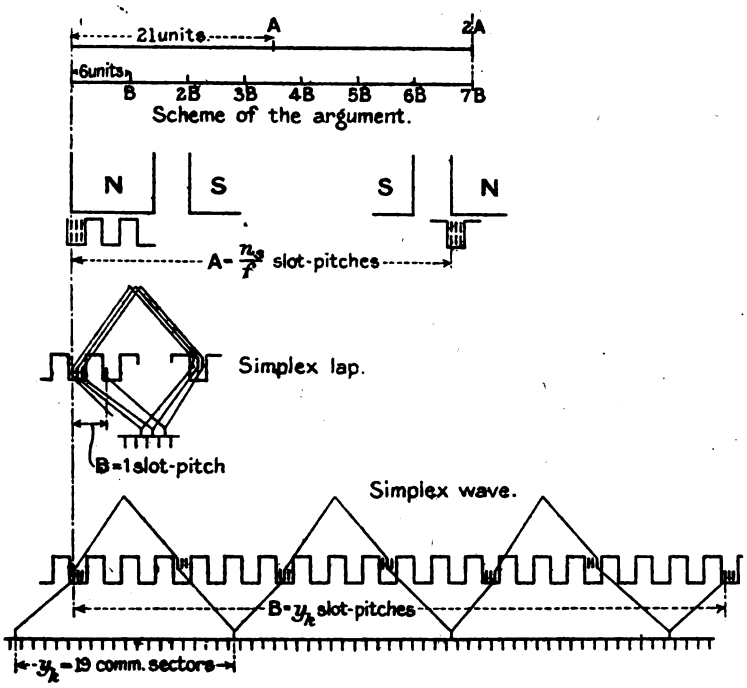


FIG. 2.

If there is a common factor higher than 1 between m and u_l, this common factor may be either the whole or a part of the common factor between m and $n_s \cdot u_l$. Further, the component of m which is not common to u_l and which fixes B may or may not have a common factor higher than 1 with n_s/f.

Four cases are thus to be distinguished.

(I.) *m and u_l have some common factor greater than* 1 *or are equal* (Fig. 4).—

Let m/u_l when reduced to its lowest terms=g/h; then to reach a coil in the same slot positions as the first coil, we must traverse h coils, and the advance in slot-pitches is $B=g$, which would be 1 in the case of $m=u_l$ (Fig. 4).

Now g may or may not have a common factor higher than 1 with n_s/f. Hence,

1. When g and n_s/f have a common factor f' greater than 1, so that $g=k_2 f'$ and $n_s/f=k_1 f'$,

$$y_p=\frac{g}{f'}\cdot\frac{n_s}{f}.$$

There will then be repetitions, so long as $g/f'<f$, and the number of repetitions is $f.f'/g$ which will be less than the number f of similarly situated slots, unless $f'=g$, *i.e.*, unless g is contained in n_s/f.

The pole-pairs over which one repeating system extends are correspondingly,

$$p'=\frac{mp}{f}\times\frac{g}{f'}.$$

When $g/f'=f$, closure results and there is no repetition, *i.e.*, the starting coil is again reached by the first equipotential pitch, and its potential is, of course, the same as when it formed the starting point. From the physical fact that closure results when $g/f'=f$, it is also evident that g/f' can never exceed f.

A simple example will render this clearer, even if the number of slots is too small to be practical, and we will take a case (*a*) with $m=4$, $u_l=2$, $n_s=30$, $p=3$. Thence $f=3$, and 3 similarly situated slots are 1, 11 and 21. $m/u_l=4/2=g=2$. Starting with the coil-side occupying the last position in slot 1 and numbering it No. 4, the number of successive corresponding elements divided by $2u_l=4$ will give the number of the slot and the position therein in which they fall; if a

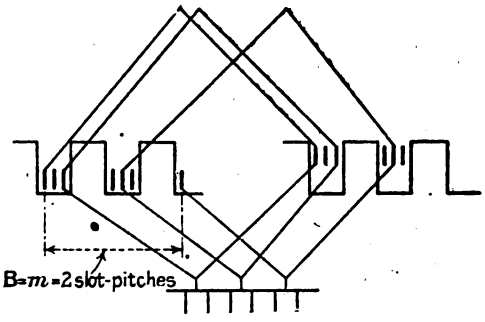


FIG. 3.—MULTIPLEX LAP $m=2$ m PRIME TO u_l.

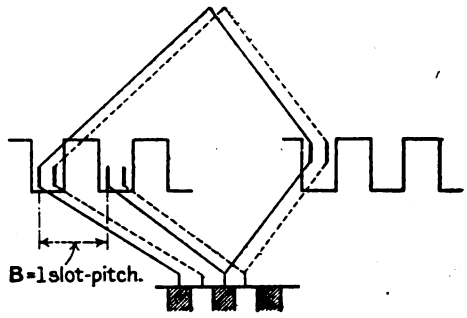


FIG. 4.—MULTIPLE LAP, INDEPENDENT WINDINGS, $m=W_l=2$.

whole number, the element is the last of the slot. The pitch of the coils or $y_k=m=4$, and the pitch of the first coil-sides in elements is $2m=8$. Therefore the winding runs as shown in Table II.:—

Table II.

No. of element at front end.				
4 being the last element in slot				1
12	,,	,,	,,	3
20	,,	,,	,,	5
28	,,	,,	,,	7
36	,,	,,	,,	9
44	,,	,,	,,	11
52	,,	,,	,,	13
60	,,	,,	,,	15
68	,,	,,	,,	17
76	,,	,,	,,	19
84	,,	,,	,,	21
92	,,	,,	,,	23
100	,,	,,	,,	25
108	,,	,,	,,	27
116	,,	,,	,,	29
4	,,	,,	,,	1

g being contained in $n_s/f=30/3=10$, there are f repetitions. But in another case (*b*) let $m=8$, $u_l=2$, $n_s=108$, $p=6$. Then

Digitized by Google

$f=6$, and six similarly situated slots are 1, 19, 37, 55, 73, 91. $g=4$, and the H.C.F. of this with $n_s/f=108/6=18$ is $f'=2$. Then we have the result shown in Table III.

Table III.

No. of element.				
4	being the last element in slot			1
20	,,	,,	,,	5
36	,,	,,	,,	9
52	,,	,,	,,	13
68	,,	,,	,,	17
84	,,	,,	,,	21
100	,,	,,	,,	25
116	,,	,,	,,	29
132	,,	,,	,,	33
148	,,	,,	,,	**37**
164	,,	,,	,,	41
180	,,	,,	,,	45
196	,,	,,	,,	49
212	,,	,,	,,	53
228	,,	,,	,,	57
244	,,	,,	,,	61
260	,,	,,	,,	65
276	,,	,,	,,	69
292	,,	,,	,,	**73**
308	,,	,,	,,	77
324	,,	,,	,,	81
340	,,	,,	,,	85
356	,,	,,	,,	89
372	,,	,,	,,	93
388	,,	,,	,,	97
404	,,	,,	,,	101
420	,,	,,	,,	105
4	,,	,,	,,	**1**

It will be seen that the winding misses the last slot position in three out of the six similarly situated slots, viz., 19, 55 and 91.

2. When g and n_s/f have no common factor higher than 1, $y_p=g\times n_s/f$.

There will then be repetition, so long as $g<f$. When $g=f$, closure results.

This is evidently only the special case when f' in (1) is $=1$.

(II.) *There is no common factor higher than* 1 *between* m *and* u' (Fig. 3); *e.g.*, u_l may itself be 1, or m may be 2 and $u_l=3$. Whether m exceeds or is less than u_l, it is in either case necessary to traverse u_l coils to reach a coil occupying the same positions within its slots as the first coil, and the advance in slot-pitches is therefore as in the corresponding case of a single closed helix $B=m$. But now since $y_k=m$ is prime to u_l, m must be a factor in n_s. In this case then m may or may not have a common factor higher than 1 with n_s/f.

3. When m and n_s/f have a common factor higher than 1, so that $m=k_3f''$ and $n_s/f=k_3f''$

$$y_p=\frac{m}{f''}\cdot\frac{n_s}{f}.$$

There will then be $f.f''/m$ repetitions, so long as $m/f''<f$. When $m/f''=f$, closure has resulted, and there are no repetitions.

Thus in case (*c*) let $m=2$, $u_l=1$, $n_s=30$, $p=3$; then $f=3$ and the H.C.F. between m and $n_s/f=10$ is $f''=2$.

Table IV.

No of element.				
2	being the last element in slot			1
6	,,	,,	,,	3
10	,,	,,	,,	5
14	,,	,,	,,	7
18	,,	,,	,,	9
22	,,	,,	,,	**11**
26	,,	,,	,,	13
30	,,	,,	,,	15
34	,,	,,	,,	17
38	,,	,,	,,	19
42	,,	,,	,,	**21**
46	,,	,,	,,	23
50	,,	,,	,,	5
5	,,	,,	,,	27
58	,,	,,	,,	29
2	,,	,,	,,	**1**

f''/m being $2/2=1$, there are the full number of f repetitions in the one winding.

But case (*d*), let $m=4$, $u_l=1$, $n_s=56$, $p=4$, then $f=4$ and the H.C.F. between m and $n_s/f=56/4=14$ is $f''=2$. The four similarly situated slots are then, say, 1, 15, 29, 43.

Table V.

No. of element.				
2	being the last element in slot			1
10	,,	,,	,,	5
18	,,	,,	,,	9
26	,,	,,	,,	13
34	,,	,,	,,	1
42	,,	,,	,,	21
50	,,	,,	,,	25
58	,,	,,	,,	**29**
66	,,	,,	,,	33
74	,,	,,	,,	37
82	,,	,,	,,	41
90	,,	,,	,,	45
98	,,	,,	,,	49
106	,,	,,	,,	53
2	,,	,,	,,	**1**

Two out of the similarly situated slots viz. 15 and 43 are here missed by the one winding, since $m/f''=2$.

4. When m and n_s/f have no common factor higher than 1 no repetitions are possible. For y_p would then be $=m\times n_s/f$; but since m is a factor in n_s, if m and n_s/f are to have no common factor, it follows that m must $=f$, so that $y_p=n$ and closure has occurred.

Wave-winding.—Analogously to former cases, the advance in slots per coil traversed is y_k/u_l, but there *may* be a common factor greater than 1 between y_k and u_l, such factor being either the whole or a part of the common factor between y_k and n_s . u_l .

y_k with wave-winding will always in practice exceed u_l, but the same four cases arise, except that y_k now appears in place of m.

(I.)—*If* y_k *and* u_l *have some common factor greater than* 1, or if y_k is a whole multiple of u_l, let y_k/u_l when reduced to its lowest term $=g/h$. Then $B=g$.

1. If g and n_s/f have a common factor f' higher than 1,

$$y_p=\frac{g}{f'}\times\frac{n_s}{f}.$$

There will then be repetitions so long as $g/f'<(y_k/m)f$, when closure results.

2. When g and n_s/f have no common factor higher than 1

$$y_p=g\times\frac{n_s}{f}.$$

There will then be repetitions so long as $g<(y_k/m)f$.

This is evidently only the special case when in (1) $f'=1$.

(II.)—*There is no common factor higher than* 1 *between* y_k and u_l; then $B=y_k$. But now since y_k is prime to u_l there must be a common factor m higher than 1 between y_k and n_s, and y_k may or may not have a common factor higher than 1 with n_s/f.

3. In the former case, let this common factor be f'', then

$$y_p=\frac{y_k}{f''}\cdot\frac{n_s}{f},$$

and there will be repetitions so long as

$$\frac{y_k}{f''}<\frac{y_k}{m}\cdot f,$$

i.e., so long as $\frac{m}{f''}<f$.

4. In the latter case, f must $=m$, and

$$y_p=y_k\cdot\frac{n_s}{f}=\frac{y_k\cdot n_s}{m},$$

which implies closure without any repetition.

This again is evidently only the special case when in (3) $f''=1$.

The general formulæ are, therefore, for both lap and wave multiplex windings, consisting of two or more independent helices,

(I.) $y_p=\frac{g}{f_1}\times\frac{n_s}{f}$, and for repetitions $\frac{g}{f}$, must be less than $\frac{y_k}{m}.f$.

(II.) $y_p=\frac{y_k}{f''}\times\frac{n_s}{f}$, and for repetitions $\frac{m}{f''}$, must be less than f.

Digitized by Google

It will now be seen that multiplex windings forming two or more independent helices cannot always take advantage of the possibilities presented by the f slots as starting-points for repetitions.

But there still remains the further question of whether there are any exact repetitions between portions of the two or more independent windings.

If $u = m$ or an exact multiple of m, the independent windings, whether wave or lap, never interchange their relative positions within the slots (cp. Fig. 4). Therefore there can never strictly be any exact repetition in phase and value of the E.M.F. of one portion of one winding in a portion of another winding, although the only difference is that due to their slightly different positions within the same slots. Thus, cases (*a*) and (*c*) admit of no exact repetitions between different windings, since the last position in each of the three similarly situated slots is in every case occupied by elements of one and the same winding.

But when m is an exact multiple of u_1, and further exceeds $2u_1$, so that $g'f'$ or $m'f''$ can be two or more, the equipotential pitch in slots is twice or more times $n_s f$, or the number of repetitions in one winding is one-half or less than one-half of f. Then as shown in cases (*b*) and (*d*), one winding has missed the correct equipotential positions within some of the similarly situated slots. These positions are then filled by another winding, until once again the total number of repetitions of any one system as between all the windings is brought up to f. Thus to continue case (*d*), the sequence of the remaining windings will be :—

—	No. of element at front end.			Position in slot.		
No. of winding	2nd.	3rd.	4th.	2nd.	3rd.	4th.
	4	6	8	2	3	4
	12	14	16	6	7	8
	20	22	24	10	11	12

and so on. Evidently the third winding will occupy the last positions in slots 15 and 43, so that there are four repetitions in the first and third windings. Similarly there are four repetitions in the second and fourth windings, but none between the pairs of windings.

In the same way in case (*b*) the fifth winding will fall into the last positions in slots 19, 55 and 91, which had been previously missed by the first winding, so that there are six repetitions in the first and fifth windings together. Similarly there are six repetitions in each of the other pairs of windings, 2 and 6, 3 and 7, 4 and 8.

While easier to follow in the case of lap windings, exactly the same action occurs in wave-windings.

(C.)—Single-layer Windings.

So far, only a winding with two or more layers has been under consideration. A single-layer winding of continuous-current type is, however, at once brought under the same laws, if we imagine the number of slots to be halved, and one side of each coil to be mounted on the top of a lower layer. The only difference thereby introduced is in the span of the coils which does not enter into the argument. The simplest plan is then to halve the actual number of slots and to work with this halved number as n_s for the present purposes.

If the reader has been patient enough to follow the line of argument used above, it will have occurred to him on reaching the end of section (A) that a single elementary consideration suffices for the case of all windings forming a single closed helix. If all the slots are completely wound, and there are any slots repeating similar positions under poles of the same sign, then in every such repeating slot there is, of course, a coil-side u_1 occupying the same slot-position as the coil-side u_0 chosen as a starting-point, and since these coil-sides form part of one and the same copper winding, u_1 can be reached from u_0. The winding being perfectly regular, it follows that whatever course the conductors follow between u_0 and u_1, and whatever the resultant E.M.F. therefrom, exactly the same course will be followed by the conductors between u_1 and the return to u_0 or between u_1 and the next repeating coil-side u_2, and exactly the same E.M.F. will result therefrom. But when there are two or more independent windings such an argument requires modification, and although true when so modified, the final form which it must take is not so immediately self-evident. The purpose of the more detailed method of treatment adopted above is then to make the case of independent windings clearer, and to show that if one of the independent windings possesses the full number of f repetitions, another independent winding may also possess the full number f, but they will be repetitions differing from those of the first winding. If, on the other hand, one winding shows repetitions less than f in number, there will be another or other windings which may be regarded as conjugate to the first, and supplying the number by which it falls short of f repetitions.

CONFERENCE OF INDIAN ELECTRICAL INSPECTORS.

The Official Report of the proceedings at the second conference of electrical inspectors and electric engineers to the Government, which was held in Calcutta in December last, has been issued. The report, which is edited by Mr. J. W. Meares, M.Inst.C.E., M.I.E.E., electrical adviser to the Government of India, is a useful record of the electrical position in India. It is published at 2s. 6d. (or 3s. 7d. cloth).

Many topics appear to have been considered, and the legal aspect of the Indian Electricity Act was discussed at some length, and the conference resolved that it would be highly desirable that all doubtful cases of law should be taken to court and argued out, so that a final decision should be arrived at. A resolution was passed regarding the amendment of secs. 39 and 44 of the Act, which relates to theft of energy; the amendment proposed that the onus of any tampering with the licencee's works shall be on the consumer, who alone benefits by such tampering. It was pointed out that the wording of the Act made it difficult for the licencee to obtain conviction by a court, as it was generally impossible to prove who the actual malefactor was.

The most important subject dealt with by the conference appears to be that relating to the Indian Electricity Rules of 1911. In addition to the amendment of some of the existing rules, it was decided to introduce certain new rules and amend some of the existing rules at present applicable to mines. The proposed additions and amendments to the rules applicable to mines cover about 10 pages of the report, and are more in the nature of a specification than rules; this we consider is a step in the right direction. Among the modifications resolved upon we particularly note the following :—

1. Pressures exceeding 3,300 volts shall not be permitted below ground.
2. Earthing is to be carried out by a connection to an earthing system at the surface of the mine, and this earthing system has to comply with certain conditions as regards the size of earth plates, &c.
3. The use of arc lamps below ground is prohibited.
4. Certain qualifications are required in persons in charge of electrical apparatus, and their respective responsibilities and nature of duty are also laid down pretty fully. We consider this a very important point, and are glad to see that the conference have decided to introduce it into the new rules.
5. Rule 90, prohibiting the haulage by locomotive on the trolley wire system at high pressure has been amended so as to permit of pressures not exceeding medium being adopted with the consent in writing of an electric inspector. The proposed amended rule also includes haulages by storage battery locomotives. As regards these proposed new amended rules we must congratulate the members of the conference on their work. The proposed rules are very full and, as already stated, are more in the nature of a specification, a point that should be of great assistance to managers and owners of mines.

Some discussion arose on Rule 33, by which installations of less than 125 volts pressure are excluded from the Indian Electricity Rules. The conference resolved to introduce a further rule empowering the electric inspector (without reference to the local Government) to enforce any rules he may consider necessary in any installation whatever.

Rule 55 was discussed at great length. This rule relates to the pressure tests required for high-pressure circuits and apparatus. The existing rule demands that the circuit or apparatus must withstand the continuous application during half an hour of a pressure 50 per cent. greater than the maximum pressure which it is intended to be subject to in use, provided that the testing pressure need in no case be more than 10,000 volts in excess of the working pressure of the circuit or apparatus. The conference resolved to recommend the amendment of the rule. The proposed amendment is that the apparatus must withstand a pressure of 100 per cent. greater than the maximum working pressure of the apparatus under test for a period of one minute, provided that the testing pressure is in no case less than 2,000 volts, and also provided that, for apparatus designed for pressures exceeding 6,600 volts, the testing pressure does not exceed the working pressure.

Digitized by Google

A proposal prohibiting high-tension motors of less than 20 H.P. was accepted by the conference.

An important point regarding the erection of telegraph lines was taken up, and the conference resolved that it is absolutely necessary that the telegraph authorities should give notice to licencees before erecting crossing wires. At present the telegraph authorities are under no obligation to give this notice unless the licencee happens to be a local body, in which case it becomes necessary in accordance with the Telegraph Act, but in all cases it is incumbent on the licencee to carry out the guarding of all lines.

Some interesting data regarding wind pressures in different parts of India was placed before the conference, together with a map dividing India into areas in which certain specified pressures per square foot had not been and are unlikely to be exceeded in the future. The conference decided to adopt the figures given for various localities, in place of the existing 25 lb. per square foot, as laid down in rule 60.

The conference resolved that publicity of licencees' cost was desirable. A point that arose in the discussion referred to the necessity of defining what costs are intended, whether the cost per unit generated or the cost per unit delivered to consumers.

Some points relating to the statutory and other duties of electrical officers in Government employ were discussed, and the conference resolved to lay before the Government a suggestion that young electrical engineers be appointed as assistant (electrical) engineers, exactly in the same way that civil engineers are appointed to the department, so that eventually they may be able to take the place of officers who retire.

Another proposed amendment is that the licencee should be given the right to cut off a consumer for failing to allow access to his meter. According to the rules at present the licencee can cut off a consumer for non-payment of bills, but not for refusing access to his meter.

The question of aggregate consumption of one party where the consumption takes place in different premises was discussed, and the conference resolved to obtain an authoritative decision as to the legality of the system. The conference was of opinion that the system of "lumping" the consumption in various buildings is permissible, and the applicant for the supply (including Government) should be treated as a single consumer with respect to those buildings. Questions relating to cost of service lines and miscellaneous charges made by licencees were discussed at some length, and also the important matter regarding the compulsory reduction of maximum rates for electric supply. The conference was of opinion that a cumulative dividend of 10 per cent. and provision to an average extent of at least 5 per cent. on actual expenditure for depreciation, with a substantial reserve fund to meet such risks as cyclones and earthquakes, is not unreasonable for India; but they considered the exercise of these powers of compulsory reduction inadvisable, except in cases where the maximum rates are unreasonably high, and that if the reduction proposed affects the actual working rates of the company, the figures given above should be the basis for the limit of such reduction.

The conference resolved that in all new licences the British standard pressures should be adopted, and as regards existing licences, local Governments should make inquiries with a view to seeing if, and to what extent, their undertakings can be modified in the same direction.

A deputation from the Institution of Electrical Engineers (Calcutta Local Section) attended the conference at one of the public sessions, and laid before them their views on certain important matters that they considered required modification. Among these was the opinion expressed that the specification and general conditions of contract for all Government electrical work in India should be standardised as fully as possible. The deputation presented to the conference a statement in schedule form showing the differences in the several provincial specifications. With regard to this point the conference resolved that a uniform set of "General conditions of contract for electrical works" is desirable for the use of the Public Works Department all over India. A standard specification for wiring was agreed to by the conference, and they resolved to give effect to the points agreed upon as the specifications are revised.

As the result of a communication received from a local engineering firm, drawing attention to the large amount of so-called association cable made in Japan, and sold in India, the conference resolved that contractors who proposed using materials of other than British manufacture should state the country of origin of the material in their tender.

A lengthy discussion took place on the subject of the licensing of electric wiring contractors, and there was considerable divergence of opinion on the subject by individual members. The conference referred the separate points discussed to a deputation representing the contractors in Calcutta, who passed the following unanimous resolution: "That contractors only should be licensed, not foremen or mistries. The question of what constitutes a contractor to be left to the licensing authority, which should be the local Government through its duly authorised electric inspector for the time being."

Matters relating to the use of iron wire as a substitute for copper, and different methods adopted for wiring, were also mentioned at the conference by individual members.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"The Electron: Its Isolation and Measurement and the Determination of Some of Its Properties," by R. A. Millikan. (Chicago: University of Chicago Press). Pp. xii.+268. $1.50 net.

"Miniature Electric Light," edited by B. E. Jones. (London: Cassell & Co., Ltd.). Pp. 156. 1s. 3d. net.

"The Munition Workers' Handbook," by Ernest Pull, A.M.I.Mech.E. (London: Crosby Lockwood & Son.) Pp. 158. 2s. 6d. net.

THE DETECTION OF SUBMARINES.

At the present time it is of the highest importance that those capable of assisting in the problem of detecting enemy submarines should know something of the difficulties that must be overcome and the conditions under which the submarines usually operate. In this connection the following memorandum, which has been published in the "Mining and Scientific Press," of San Francisco, by the American Committee of Engineers in London should be useful.

The Engineering Committee of the National Research Council issues the following data to guide those desirous of helping to circumvent the enemy's submarine campaign by means of invention and suggestion. Any communication on the subject should be addressed to Mr. W. F. Durand, vice-chairman of the Committee, at Washington.

Submarines operate singly or in groups, as may seem best suited to local or special conditions.

They are supposed, where circumstances favour, to lie on the bottom at rest and with listening devices attempt to detect the approach of vessels. On receipt of evidence that a vessel is approaching they rise to a level permitting observation with periscope, and then manœuvre accordingly. When in water too deep to permit lying on bottom the submarine must maintain steerage way in order to hold its level of submergence. The minimum speed at which this can be done will range with circumstances from 2 to 4 knots. The maximum depth of submergence is about 200 ft. The usual depth of running is from 50 ft. to 100 ft.

They have been supposed to return to the home base at intervals of 30 to 35 days. The total radius of action will presumably range from 5,000 to 8,000 miles at a moderate cruising speed of 10 or 11 knots. The high speed emerged will range from 14 to 18 knots, or possibly more in latest designs. The maximum submerged speed is about 10 knots.

Hidden bases have been presumably used off the Irish and other coasts. There have also been suspicions of bases on the coasts of Greenland and Iceland. Submerged bases for oil and supplies have also been employed.

The time required from emergence to submergence will range from one to three or four minutes, according to circumstances. When submerged near the surface, the time required to raise the periscope, take a quick observation and lower it again, may range from 15 to 30 seconds. If desired, the submarine can follow an undulating path, rising and submerging alternately, at frequent intervals, at will. Or otherwise it may run fully submerged but near the surface, and take frequent observation through the periscope. Modern submarines are provided with two or three periscopes. The loss or destruction of one, therefore, will not necessarily disable the boat.

Torpedoes fired from submarines are presumably aimed by changing the direction of the boat. This, however, is not assured in all cases. The torpedo, in order to run true, must travel at an immersion of about 10 ft. In smooth water it may be run at a shallower depth than in rough water.

Submarines may operate at night with less liability of detection, but with, of course, greater difficulty in picking up their target.

Submarines use the gyroscopic compass.

Sounds produced by the movement of a submarine through the water, including those traceable to the propeller, to movements of the rudder, &c., should permit of detection by the use of modern refined sound detecting devices.

The distance at which a protecting net, plate or shield or other means of exploding the torpedo before reaching the side of the ship must be located in order that such distance will render the effect of the torpedo harmless, will depend primarily upon (1) weight of explosive charge, (2) depth of torpedo when exploded. (3) strength of the ship's structure. With modern torpedoes and a depth of 10 ft. or 12 ft., and with the structure of mode n merchant ships, distances of 20 ft. or 30 ft. would perhaps be required in order to give good assurance against injury. With rough water and possibly much less submergence at the time of explosion, reduced distances of 15 ft. or 20 ft. might prove sufficient. Experimental investigations on this subject show a very wide divergence among the results, and no precise rule can be given. It may be added, however, that naval constructors generally are satisfied that the distance at which protecting plates or shields would have to be placed in order to secure immunity is so great as to render their use of very doubtful practicability.

Digitized by Google

The Electrician.

FRIDAY SEPTEMBER 14th, 1917.

Editorial and Publishing Offices:—

8, BOUVERIE STREET, LONDON, E.C. 4.

Telephone: City 9853 (4 lines). *Telegrams:* "Electric Fleet London."

THINGS WE DO NOT KNOW.

In all branches of engineering the engineer depends very largely upon approximations, and nowhere is this more apparent than in the ultimate calculations which involve what is known as the factor of safety. Broadly speaking, it may be said that the factor of safety is an admission of our ignorance. Its presence is due to a number of causes, partly to ignorant assumptions, partly to conditions that we cannot control, and partly to conditions that arise with the lapse of time, resulting in deterioration.

The subject has been brought to mind by a recent Paper on "Things we do not know about Structural Engineering," by Prof. W. M. WILSON, the Paper being contributed to the Western Society of Engineers (U.S.A.). Prof. WILSON draws his illustrations chiefly from the iron structures required in bridges. Among the ignorant assumptions to which he refers is the one assuming that the connections of the various members are frictionless hinges. This, of course, as a rule, is very far from the case, with the result that very considerable secondary stresses may be set up when the structure is loaded. Modern designers are able to compute these stresses and to allow for them if desirable, so that the assumptions made may be more reasonable.

As examples of conditions which we cannot control may be mentioned wind pressure, lack of uniformity in the material employed and the future use to which the structure may be put. Here we are not so much concerned with ignorance as with probabilities. We know that wind pressures, for example, may reach high values; but the question arises whether there is a fair probability that these high values will be reached in combination with other high stresses, and how far certain risks may be taken. In such matters, therefore, the factor of safety is not so much a matter of ignorance, but is in the nature of insurance.

Finally, there are causes leading to deterioration. Such deterioration may, for example, arise through the repeated application of stresses which would not otherwise be sufficient to cause failure. This phenomenon is the basis of Wöhler's Law, and has been confirmed by the classical experiments of Sir BENJAMIN BAKER and others. Further, there is fatigue, and the possibility of crystallisation being set up by vibration.

There is no doubt that safety should be the first consideration; but if this is gained by very high factors of safety, then economy is sacrificed, and the results are obtained on a basis of ignorance. On the other hand, there is no use working with formulæ which apparently lead to an accuracy beyond that of the assumptions.

It is more particularly in so-called civil engineering that the factor of safety plays the greatest part; but it is very far from being unknown in the construction of electrical machinery, though it may possibly not be so evident superficially. In the mechanical parts of such machinery the usual factor of safety must, of course, play its part. The rotating members are submitted to stresses which can be calculated, and which must be kept within certain limits. These limits, however, are fairly well known. When we come to magnetic calculations the ground is much more definite and more exact, and, likewise, calculations of electrical conductors can be made to be exact under certain conditions; but in electrical machinery such questions are generally complicated by problems of the thermal conductivity of the surrounding insulation, and, consequently, the rules followed must be more empirical. It is, however, in the electrical qualities of insulation itself that our ignorance is the most profound. So far, it must be admitted that we have but little knowledge as to why one substance is an insulator and another a conductor, and still less why one material is excellent as an insulator and another is comparatively poor in this respect. Nor are we able to say very definitely what conditions of working will cause gradual deterioration of insulating qualities. Such questions are, of course, largely bound up with chemical composition and chemical constitution, and this is a subject which the electrical engineer is disinclined to investigate. Possibly, when there is greater combination between the physicist and the chemist than there is at present, we may come to know more on this important subject, and realise how we can improve the insulating materials which are at our disposal.

REVIEWS.

Colour and its Applications. By M. LUCKIESH. (London: Constable & Co., Ltd.) Pp. xiii.+357. 16s. net.

In this book the author reviews the chief applications of colour. The early chapters deal with elementary matters, others are devoted to problems, such as colour-photometry, in which the author takes a special interest; while the later part of the book deals in a general way with the utilisation of colour in special industries, on the stage and for spectacular and decorative purposes.

After explaining the nature of light vibrations, the effect of temperature on incandescent radiation and the distinctive features of spectra of luminescent gases and incandescent solids the author passes on to the production of colour. The production of spectra by refraction and diffraction are illustrated and a considerable amount of attention to coloured media (glasses, filters, &c.) and reflection from coloured surfaces, which also forms the subject of a special final chapter. We notice an interesting diagram showing the absorption of the earth's atmosphere with the sun at various altitudes. In the chapter on colour-mixing the well-known methods of mixing colours by rotating discs are described and a useful distinction is drawn, by the aid of a colour plate, between "additive" and "subtractive" methods of mixing. The chapter on colour terminology emphasises the need for a generally accepted system of colour-notation and discusses in considerable detail the various methods proposed for illustrating colours by geometrical figures. Under the heading of colour-analysis several spectro-photometers, and the Ives and Arons colorimeters, are described and illustrated. We notice that the spectro-photometers mentioned utilise the system of crossed Nicols—an inconvenient method of solving a somewhat awkward problem which we believe has been superseded in some of the most recent types. The author appears to have omitted any reference to the Lovibond Tintometer, which deserves to be mentioned in a later edition.

We now come to the sections of the book dealing with colour and visibility, colour-photometry and theories of colour. The latter is somewhat brief, but the chapter on colour in vision contains much interesting information; the influence of colour on acuteness of vision is fully discussed and a curve is presented ascribing a gain in acuteness to the use of yellow glasses.

Digitized by Google

The final section of the book, dealing with colour in lighting, colour phenomena in painting, and colour on the stage, is perhaps the most useful and suggestive part. The discussion of the effect of colour on the appearance of pictures, which is illustrated by some excellent colour-reproductions, is good, and the author is also in his element in dealing with the production of artificial daylight, colour matching, and the "art of mobile colour" (*i.e.*, the combination of colours to produce artistic effects in a similar manner to musical harmonies).

The work is essentially of a specialised character and contains much that is the result of the author's own researches. In these circumstances an author may be pardoned for "letting himself go" occasionally in his own province, with the result that matters are dealt with sometimes in a manner informative to the expert but possibly rather too intricate for those who have only a casual knowledge of these problems.

In many respects the work breaks new ground. The type and mat paper selected are exceptionally good and many of the illustrations, both black and white and coloured, are very apt.

J. S. D.

Principles of Alternating-Current Machinery. By R. R. LAWRENCE. (London: The Hill Publishing Co., Ltd.) Pp. xvii.+614. 18s. 9d. net.

In view of the recent correspondence in these columns on the duties of a reviewer, we are not at all certain that we possess the qualifications deemed to be necessary by exacting authors, and equally exacting readers. As this is not the place, even if we were so disposed, for detailing our qualifications, both author and reader will have to take these on trust. In an age when it is customary for men to do little on life's stage without the limelight, maybe it is well that there should still be some who prefer to keep their left hands in ignorance of what their right hands are doing.

The book under review is the second volume of a series of electrical engineering text books outlined by a committee of eminent professors in American engineering schools and of engineers of several of the large manufacturing companies in America.

Probably there is no better elementary book on the principles of alternating-current machinery. It can be confidently recommended to those students who wish to take up the study of electrical engineering *seriously*, and who in the first place are prepared to do the things which are requisite and necessary for themselves. From this it will be inferred that the book is mathematical. In the words of the author, "Mathematical and analytical treatment of the subject has been freely employed where such treatment offered any advantage." The mathematics employed are, however, of an elementary kind, and the knowledge which the author presupposes can be acquired in less time than one has to spend in order to become proficient in the use of tools or in, say, the winding of the stator of an induction motor.

The author is Associate Professor of Electrical Engineering in the Massachusetts Institute of Technology and Harvard University. If his book represents part of the course of study we are not surprised that students of Harvard "make good" with the manufacturing companies having the good sense to employ them.

Although little more than a summary of the contents can be given we think that such a summary will serve to show how well planned is the arrangement of the book. The 62 chapters are divided into eight groups, namely, synchronous generators, static transformers, synchronous motors, parallel operation of alternators, synchronous converters, polyphase induction motors, single-phase induction motors and series repulsion motors.

In general, the notation recommended by the American Institute of Electrical Engineers has been followed, and this is given at the beginning of the volume. The line which is often used over quantities in equations to indicate that they are to be considered in a vector sense has been omitted in all but one or two cases.

Readers will welcome the openness of the vector diagrams as well as the very clear lettering on many of the diagrams. The diagrams of the "equivalent circuits" will be helpful alike to teachers and students.

An outstanding feature of the book is that pen and ink perspective sketches take the place of half-tone illustrations. Many of these illustrations are of striking merit, and those in any way connected with their production deserve unstinted praise. The half tone illustration was introduced into engineering publications in a moment of folly as an easy way out of a difficulty, and being easy it has survived. But the indiscriminate use of such illustrations tends to put engineering books on a level with the halfpenny illustrated papers and to make articles on engineering topics like badly-illustrated lantern lectures. The publishers are to be congratulated on their enterprise and we hope that the practice will be copied by other publishers.

Of the eight groups of chapters into which the book is divided those dealing with synchronous generators, motors and converters and parallel operation of alternators will help to throw a good deal of light on the principles underlying the design and performance of synchronous machinery.

Although the author modestly states that no new methods have been used, we endorse the view that the bringing together of a large amount of scattered material will be appreciated by those who have neither the time nor the facilities for consulting original Papers. At the same time it is likely that many students who read this book will wish to continue their studies, and for this reason we suggest that a list of references at the end of each chapter would be helpful.

The groups of chapters dealing with static transformers and induction motors will appeal strongly to those who are at a stage between the elementary student and the specialist. These men and their teachers would appreciate a number of carefully selected examples on the subject matter of each chapter. Such examples give one confidence, and inability to solve them may be taken as an indication that further study is necessary. As we have said, the book as it stands is probably the best that has been written on the elementary principles of alternating-current machinery, and as such is worthy of a place on the shelves of electrical libraries.

Spon's Electrical Pocket Book. By W. H. MOLESWORTH. (London: E. & F. N. Spon, Ltd.) Pp. vii.+488. 6s. net.

This pocket book may doubtless be taken as an extension or offspring of the electrical part of Molesworth into a distinct entity. It is almost impossible to judge of the true worth of a work of this kind except by constant use, so as to determine whether the desired information is always at hand, whether it is sufficient for the purpose and whether it is accurate. We must be content on the present occasion with saying that the book covers a great deal of ground and gives a deal of information which should be useful.

In compiling such a work an author is always faced with the problem of what he should include to make it complete and what he should exclude so as to avoid bulkiness. Although the present volume is not bulky we are inclined to the view that the author is a little too diffuse in some directions. For example, one scarcely expects to find a section of the electric furnace house at Trolhattan in a work of this kind. Again, the maximum and minimum dimensions on railways in India (which take up several pages) seem to us to be of restricted interest, and it may also be questioned whether the Institution Wiring Rules should be included.

On p. 11, among the data, it is not clear why the author has given 62·425 lb. as the weight of a cubic foot of water, whereas official departments give a lower value, as pointed out in a footnote. A few misprints are noticeable and to be expected in a first edition. For example, on p. 75, flat irons do *not* take 400 watts per hour, and on p. 272 the limiting voltage of Edison cells should be 1·0 volt. The book is clearly printed.

Digitized by Google

REPORT OF THE COMMITTEE OF THE PRIVY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH FOR THE YEAR 1916-17.

(*Concluded from page* 901.)

Part II.

This part gives a short description of a number of investigations we have aided or initiated. They fall into no considered plan, but they are good in themselves and may well find their place later in some co-ordinated scheme or schemes of work, as already seems likely to happen in the near future in the case of some of them. In the later sections we refer to the assistance we have been able to give to individual research workers, and we discuss the two important problems of how best to encourage inventors and to assist individual manufacturers who want scientific assistance.

Light Alloys.—The Institution of Mechanical Engineers have received a grant from the Department since 1915-16 in aid of a research into the properties and composition of alloys conducted at the National Physical Laboratory. The rapid growth of work at the laboratory on aluminium alloys for the Advisory Committee on Aeronautics has reacted upon the work of the Alloys Research Committee of the Institution of Mechanical Engineers. The Department have accordingly made an additional grant to the aboratory for this research, besides renewing their grant to the Mechanical Engineers during the current year.

Corrosion of Non-Ferrous Metals.—The investigation into the corrosion of non-ferrous metals in sea-water initiated by the Institute of Metals and carried on during 1915-16 at the University of Liverpool has already yielded positive results which may prove of great practical value. The transfer of the research last October to the Imperial College enabled the conditions under which the research was being carried on to be greatly improved and its scope extended. The rapid progress made since last October has been due to the undivided attention which Capt. Bengough has been able to give to the work and to the favourable conditions we have been able to secure for its conduct. The research has now been extended, on the initiative and with the assistance of the British Electrical and Allied Manufacturers' Association, to cover corrosion of condenser tubes in service on land. The Committee of Council have made a further grant for this purpose; the investigation will be carried out under the direction of a joint committee of the British Electrical and Allied Manufacturers' Association and the Institute of Metals. At a later date it is proposed to extend the inquiry into the corrosion of non-ferrous metals under atmospheric conditions.

Refractories.—The Central School of Science and Technology at Stoke approached the Department for aid towards the cost of a much needed extension of their laboratory for refractories. The Council recognise that the problems connected with refractory materials call for greatly increased attention. A Refractories Conference has recently been summoned on the initiative of the Faraday Society at which no less than 13 societies and bodies were represented, with a view to working out a co-ordinated scheme of attack on a national scale. The Council agree that nothing less comprehensive would be satisfactory and they await the proposals likely to be formulated by the Conference with great interest.

Hard Porcelain.—The other important research being conducted at the Stoke School under Dr. Mellor and Mr. Bernard Moore is making very satisfactory progress; it is an attempt to produce a marketable hard porcelain from purely British material. The problem of firing has proved easier than was expected, and we understand that a ware has already been produced which is expected to prove cheaper than English earthenware, to be susceptible of satisfactory decoration, and while felspathic in body to have some of the best characteristics of English bone china. A cheap and new glaze has also been developed.

Hardness Tests for Journals and Pins.—The Institution of Mechanical Engineers had since 1914 financed a research into hardness tests for journals and pins conducted at the National Physical Laboratory. The Committee of Council made a grant last year to the Institution in aid of this research, and have since renewed it for the current year.

Flow of Steam through Nozzles.—Another research, proposed by the Institution of Mechanical Engineers, was originally planned upon a scale which the circumstances of the time made impracticable. The flow of steam through nozzles is a matter of deep importance to steam turbine manufacturers, and the Council recommended a grant for a series of preliminary investigations in which the University of Manchester, the Royal Technical College, Glasgow, the British Westinghouse Co. and the British Thomson-Houston Co. are taking part.

Heating of Buried Cables.—A research at the National Physical Laboratory into the heating of buried cables, planned by the Institution of Electrical Engineers more than four years ago, had been held up through lack of funds until the Committee of Council made a considerable grant on our advice. The work was put in hand early in 1916 and the experimental cables are now all laid and connected except one. The installation of apparatus in the huts is complete and regular observations are in progress. The cables, which are all paper-insulated, include armoured cables laid direct in the ground, cables laid solid in bitumen, and cables drawn into a six-way stoneware duct. We desire to acknowledge in this connection the assistance given by a number of electricity supply companies and municipalities.

Concurrently with this work, and with the aid of the Department, extensive research has also been carried out for the Institution of Electrical Engineers at the University of Liverpool under the direction of Prof. E. W. Marchant and Mr. F. J. Teago. A careful study has been made of the heating of feeder cables of various sections laid in stoneware troughs filled with bitumen at a depth of about 3 ft. below ground. The mains were laid by the staff of the Liverpool Corporation Electricity Works. Valuable results have been obtained showing the relation between final temperature rise and current density. In addition the values of the thermal resistances of the cable coverings and the trough are being determined.

Insulating Oils.—Another research, initiated by the Institution of Electrical Engineers into the properties of insulating oils and aided by the Department, has been carried out with the assistance of a number of important engineering laboratories and firms, who have placed the services of their technical staffs and their works, together with a considerable quantity of oil, at the disposal of the research. The Council note with satisfaction from the report of the Institution that a careful collation of existing information was undertaken before laying down the programme of new work. The research had already been in progress three years before it was aided by the Department. Reports received show that considerable progress has been made, but some delay has been caused by difficulty in obtaining certain glass apparatus and by the lack of laboratory assistance due to the war.

Heat Treatment of High Speed Steel.—Valuable results have emerged from the experiments in the heat treatment of high speed steel which have been conducted for some time past by Mr. Dempster Smith for the Manchester Association of Engineers at the School of Technology in that city. The Department made a grant in 1915-16 sufficient to cover the cost of the research, with the exception of certain materials and apparatus (found by the firms in the Association) and the cost of housing, light and power, which were contributed by the School of Technology. Mr. Dempster Smith has succeeded in standardising the heat treatment of high speed steel in a manner which, though not susceptible of protection by patent, has been of great value to the Admiralty in the manufacture of certain implements of war. The Council think that Mr. Smith's results may be of much wider application than this, and the Ministry of Munitions are publishing a memorandum in their "Journal," explaining the methods to be adopted.

Notched Bar Impact Tests.—The Engineering Standards Committee applied for and received a grant during 1915-16 to enable them to continue a research which had been carried on at the National Physical Laboratory with the object of standardising the methods of notched bar impact tests. The work during the past year has been devoted to determining the best form of notch to standardise.

Heat Transmission from Hot Surfaces.—Another research carried on at the National Physical Laboratory was maintained directly by the Department. This investigation had for its object a reduction in the weight of petrol engines for aircraft by the more efficient design of the cooling surface of the cylinders, and investigation has accordingly been made into the rate of heat transmission from the surfaces of hot bodies to fluids passing over them. The data obtained will also have other important industrial applications.

Other Researches in Progress.—Reference must be made to four other researches initiated during 1915-16. They are (*a*) an investigation initiated by the Faraday Society into the setting and disintegration of salts, on which no report is yet due; (*b*) a series of eight researches into the better recovery of tin and tungsten initiated by the Institution of Mining and Metallurgy in co-operation with the Royal Cornwall Polytechnic Society; (*c*) a research into the degumming of silk initiated by the Silk Association of Great Britain and carried on under Mr. Schryver at the Imperial College; and (*d*) an important investigation being carried out in a number of harbours in the Empire with the assistance of the Institution of Civil Engineers into the deterioration of timber, iron, steel and concrete structures in sea water. One of the researches into the better recovery of tin has already produced results which will, we are told, give a 5 per cent. improvement in the amount of tin recovered in Cornish mines.

Superheaters.—We have initiated a research which has an important bearing on mechanical engineering. It is a series of preliminary experiments in steam plant for high temperatures and pressures, which is being carried out with the assistance of Messrs. Babcock & Wilcox, Ltd., at the Royal Technical College, Glasgow. The investigation will begin with observations of the internal and external deterioration of superheaters operating at high temperatures.

Other New Researches.—These include a research initiated by the Society of Chemical Industry into cellulose at the Manchester School of Technology, and a series of researches into problems of the dyeing trade. In the latter instance the proposing body contributed to the cost of the researches. In the first case the grant was made for work of a preliminary nature on a chemical problem of fundamental character not likely to interest any one industry immediately.

Applications Refused.—We have refused during the past year to recommend grants in 25 cases.

Grants for Apparatus.—In two cases we have recommended and the Committee have made grants for special apparatus. In the first the

Digitized by Google

Council were asked by the authorities of University College, Nottingham, to recommend a grant for equipment to enable Dr. Shaw to undertake a research into the methods of measuring screws. In the other case, the applicant is an employee of a firm who is working in a private laboratory, and who has been allowed by his employers to devote time to an independent research in which he had become interested through his connection with the firm. After a few months' work interesting results were obtained which it has been thought desirable to protect during the war by a secret patent. The investigation is proceeding and the results already obtained have been communicated to the Government Departments interested.

Personal Grants to Research Workers.—We reported last year we had recommended maintenance grants to nearly 40 individuals, but a number of these were unable to begin work, mostly because they were called to the Colours. The actual awards made during the session 1916-17 were 36, of which 24 we e to students being trained in the methods of research, 10 were made to independent research workers, and 2 were made for research assistants.

The Committee of Council have placed a sum not exceeding £6,000 at our disposal for grants to research workers to be made during the session 1917-18, and we intend to continue our experiment of last year, extending it, however, in two respects. We propose, in suitable cases, to include grants for apparatus, materials and equipment, now that we have an understanding with the Royal Society as to the method of dealing with these applications. We also propose to consider applications for personal allowances and for assistants, apparatus, materials and equipment from research workers in general and not to confine the grants, as we did at first, to workers in educational institutions.

The Encouragement of Inventors.—The problem is undoubtedly one of great importance, but also one of great difficulty. The cases which have come before us fall into two or possibly three classes. In the first class are patentees. In most of the cases that have come before us money was needed for the introduction or exploitation of the patented process or device, and when this was so we have informed the applicant that the Department cannot assist in the commercial exploitation of patented inventions. In any suitable cases, however, where funds were needed for working out on a full scale a process or device already patented, we think that we might properly recommend a grant for this purpose, since it would clearly fall within the meaning of industrial research. The second class of case is that of inventors who submit suggestions or ideas for investigation. They are advised if they wish to retain proprietary rights in their invention to obtain provisional protection before submitting details of their invention to the Department. But if an inventor is not prepared to do this, he is asked to make a full statement of his invention in confidence to a representative of the Department. His assent in writing is then obtained to the record of this statement, and before any steps are taken to conduct any research in connection with the invention, the Department consider whether they should not themselves obtain provisional protection. The third class consists of the makers of vague and impracticable suggestions, whom to treat seriously would be to waste time. The Board of Trade have recently called our attention to the question of the encouragement of inventors, and in particular to a suggestion that any trade combinations established for the erection and equipment of laboratories for experimenting with and perfecting such inventions as may be useful to their constituent members and receiving grants from the Government for that purpose, should be required to observe provisions framed in the interest of poor inventors. The Board of Trade have been informed that the Department propose to make it a condition of their recognising trade associations for research that provision should be made in the Articles of Association for the results of any researches undertaken, as obtained from time to time, being communicated in the first instance to the Committee of Council in order that the Committee may determine in the national interest whether and, if so, to what extent and under what conditions, the results shall be made available. The Department has also included among the conditions of grant to research associations articles reserving to the Committee of Council the right to determine whether and, if so, to what extent and in what proportions the Committee of Council and the association and any other co-operating bodies and persons shall secure to themselves by patents, designs or otherwise the ownership in the results of any investigations undertaken by the Association for the benefit of the X trade or industry generally, and any benefits and profits arising therefrom, and requiring that the association will enter into agreements with its employees in a form to be approved by the Committee of Council, reserving to the association and the Committee of Council or their nominee all rights and ownership in any discoveries, inventions, designs or other results arising in the course of research or other scientific work, but, nevertheless, the association will pay to the employee making any such discovery such pecuniary reward as the Committee of Council, after consultation with the Board of the Association, may consider adequate.

Assistance to Individual Manufacturers.—We have also received a number of applications from individual firms asking for assistance in dealing with difficulties encountered in the course of manufacture. The co-operative associations for research which we hope to see established will no doubt prove very useful to their constituent firms who are in difficulties of this kind, but it will take time for all the many industries of the country to organise themselves, and meantime we shall do our best to assist inquirers to obtain the best advice available. In cases where the difficulty put before us appears to raise a problem of research, we have made an arrangement with the Royal Society by which they assist us in selecting the institution or institutions or research workers best fitted to undertake the investigation in question. We shall then in suitable cases propose the problem for research, and if an assistant is required provide the necessary funds under the usual conditions. We shall inform the manufacturer of the action we have taken, and when a result is obtained we shall invite him to repay the cost of the investigation, or part of the cost of the investigation, in return for an exclusive right to the use of the results for a period to be agreed on. We have been considering other possible means of encouraging individual manufacturers who have shown in an unmistakable way that they are anxious to place their works on a scientific basis. In cases such as these we should be prepared to entertain a proposal to attach a young research worker to the works laboratory for an agreed length of time, which might be divided into three periods. During the first period the Department would pay the salary of the worker, during the second the Department would pay half and during the third the firm would pay the whole. Whatever has been accomplished would be better understood by comparing the general attitude of manufacturers to-day with their attitude before the war or even 18 months ago; by noticing the rapidity with which men of science at long last are coming to their own; by listening to the altered tone of all classes, and not least the men of business, towards the claims of education.

CORRESPONDENCE.

"MEASUREMENTS OF RADIO ANTENNÆ ON SHIPBOARD & SOME INTERESTING COMPARISONS."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the issue of June 8, 1917, on page 388, Mr. F. A. Hart gives a table of constants for radio antenna. This table is of practically no value unless the spacing of the parallel wires in the antenna is given. With this additional data the table would, indeed, be of considerable value. I hope that Mr. Hart has this data available and that you may find it convenient to publish it at an early date.—I am, &c.

Brooklyn, N.Y., July 23. F. H. KROGER.
Chief Engineer, National Electric Signalling Co.

We submitted the above letter to Mr. Hart, from whom we have now received the following reply:—

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have your communication of Aug. 13, also copy of letter to you from Mr. F. H. Kroger, of the National Electric Signalling Co., and am fortunately able to give the data asked for by him.

I do not agree with Mr. Kroger that the data previously given are valueless without the spacing values, as practically everyone engaged in radio work is familiar with the average spacing between wires. However, with this additional data the table should now be very complete.—I am, &c.

Brooklyn, N.Y., Aug. 27. F. A. HART.

The data sent by Mr. Hart are as follows:—

MEASUREMENTS OF RADIO ANTENNÆ ON SHIPBOARD.
Spacing Between Wires (in feet and inches).

No.	2-Wire	Horizontal. Ft.	in.
1		12	0
2		10	0
3		12	6
4		10	0
5		12	0
6		10	0
7		13	0
	4-Wire		
8		3	4
9		3	4
10		3	4
11		3	4
12		3	4
13		3	4
14		3	0
15		3	4
16		3	4
17		3	4
18		3	4
19		3	0
20		3	0
21		3	6
22		3	4

No.	6-Wire	Horizontal. Ft.	in.
23		2	3
24		2	3
25		2	3
26		2	3
27		2	3
28		2	3
29		2	3
30		2	3
31		2	3
32		2	3
33		*	
34		2	0
35		2	3
36		2	3
37		2	3
38		2	3
39		2	3
	10-Wire		
40		1	4

* In 33 spacing forward is 2 ft. 3 in., 80 ft. *in* to centre spacing between three wires (set each side) 12 in., spacing between two inside wires at centre 19 ft. Aft end 85 ft. from centre spacing graduates to 2 ft. 3 in.

Vertical lengths are identical with horizontal at junction of wires graduating to a point approximately 2 ft. at bottom.

Digitized by Google

THE PROTECTION OF CABLES AGAINST ELECTROLYSIS.*

Preventive measures against electrolysis are obviously preferable to steps taken after the defect has become apparent; the latter are essentially palliative and intended to stay the progress of what would otherwise prove rapid degeneration. The best course is to improve the distributing system with a view to eliminating stray currents, but as time does not always permit of a radical solution of the difficulty, palliative methods, though of secondary value, deserve study.

Electrolysis occurs when chemical decomposition is produced by the passage of an electric current, and in general there are two distinct phenomena to consider, the chemical change in the electrolyte and the dissolution of the metallic conductors. More or less moist earth, containing nitrates, chlorates and other salts to an appreciable amount, becomes an electrolytic medium, and the same is true of wet concrete. The essential factor in determining decomposition is the strength of the current straying between metal surfaces and the earth. The potential difference has only an indirect influence in so far as it determines the current, and it is impossible to prescribe a minimum P.D. below which electrolysis will not occur.

Such stray currents are commonly derived from the return of current from electric railways, employing the rail as the return. The negative side of the circuit is usually earthed and the positive insulated. The insulated positive of the circuit feeds the trolly-wire, while the negative is earthed and the rails are used as the return circuit. In these circumstances a certain portion of the current flowing along the rails may leak to earth, and may then be conveyed by lead-sheathed cables, water-pipes, &c., in the vicinity. Wherever metal surfaces constitute the anode of an electrolytic element, chemical action is liable to occur. Lead, which resists many corrosive solutions, is easily affected by the alkalis present in the soil. It may, therefore, be acted upon even at points where it serves as a cathode to stray currents. A secondary reaction takes place. The passage of a current accumulates alkali bases at the point of contact with the cable. If no trains are running and no current flowing through the rails corrosion is produced nevertheless by simple chemical action. Thus deterioration occurs not only at the point of entry of the current but also at the point of exit.

Regular and periodic inspection is essential in order to detect and avoid the ravages of electrolysis. The most effectual method of ensuring that there is no appreciable stray current is to determine the potential between the envelope of a cable and a piece of metal placed in contact with the soil in the vicinity. Should the exterior of a cable show a positive potential, the existence of a current passing therefrom into the soil must be considered. Only in the case of the sheath of the cable being completely insulated from the earth would such a current be impossible. It is also well to observe the linear fall of potential along a given length of cable and to ascertain the P.D. between it and the rail or other neighbouring conductors. These tests should show either the absence of any current passing from cable to earth, or at least that the current does not exceed a minimum prejudicial value. Such tests should be frequently applied to cables near tramways or electric railways using direct current. Extensions and alterations either of the cable-system or the tramway may materially affect the conditions on which electrolysis depends.

Whenever a cable is laid in circumstances rendering electrolysis a possible danger a preliminary inspection supplemented by periodical tests should be made. These tests should include:—

(1) The determination of the potential between selected points on the network and the adjacent soil.

(2) The determination of potential between the network and cables conduits metal bridges railway trucks, &c., at points where these approach the network.

(3) The measurement of currents circulating in the sheathes of cables.

In determining the current it will suffice to observe the indication of a millivoltmeter applied to the extremities of a given length of cable; the resistance of this length of sheath being known the current flowing is readily deduced. At points where a difference of potential suggests an appreciable current in the earth it is helpful to apply the above process to successive lengths of cable and determine, by difference, the current flowing between two successive points. Such measurements should be made at periods when the rail currents are likely to be greatest, and, if possible, at times when trams or trains are actually passing. At selected points one can with advantage obtain a record of the potential difference variations during 24 hours by means of a recording instrument. In cases where the network approaches sheets of water, and particularly when salt or blackish water is in the vicinity, the conditions should be regarded as particularly favourable to electrolysis. The tests at selected points should be repeated at regular intervals and note taken of the condition of the sheath. However, corrosion, oxidation or diminished thickness of the metal is not necessarily a proof of electrolysis, and may be due to simple chemical action. But when these effects co-exist with an indication of stray currents in the soil they afford presumptive evidence of electrolysis.

When a survey of a cable network has shown the danger of electrolysis, protective measures should be taken. The usual procedure is to provide a conductor to carry off the current which would otherwise leak to earth. The effectiveness of such a device will be indicated by a negative potential between cable and earth at all points. In some cases a leakage-conductor may be laid merely at points where the difference of potential is positive and greatest.

Conduction may be provided to the negative terminal of the works or sub-station to which the stray currents return. In certain cases such conductors may be applied to the tramway-rails, but it is essential in this case that the conductivity of the latter should be high, otherwise they may act to the disadvantage of neighbouring cables instead of protecting them. In any case, the potential at the point of attachment of the leakage-conductor should always be sufficiently low for the current to be diverted from the cable towards it.

As regards the dimensions of such leakage-conductors, experience is the best guide. If one is only operating with small lengths of say 20–30 metres, one may first employ a relatively small section, and then add, if necessary, other lengths in parallel, until the potential of the cable, as examined at various points, has been reversed with respect to the earth. By introducing an ammeter in series with the provisional conductor, and noting the difference in potential between the earth where it finishes and the point where it rejoins the return wire, we can readily determine the desirable conductivity. A given current having produced a noted variation in the potential difference between cable-sheath and earth, one can easily calculate the current which must flow along such a conductor in order to reduce the potential to zero. Knowing this current and the P.D. between its terminals we then know the resistance and hence the necessary cross-section. A more accurate method is to introduce a variable resistance in the auxiliary conductor and trace the curve of potential as a function of the current carried. The dimensions of the auxiliary conductor having been decided and adopted, the cable is again surveyed, and if at all points its potential with respect to earth is negative, it may be assumed that all danger of electrolysis is avoided.

The use of leakage-conductors is desirable when a positive potential with regard to earth exists over the greater part of the network. But one sometimes finds that small sections of cable situated in the vicinity of conduits, metal bridges, or earth saturated with sea-water, are exceptional in being positive with regard to earth, the adjacent good conductors deriving from outside the cable a large portion of the current carried to the spot by the cable in question and then by returning it again re establishing a negative potential. In such a case one may avoid the expense of installing a leakage-conductor by isolating the negative portion of the cable from the rest of the network the continuity of the armour covering being preserved by running an insulated conductor parallel to the disconnected section Some such arrangement will be desirable whenever similar circumstances give rise to a pronounced local negative potential, an effect which reacts on other parts of the network and is extremely difficult to overcome. It is not always necessary to preserve continuity of the sheath, and one may sometimes dispense with the connecting bond.

Sometimes danger of electrolysis is caused by a disconnection of a bond between rails or other interruption of the return-circuit of an electric tramway. In such cases it is best to take temporary precautionary steps and to notify the company at once of the defect in question.

In some cases one can replace leakage conductors by guard-plates, which serve to drain away outside the cable the currents which would otherwise pass into the earth from its surface. This arrangement, which can be employed when leakage-conductors would prove unduly expensive and the stray currents are not very strong, causes the decomposition to take place in the plate where it enters the soil instead of on the surface of the cable.

Among the apparatus suitable for tests as described above, may be mentioned the combined voltmeter and millivoltmeter, having five degrees of sensibility corresponding to 5, 50 and 500 millivolts and 5 and 50 volts. The resistance of the circuit may attain 500–600

* Abstract of an article in "Annales des Postes, Télégraphes et Téléphones."

Digitized by Google

ohms per volt; 5 millivolts corresponds to a resistance of about 3 ohms. Such an order of resistance increases the accuracy of measurements and diminishes the effect of contacts and connections. Standard shunts may be applied to convert the instrument into an ammeter, a range of 5, 50 and 100 amperes being convenient for electrolysis measurements. There is available a voltmeter with a zero in the centre of the scale constructed to read 10, 50 and 500 millivolts and adaptable as an ammeter to read corresponding values in amperes. It is very advantageous to have the central zero, for it is not always possible to predict in advance the direction of the current or the polarity. Moreover the direction of currents studied may alter from moment to moment during observations. When readings have to be made simultaneously at a number of points one cannot conveniently compare the indications of instruments of widely different type and sensibility, especially as the current is constantly fluctuating. Identical types of instruments should therefore be employed. Recording instruments are generally arranged to operate for 24 hours without it being necessary to replace the record sheet. Here, again, instruments with central zeros, enabling both positive and negative results to be recorded, are essential.

In determining difference of potential between conductors and earth special electrodes attached to rods may be employed. Two of these appliances should be utilised, the extremity of one of them being made of the same material as the exterior of the cable, and the other terminating in a steel point, enabling good contact with the sheath of the cable to be established. The metal terminations of these testing rods should be kept clean and polished. It is also necessary to remove oxide or other corrosion products from the surface of the cable when the point is applied.

Electrolysis is the consequence of contacts established between cables and moist soil. As such a medium is almost omnipresent, it is desirable to reduce contact of sheath and soil to a minimum. To completely insulate a cable from the earth is an operation requiring considerable care and expense. The conduits commonly employed are sufficiently good protectors, but experience has shown that even so it is impossible to avoid completely contacts between sheath and earth. The proper installation of conduits is the best means of reducing the possibility of such contacts to a minimum. Well designed and supervised junctions should avoid interruption of alignment, and suitable conduits, kept clean and preserved in cement may be recommended. The position of a cable needs careful initial supervision. It not infrequently happens that corrosions occur before any precautionary steps have been taken. An initial survey of the district by a person acquainted with electrolytic problems will determine whether preventive measures should be taken at the time the installation is made.

TOTALLY ENCLOSED INDUSTRIAL SWITCHGEAR.

The distinctive features claimed for the totally-enclosed industrial unit type switchgear listed by Geo. Ellison (Birmingham) are safety, economy and robust construction.

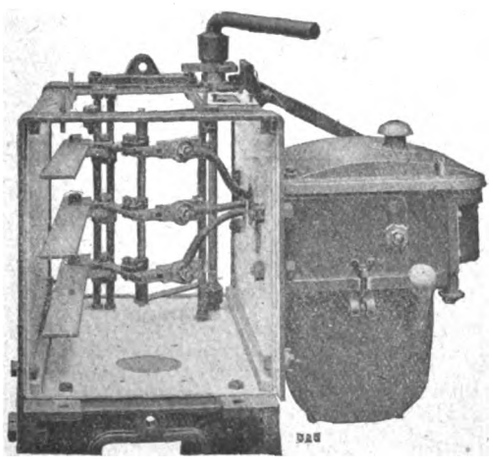


FIG. 1.—INTERIOR OF A 'BUS-BAR CHAMBER.

The list before us (No. 151) contains a variety of such appliances for mines and factories, the boards being built up from the individual elements in a very simple manner. In the two illustrations herewith are shown the interior of a 'bus-bar chamber, and a typical two-panel board with star-deltas. Such gear is appropriate for a plant capacity of about 1,000 kw; above this the cellular type of board is required.

It will be seen from Fig. 2 that the units are supported on cast iron stands, and are bolted together so as to form a compact totally-enclosed switchboard. The 'bus-bars are clamped to mica-insulated steel rods, and are made continuous by links connecting each unit, this construction rendering the boards exceedingly strong longitudinally. For multiple-panel switchboards special interlocking safety arrangements are made.

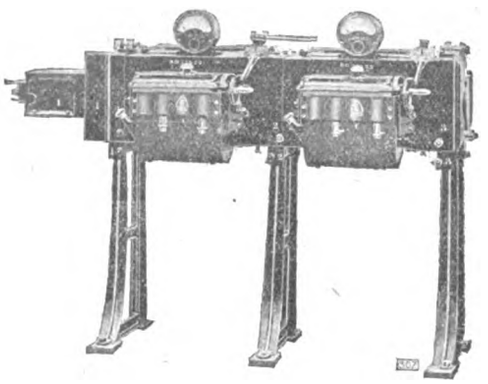


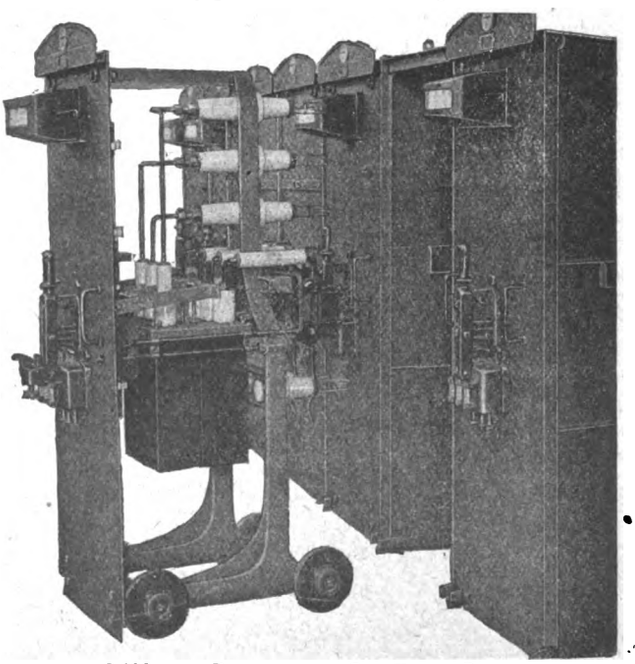
FIG. 2.—TWO-PANEL BOARD WITH STAR DELTAS.

The list also comprises control apparatus of various kinds, such as series-parallel starters. A supplementary list (No. 304) gives particulars of totally-enclosed limit and emergency switches for cranes, hoists, lifts, &c., and these again appear to be of an exceptionally substantial and well-protected character. The switch contacts are closed by a copper roller, which is made to swivel, thus keeping the contacts cool and diminishing pitting to a minimum, while a double toggle mechanism ensures the switch being either positively open or closed.

B.T.-H. TRUCK-TYPE IRONCLAD SWITCHGEAR.

A recent list issued by the British Thomson-Houston Co., Ltd. (No. 3,313), describes the company's latest forms of Truck-type Ironclad Switchgear for Polyphase Systems up to 11,000 volts.

A feature of this switchgear is the attention given to safety requirements, all live parts being enclosed so that accidental contact therewith is impossible. The complete equipment is mounted on a truck which can be withdrawn without dismounting bus-bars or isolating switches and removed to any convenient place. Continuity of supply can thus be obtained while any particular circuit is being overhauled.



6,600-VOLT PANELS, WITH ONE TRUCK REMOVED.

The switchgear illustrated includes alternating current switchboard panels, oil- and auxiliary switches, synchronising gear, instrument transformers and accessories, &c. The illustration shows a typical 6,600-volt panel with truck removed. It will be noted that all high-tension bus-bars and cable connections are carried on porcelain insulators, mounted on castings which are built up to form a complete "cell." The framework is so designed that a new panel can be added at any time.

At the conclusion of the list there are a series of detailed drawings of polyphase panels of various types, and a set of four photographic illustrations shows very clearly how trucks and oil-switches can be safely handled.

Digitized by Google

ELECTRO-TANNING.

We have received some particulars of the methods of tanning due to Dr. L. A. Groth, and now being developed by Electro-Leather Industries (Ltd.) at the Grothine Works in Coulsdon. We gather that the subject has been discussed in Dr. Groth's book on "Modern Tannage."

The claims of Dr. Groth are (1) that the loss in weight of fresh market hides, caused by fermentation, will be entirely avoided by means of "Grothine"; and (2) that a pure and strong tannage of heavy hides will be produced in six weeks with a reduced working capital by 75 per cent. and at 50 per cent. of the ordinary cost of production, the quality of the leather produced being unsurpassed by reason of its uniform tannage. Four suspender pits only are needed for a weekly input of 40 hides, all the other ordinary pits being dispensed with.

It is stated that the working and checking of figures will be undertaken by Government representatives, and it is hoped that the processes will have a very beneficial influence on the British leather industry.

We understand that, apart from the system of "electro-tanning," antiseptic germicides and other chemical specialities are being made. It would be interesting to receive fuller details of the electrical side of the work. We need scarcely remark that the subject is not new.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

6,517 HAY. Systems of telegraphy. (5/5/16.) 108,330.
10,950 DONOVAN & DONOVAN. Electric switches. (3/8/16.) 108,357.
10,999 CROSS. (Svenska Aktiebolaget Gasaccumulator). Detectors for wireless telegraphy. (3/8/16.) 108,361.
11,348 SWITCHGEAR & COWANS & NEEP. Starters for electric motors. (11/8/18.) 108,366.
11,972 STERLING TELEPHONE & ELECTRIC CO., BELL & DAVEY. Mine signalling keys. (23/8/16.) 108,373.
12,441 B.T.-H. Co. (General Electric Co.) Electric measuring instruments. (2/9/16.) 108,379.
12,709 SHADO-LITE MFG. CO. & MCPHERSON. Lighting means for motion-picture auditoriums. (7/9/16.) 108,380.
12,758 HENLEY'S TELEGRAPH WORKS CO. & WAKEFIELD. Shoes or sockets for electric cable terminals. (8/9/16.) 108,381.
13,798 FORBES & COLLETT. Therapeutic arc lamps. (28/9/16.) 108,392.
14,930 COMSTOCK. Method and apparatus for controlling electric arcs. (20/10/15.) 101,885.
15,007 ELLISON & ANDERSON. Electric motor controllers and like apparatus. (21/10/16.) 108,403.
15,053 GARDE. Electric candle fittings. (23/10/16.) 108,406.
18,503 LUCAS & BREEDEN. Electric signalling lamps. (27/12/16.) 108,424.

1917 SPECIFICATIONS.

1,347 AUTOMATIC TELEPHONE MFG. CO. Automatic telephone systems. (14/2/16.) 104,171.
1,754 B.T.-H. Co. & HASTINGS. Electric motor control and apparatus therefor. (3/2/17.) 108,430.

The system comprises separately actuated switches adapted to operate in succession, and electro-magnetic auxiliary switches the magnetic force of which varies with the E.M.F. generated in the machine under control, each of said auxiliary switches being mechanically interlocked with a contactor and arranged to control the closing of the next contactor in succession, so that this contactor can only close when the speed of the machine has reached the value at which the auxiliary switch is set to close.

5,588 ROUND. Electrodes for electric arcs for medical and other purposes. (29/3/17.) 108,437.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

July 27, 1917.

10,785 HOBLEY. Forming and treating electrical coils.
10,794 AUTOMATIC TELEPHONE MFG. CO. & ROSEBY. Magnetising coils.
10,813 DELVES-BROUGHTON. Magnetic drive for petrol pumps.
10,817 TELEPHOS DOMESTIC & STREET LIGHTING CO. & FRANCKS. Operating electric switches from a distance.
10,822 B.T.-H. Co. (G. E. Co.) Electrical induction apparatus.
10,830 BROWN. Utilisation of high-frequency oscillations in wireless installations.
10,832 BIRRELL & CAVENAUGH. Telephone transmitter.
10,843 SYNDICAT GRAAMANS PATENT. Electric batteries. (29/7/16, Holland.)

July 28, 1917.

10,859 Tramway systems and transporting goods thereon.
10,884 SPIDY. Sparking plugs.
10,885 VANDERVELL & MIDGLEY. Electric starters for internal combustion engines.
10,896 DRESCHER. Electric switches.

July 30, 1917.

10,944 WARD. Electric battery lamps.
10,962 RANKIN. Electrical switches.
10,963 B.T.-H. Co. (G.E. Co.) Fluid pressure brakes.

July 31, 1917.

11,028 FRICKER. Distillation and refining of zinc, &c.
11,031 B.T.-H. Co. (G.E. Co.) Electric motor control systems.
11,034 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Power operated switches.
11,035 & 11,036 IGRANIC ELECTRIC CO. (Cutler Hammer Mfg. Co.) Electric circuit controllers.
11,038 LONGHI. Circuit-breakers.

August 1, 1917.

11,060 BROWN & SCHEITLIN. Manufacture of electrolytic compounds.
11,064 OATES. Electrode lamp connector.
11,065 AUTOMATIC TELEPHONE MFG. CO. & HARRISON. Telegraph systems.
11,071 THOMPSON. Magnetic compass.
11,073 BINNIE & LUCAS. Electric detonators.
11,078 LODGE SPARKING PLUG CO. & HOPPS. Sparking plugs.
11,079 CHLORIDE ELECTRICAL STORAGE CO. & DEAN. Secondary batteries or accumulators.
11,081 ANTONOFF. Electric batteries.

August 2, 1917.

11,112 CUTHBERT & KEESON. Electric induction apparatus and submarine detectors.
11,121 GABRIEL. Brackets or supports for lamps, &c.
11,149 B.T.-H. Co., HAMLYN & SUGDEN. Starting devices for electric motors.
11,154 ANTONOFF. Electric batteries.
11,160 CAMPBELL. Utilisation of light of electric lamps.

August 3, 1917.

11,217 GARBARINI, GAUTIER & MANCLAIRE. Arc lamps with rotary arcs, and wireless telephony and telegraphy.
11,222 CROMPTON & PENSABINE. Dynamo-electric machines.
11,226 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Motor control systems.
11,230 ENFIELD ELECTRIC CABLE MFG. CO. & WISE. Machines for trimming ends of insulated wires.
11,231 ANTONOFF. Electric batteries.
11,235 & 11,236 MASON. Ignition dynamos. (15/9/16 U.S.)
11,249 (Pittsfield Spark Coil Co.) Make-and-break devices.

August 4, 1917.

11,287 GUINNESS. Electrical couplings or connections.
11,289 VANDERVELL & MIDGLEY. Self-regulating dynamos.
11,298 OSRAM & ROBERTSON LAMP WORKS & DRIVER. Means for supporting electrodes in ionic tubes.

August 7, 1917.

11,348 ELMORE. Extraction of lead and zinc from their ores.
11,350 RITCHIE. Printing telegraph.
11,357 KHISANACHVILI. Magnetic clocks for holding iron and steel during grinding, &c.
11,358 KENNINGTON. Means for controlling electric circuits.
11,360 SOC. FRANCAISE RADIO-ELECTRIQUE. Alternating-current generator and group converter. (4/8/16, France.)

August 8, 1917.

11,380 SANTANGELO. Thermo-electric generators.
11,389 FULLER ACCUMULATOR CO. Lamps or lanterns for aircraft.
11,390 FULLER ACCUMULATOR CO. & BROWN. Lampholders for electric lamps.
11,392 B.T.-H. Co. (G.E. Co.) Electric transforming and converting apparatus.
11,399 GEHRIG. Automatic regulator for electric machines.
11,420 KENNINGTON. Ignition devices for internal combustion engines.

August 9, 1917.

11,440 GRANT. Igniting spark for internal combustion engines, &c.
11,457 SOC. LORRAINE DES ANCIENS ETAB. DIETRICH ET CIEDE LUNEVILLE. Ignition apparatus for aviation engines. (16/8/16, France.)
11,465 BOSCH. Interrupter for electric circuits.

August 10, 1917.

11,486 MORPHY. Apparatus for rectifying h.t. discharge from transformers, &c.
11,489 FRASER. Dynamo-electric machines.
11,490 HENERG. Control of electric motors for cranes, &c.
11,497 JONES. Electrical distilling apparatus. (7/12/16, U.S.)
11,505 B.T.-H. Co. (G.E. Co.) Electrical induction apparatus.
11,506 LONG. Alternating-current circuits.
11,511 CARY. Electric welding.
11,528 SEYMOUR. Electric cables or conductors.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Officer Commanding: Lieut.-Col. C. B. Clay, V.D.

Orders for the Week :—

Officer for the week.—Sec.-Lieut. E. A. Ullmann.

Next for duty.—Sec.-Lieut. C. E. Campbell.

Extract from "Gazette."—County of London Volunteer Engineers. Alfred Hugh Gibbon to be temporary Lieut. and Medical Officer, 10th Aug. 1917.

Monday, September 17th.—Technical instruction (searchlight) for No. 3 Company, Right Half Company, at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling class, 6.30. Recruits' drill, 6.30.

Tuesday, September 18th.—Physical drill and bayonet fighting.

Wednesday, September 19th.—Drill and elementary bridge construction for No. 1 Company, Left Half Company.

Thursday, September 20th.—Drill and elementary bridge construction for No. 2 Company, Left Half Company. Signalling Class, 6.30. Ambulance Class, 6.30.

Friday, September 21st.—Technical instruction (searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' drill, 6.30.

Sunday, September 23rd.—Commandant's parade for technical instruction at Esher. Parade at Waterloo Station 8.45 a.m. opposite No. 10 platform. Uniform, haversacks, water-bottles to be worn. Midday rations to be carried. Compulsory for "A" and "B" men.

Band.—All Buglers and Drummers who have not attested are required to attend on Monday or Thursday next at 6 p.m.

Uniform.—"A" and "B" men are warned to attend Headquarters on Tuesday, September 18th, to be measured by the Regimental tailor for the Service uniform.

Musketry.—All N.C.O.s and men who have signed the "A" and "B" agreements are required to attend during this month to re-classify in order to enable the Corps to obtain the Capitation Grant. Preference will be given to these men in firing. This does not apply to those who hold the proficiency badge.

Armlets.—The new issue armlets can now be had at Headquarters and every enrolled man must obtain one without delay, at the same time all old red armlets (now obsolete) must be returned.

Note.—Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street).

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

Ministry of Munitions' Lead Order.

The Minister of Munitions has taken possession as from September 1 until further notice of all pig lead, whether virgin or remelted, old and scrap lead and lead residues in the United Kingdom, excepting such lead as may be in the possession of or due under an existing contract in writing for future delivery to a manufacturer for use in such manufacturer's own works, and all such lead as may be specially excepted under the written authority of the Minister of Munitions.

The lead of which possession is taken until further notice will be paid for by the Minister of Munitions on delivery at the undermentioned rates: Virgin pig lead, £29 per ton c.i.f., or £30 ex store or refiner's works; sheet lead, £39. 10s.; lead pipe £40 (usual trade allowances to apply).

* * * *

Work of Chambers of Commerce.

The status of Chambers of Commerce throughout the United Kingdom, which has already been considered by a special committee of the Association of Chambers of Commerce, will be further considered at a meeting in October, when the presidents and secretaries of the various Chambers will be invited to attend.

Much encouragement has already been given to the promoters of the movement for extending the scope of the work undertaken by Chambers of Commerce by the recent decision of the Foreign Trade Department of the Government to entrust to the Chambers throughout the country (through the Central Association in London) certain work which the Department was of opinion could best be discharged through their agency.

* * * *

Registration of Business Undertakings in Italy.

A Decree, dated July 18, provides that the notification of the establishment of a commercial or industrial business prescribed by Law No. 121 of March 20, 1910, in accordance with the regulations approved by the Decree of Feb. 19, 1911, must be given in writing, and must show, in addition to the information already required by these regulations, the nationality of each of the partners in unlimited liability companies, of the joint partners in partly limited and partly unlimited liability companies, and of each director in limited liability companies. Persons born in countries in which their nationality is not lost by reason of their acquisition of foreign nationality must notify their original and acquired nationality. Firms and companies existing at the date of the Decree must, before Sept. 30 present to the Chamber of Commerce and Industry of their respective districts a written notification of their nationality, even if they have already given notice of this.

* * * *

Trade Marks in Argentina.

The British Chamber of Commerce in Buenos Ayres recently sent a letter to the Association of Chambers of Commerce of the United Kingdom, asking the latter to call the attention of British firms to the necessity of registering their trade marks in Argentina.

The letter states that German firms are registering English words and phrases as trade marks there, including well-known British marks. Protests by reputable British trade mark agents (furnished with proper power of attorney in Spanish and legalised by the Argentine Consul) are generally successful. Mr. John Ballantyne, River Plate House, London, E.C. 2, has been supplied with forms in which the power of attorney should be drawn.

* * * *

Australian Metals.

According to a recent statement by the chairman of the Sydney Metal Exchange, the Federal Government propose that all minerals produced in Australia will in future be treated in Australia.

An exchange similar to the London exchange is to be established, and instead of metals being sold to London they will be sold to Sydney and Melbourne. Mr. Hughes is endeavouring to fix a standard price for copper for three years, and if the smelters are willing to heat all grades of tin ore at a fair price he is prepared to stop the exportation of tin ore for all time. The Government has already made arrangements for fixing the prices of zinc for 10 years, and in regard to rare metals a scheme is under consideration whereby the Government will take over the whole of the tungsten production at the world's current prices. It is also announced that Australia will probably have a representative at the Material Resources Bureau in London.

* * * *

Swedish Industries.

In a survey of Swedish industries the "Financier" points out that the war has intensified many industries in Sweden, and the movement began some years ago is apparently a permanent industrial policy. Sweden will not only buy more raw materials and improved machinery and factory appliances, but also compete more vigorously in its own and in foreign markets. Technical education, increased shipping and banking facilities, the establishment of selling agencies at home and abroad, the careful preparation of trade literature, and other aids are all tending in the same direction.

Sweden has benefited by the return of many engineers and other factory employés of Swedish birth who have been trained in the United States and other countries. Increases in capital were made during 1916 by about 600 joint-stock industrial and trading companies, the new issues amounting to £12,966,400. With a scarcity of coal the country has relied chiefly upon charcoal in the smelting of iron. In recent years a number of electric furnaces have been built. The cost of iron smelting with charcoal and with electric current has confined these methods to the making of pure ores for high-grade iron and steel. Rails, plates and structural iron are made at some Swedish works from ore smelted with foreign coke, but much of this class of material is still imported, as is practically all foundry iron needed in the country. A new company, organised to supply these requirements, has one blast furnace with coke works representing an investment of $2,000,000 ready for operation. Two more furnaces with steel works and rolling mills are soon to be built, but the coal will be imported. The exports of pig-iron in 1915 and 1916 were 5,994,000 and 5,539,000 tons respectively. The Swedish iron industry has been fostered by the Iron Institute of Sweden, an organisation dating from the middle of the eighteenth century, which advances capital in the form of loans to assist those engaged in the industry and grants considerable sums to be used in research in connection with mining and other technical schools, in exhibits at domestic and foreign expositions, &c. It employs technically trained experts to assist members of the association.

In the electrical industry, represented by several important concerns, there has been consolidation, increase of capital, rapid growth and the diligent seeking of new markets. At Stockholm is carried on the exclusive manufacture of Diesel engines of both stationary and marine types in sizes from 12½ B.H.P. to 2,000 B.H.P.

Of the available water power in Sweden, estimated at 6,000,000 H.P., about 15 per cent. has been utilised. The number of hydro-electric plants in operation or in process of construction in 1915 was 453. Water-power is employed to produce approximately one-half the total annual value of Swedish manufacture. Among the industries using it in 1915 were the following: Timber and pulp, 260,000 H.P.; iron, 235,000 H.P.; electro-chemical, 90,000 H.P.; and textile, 40,000 H.P. The total power developed from coal and oil for industrial purposes is about 400,000 H.P. Of the installed water and steam power about 60 per cent. is transformed into electric power.

Industrial prosperity in 1916 would have been unparalleled but for the shortage in raw materials. The wood pulp industry, dependent upon Norway for its supply of sulphur pyrites, could obtain only a limited amount, and it was exceedingly difficult to import substitute material from the United States. Machine shops and shipyards were unable to import sufficient metals for their needs, and the scarcity of rubber not only closed factories dependent upon rubber for raw material, but also put out of commission practically all the automobiles and taxicabs in Stockholm city and district.

* * * *

Japan's Commercial Progress.

In the first half of the current year there was a great increase in the values and quantities of manufactured goods exported from Japan. In most industries there was an expansion of enterprise which necessitated an increase in the aggregate of capital employed. The "Financier" states that the total capital stock of various partnership and joint stock companies projected during the first six months of 1917, including capital increases of existing concerns, is estimated at £56,000,000, which is 100 per cent. in excess of similar projected investments during the corresponding period of any previous year. Of the total mentioned, £19,000,000 was for manufacturing industries, £11,200,000 for banking, £5,600,000 for mining and £4,100,000 for electrical engineering undertakings.

* * * *

U.S.A. Copper Situation.

The copper statistics of the United States for the first six months of the current year show consumption far in excess of production, with an increase of over 3 cents a pound in cost of production over the first half of 1916.

The copper production of the mines and smelters which market their output through the United States was 1,266,377,000 lb. in the first six months of 1917. The refineries' output of merchantable copper metal, including crude copper marketed without passing through the refineries, was approximately 1,200,000,000 lb. during this period. The consumption of copper was at least 1,315,000,000 lb., including 615,000,000 lb. of copper ingots, &c., exported; 180,000,000 lb. of copper in brass exported, and at least 520,000,000 lb. of copper consumed in the States. The six months' consumption of copper exceeded the refineries' output by 115,000,000 lb., and exceeded the mine-smelter output by over 48,000,000 lb.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Bootle.—Last week the Council considered a recommendation of the Electric Power and Lighting Committee to approve estimates of expenditure of £71,000 to be incurred after the war on works and plant required in connection with the electricity undertaking, and to apply to the Local Government Board for sanction to a loan of that amount.

Mr. F. W. KING (chairman of the Electricity Committee) said the resolution was brought forward in reply to an inquiry from the Local Government Board asking the amount of work required by the Corporation after the war, and the estimate was only provisional. Undoubtedly more plant would be required. They must meet the demands of the town and others who contemplated coming in for new sites, and only a short time ago business which would have demanded a supply more than equal to the present output had to be refused. Their plant was so overloaded that they were generating something like double the capacity they should.

An amendment moved by Ald. Smith, that expert advice be obtained, was carried.

Royton (Lancs).—The Council at their last meeting discussed the proposed agreement for the supply by Oldham Corporation of electrical energy to the Royton and Crompton districts.

The heads of the agreement were approved, subject to the Royton Council having a transformer station in their own area, and to their being advised by their Parliamentary agents that the agreement would not prejudicially affect their rights in re-leasing the tramways when the time came.

Sheffield.—Extensions of mains are to be carried out at an estimated cost of £7,100.

Of the total, £5,202 are to be spent in extensions to Messrs. Kayser Ellison & Co.'s works. A plot of land adjoining the Neeppend power station is to be purchased. at £125.

The Finance Consultative Committee has approved proposals of the Electric Supply Committee with regard to spending £560,000 on the Blackburn Meadows power station, installing machinery, &c.

GENERAL.

Coal Distribution and Electricity Works.—Mr. A. J. Blackler stated at the meeting of Torquay Council last week that the electricity department had made a favourable contract for coal extending till next August, but the Government had ordered that the contract must be set aside, and that they must procure their coal nearer than Yorkshire.

At the meeting of Dundee Electricity Committee on Monday the convener (Mr. Nairn) explained that they had got notice that the company which supplied them with coal was to do so no longer, and that they had been allocated to a company that had only a fourth of the output of the other. They had been writing for a fortnight about it.

Bailie NOBLE, Convener of the Coal Committee, said if the Electricity Committee was in trouble about coal it should write to the Coal Committee—it should take advantage of the machinery set up by the Government.

Increased Charges for Electrical Energy.

Stratford-on-Avon Council has referred to a special committee a proposal by the local electricity supply company to increase its charge for current for lighting from 6d. to 6½d. per unit.

West Hartlepool Tramways Committee has agreed to an increase of 15 per cent. in the charge for current for the tramways.

The Richmond (Surrey) Electric Light & Power Co. has increased its charges by 15 per cent. as from Aug. 22.

Maidstone.—The Council has decided to increase the salary of Mr. E. E. Hoadley, borough electrical engineer, from £500 to £550 per annum as from July 1, and those of Mr. H. Wilson, mains superintendent, to £190, and Mr. G. E. Wintle, station superintendent, to £185 (inclusive of all bonuses), as from July 13.

Meltham (Yorks.).—The Yorkshire Electric Power Co. having intimated its willingness to negotiate for a supply of electrical energy for Meltham, the Urban Council has referred the matter to its Lighting Committee.

Perth.—The demand of the employees of the electricity department for increased wages has been referred to arbitration.

Walsall.—An appeal is to be made against the assessment of the Wolverhampton-street works on the ground that since the Birchills generating station commenced to operate the former station is over assessed.

Wigan.—In presenting the minutes of the Electricity Committee last week the chairman (Ald. Grimshaw) gave some particulars of the present position of the electricity undertaking and of the progress made.

Referring to the question of the inter-connection of electricity undertakings, he asked members to keep an eye on the question, because they were afraid that it might not always be to the best interests of a town such as Wigan. Several proposals had been made by the engineer (Mr. R. Owen) for increasing the revenue by putting upon the smaller consumers some of the responsibility for their position. They considered that small consumers had been obtaining their services at a smaller rate than it was possible for them to supply. Mr. Owen had realised the sum of £1,278 in respect of the sale of scrap copper, brass, lead and iron which had been lying about the yard. Out of the amount realised they had decided to pay £300 for the intake tank for the new condenser, leaving about £900 for the suspense account.

From the balance-sheet of the last year they would see that they had burned 2,400 tons of coal less, but the price was £371 more, and the output was nearly a million units more than the year before. Coal, water, oil, wages, engines, boilers, and other machinery cost the department £23,000, against £12,000 the year before. They had to pay £700 to the bank for increased interest on their deficit. The returns showed a loss of just over £7,000, and as they had a leeway of £5,000 to make up to the Lancashire Electric Power Co., the adverse balance for the prospective year ending March 31 next was about £12,000. The increased price would bring them £800, and the 7½ per cent. they had put on the lighting would realise about £400, so that the prospective deficit they would have to face would be £10,800 net.

Wolverhampton.—At Monday's meeting of the Corporation the chairman of the Electricity Committee (Councillor Thompson) announced that the gross profit of the electricity department for the past year was £27,776, and the net profit £2,121.

Mr. THOMPSON said the expenses had increased. The station had been run with a loss in electrical current very much less than in the previous year. The reserve fund for so large an undertaking was inadequate, and he hoped it would be added to. He did not know what the position would have been had the committee not ordered more machinery some time back. There had been delay in its delivery, but he was glad to say it would be running a few weeks hence. The demand for current had increased by leaps and bounds. He believed that the new outlay would furnish a good return. During the year they had increased the output of current, and at the same time had reduced the management charges. They had not increased their charges as they should have done; as a consequence consumers had benefited at the expense of the reserve fund.

LIGHTING AND INDUSTRIAL POWER.

Aberdeen.—The Plans Committee of the Town Council has passed the plans for an electric power station at the paper mills of the Donside Paper Co.

Hydro-Electric Power in Ireland.—Last week Antrim County Council received and adopted a resolution of the Dublin section of the Institution of Civil Engineers which requested the Board of Trade Electrical Committee to take steps to ascertain the various places in Ireland where hydro-electric power is obtainable and the amount of power at each place, with the data giving the volume of water at different times of the year.

Lye (Staffs).—The Urban Council, having failed to secure a reduction of £10 in the amount of £160 charged for unlighted lamps by the Stourbridge municipal gas department, has decided to give six months' notice to terminate the public lighting contract, and has made arrangements with the Midland Electric Corpn. for Power Distribution for the lighting of seven lamps electrically. It has been suggested that the Urban Council should carry out after the war the provisions of its electric lighting order.

ELECTRIC TRACTION.

Aberdeen.—The salary of the general manager of the tramways (Mr. R. S. Pilcher) has been increased from £500 to £550 per annum, with a further increase of £600 on Aug. 1, 1918.

Bolton.—Four tenders for the supply of a 2-ton electrically-propelled vehicle are being considered by a sub-committee of the Electricity Committee.

Cardiff.—The Corporation has approved plans, prepared by the City Engineer, for the conversion of premises into an electric vehicle garage. The estimate of £50 for the necessary charging plant has also been approved.

Charging Stations for Motor Vehicles.—The Chief Commissioner of Police has issued to the highway authorities in the Metropolitan Police district a circular, of which the following is an abstract:—

A problem on which the Commissioner feels that an interchange of views between the local authority and the police might prove advantageous is that of the supply to motor vehicles on the road of fuel, water, power, &c., and it is likely to demand urgent attention after the war, when motor traffic, especially the heavy variety, will increase in volume. Owners of steam wagons have been agitating for roadside supplies of water, and now advertisements are appearing of installations for the supply of petrol by flexible hose from a stand-pipe on the footway.

Digitized by Google

Power for electric trucks can be supplied in the same way and doubtless attempts will be made to secure permission from local authorities to charge vehicles from plugs by the roadside. A later development is the running of petrol engines on ordinary gas, and the same facilities are likely to be asked for in this case also.

It is obvious that there is great objection, even if an inevitable result were not the congregation of vehicles at any particular spot, unless the places have been selected after the most careful consideration.

In most districts where there is appreciable pedestrian traffic the pavements are already too narrow to meet the present demand. Public service requirements involve a portion of these congested pavements being utilised in various directions for lamp-posts, pillar-boxes, sand-bins, &c., and any further encroachment of their limited space for what are private purposes, although in many cases useful purposes, should be jealously regarded.

It will be advantageous to consider the question in all its bearings as soon as possible, in order that a definite policy may be formulated before the conclusion of the war, and before the question is complicated by the erection of isolated installations, and therefore the Commissioner invites the co-operation of the highway authorities in considering the subject, and he invites their observations upon it.

Electric Vehicle Results at Belfast.—A report by the city electrical engineer, Mr. T. W. Bloxam, to the Tramways and Electricity Committee, u on electric compared with petrol vehicles, was presented to the City Council last week.

The report states that in May, 1915, the department commenced using an electric wagon with Edison battery in place of a petrol-driven wagon for the ordinary repair work of the overhead equipment, and a material saving in cost had resulted, as the greater facility for starting, stopping and manœuvring in traffic more than counterbalanced any loss of time on the road, unless the journey was to a distant part of the city. During the 2¼ years ended July, 1917, the electric wagon ran 7,398 miles, and used 6,651 units of electricity (0·89 units per mile), the cost per unit for the past year being 1·137d. per unit. The petrol vehicle ran 5,800 miles, and used 1,621 gallons of petrol (0·28 gallon per mile), the cost per gallon being 2s. 3⅞d. Therefore, during the year to March, 1917, the "electric" cost 1·01d. per mile for electricity, and the "petrol" cost 7·77d. per mile for petrol, a difference of 6¼d. per mile, or £70 per annum. The repairs required by the "electric" are substantially less than those necessary for a petrol vehicle. The only repair done (the re-winding of the armature of the motor) was the result of an accident. Certain firms in the city have for some time realised the considerable saving that can be effected by the use of commercial electric vehicles. One firm has two 5-ton Edison battery lorries, two 1-ton Edison battery delivery vans, and one ½-ton Edison battery delivery van in use. These are charged by this department during the night, and represent a revenue of about £200 per annum, without involving the department in any additional capital expenditure for machinery or mains.

Middlesbrough.—The Imperial Tramway Co. recently increased tramway fares by 50 per cent., but the Hackney Carriage Committee of the Corporation is endeavouring to get the company to revert to the old fares, or at least to introduce penny stages.

Munitions Tribunal.—*Belfast Municipal Employées.*—Last week a general munitions tribunal for Belfast and North East Ireland was held by Mr. R. W. W. Littledale, K.C. Belfast Corporation charged 32 employés in the electricity department with having contravened the Munitions of War Act, 1915, by taking part in a strike in connection with a difference as to terms or conditions of employment without such differences having been reported to the Board of Trade.

Mr. A. J. LEWIS, for the Corporation, said the men had no semblance of a grievance, either as to wages or conditions of employment. The defendants were employed in the electricity department, and on Aug. 23 they wired to the Town Clerk at the City Hall that they were going out on strike at 6.30 the next morning because the tramways manager had reduced the wages of other men.

Mr. T. W. BLOXAM, manager of the electricity department, gave formal evidence, and it was brought out in cross-examination that the strike was in sympathy with a grievance suffered by electrical men in the tramways department.

Mr. BLACK, for defendants, said the employés in the two departments were interchangeable, and defendants were directly interested in the dispute in the tramways department. After a short adjournment, Mr. Lewis announced that the defendants had agreed to go back to work unconditionally. The Chairman said had the cases gone on he would have felt it his duty to impose very heavy fines. The order of the Court was that the men should go back to their work on the following day (Sept. 5), and continue at their work until such time as the cases were finally disposed of by the tribunal. The Court then adjourned for a fortnight.

Tramway Assessment.—The Assessment Committee of Brentford Union has had under consideration an appeal from the London United Tramways (Ltd.) for a reduction of their assessment.

The present assessment, which was confirmed some years ago by the Divisional Court and the Court of Appeal, is £40,537 gross, £10,302 rateable. The grounds of the company's appeal are depreciation and falling off in the patronage of the lines. The Guardians' assessor (Mr. R. C. Lowe) reported that the company asked for a great reduction—practically to nil. The Guardians were unable to agree to the new figure. He had been furnished with a copy of the official statement prepared for the Receiver for the debenture holders. It showed that the company had been unable to set aside much for repairs of rolling stock. Mr. Lowe said he did not know the fares were going to be increased, and if they were, it did not follow there would be profits. The further consideration of the matter was deferred.

Walsall.—The parcels rates on the Corporation tramways are to be increased.

Women Tramway Employees.—Of a total staff of about 5,600 persons employed by the Glas_ow tramways department, about 2,500 are women.

These include 1,360 conductors, 400 drivers, 13 switchboard attendants, 6 street switch box inspectors and 490 cleaners.

IMPERIAL NOTES.

Australasia.—The "Australian Mining Standard" says the Electrolytic Refining & Smelting Co., of Port Kembla (N.S.W.), has issued a circular to its shareholders, pointing out that the British Ministry of Munitions will not pay the current market price for electrolytic copper (£140 per ton), and that, until further notice, the company's price will be £112. 5s., subject to tariff, charges, £2. 8s. 4d. being deducted to cover cost of delivery from Kembla to Sydney, and for interest charges during the period of treatment.

Treatment and realisation charges vary from 4s. 6d. to 6s. per unit, according to the class of ore, and on an average of 5s. per unit the return to the producer is £114. 13s. 4d., less £25. Those copper companies which have sold their output to the British Government in advance of production are not affected by this notification.

Trouble which threatened recently between Melbourne City Council and its electrical employés was averted by a conference between the Electric Supply Committee and representatives of the Trades Hall Disputes Committee and the Federated Enginedrivers and Firemen's Association The following are the daily wages finally agreed upon, the rates demanded (where different) being given in parentheses: Enginedrivers 13s. 6d. (13s. 9d.), Assistant enginedrivers 12s. 6d., leading firemen 12s. 6d., firemen 11s. 6d., trimmers 10s. 6d., coal conveyer attendants 11s. (12s.), switchboard attendants 13s. (13s. 6d.), sub-station attendants 12s. 6d., dynamo attendants 10s.

In the Equity Court, Sydney, recently, Mr. Justice Harvey made, on the application of the General Electric Co. and the British General Electric Co., and order restraining J. Ossawa & Co., of Sydney, from infringing their trade mark.

The Federal Minister of Works and Railways (Mr. W. A. Watt) recently inspected the station set up by Mr. J. G. Balsillie, at Bookaloo, for the accommodation of his rain-producing plant, which the Federal Government has already taken over. The results achieved, it is said, have been so satisfactory that contracts are likely to be completed shortly for the erection of additional stations. Already other stations have been installed along the railway routes, besides that at Bookaloo.

Mr. J. E. Carne, Government Geologist, in his report on the tungsten mining industry of New South Wales, records wolfram at Nangerybone, Mount Tallabung, and Eremeran Range. Recently, Mr. L. J. Jones, assistant geological surveyor, was sent to examine and report upon an occurrence of the metal about two miles west of Nangerybone homestead, on Eremeran Station, County Mouramba, and about 28 miles south-east of Nymagee, and 11 miles north-west of the Eremeran Range. He describes the country rock as typical granite traversed by quartz veins, to which the wolfram appears to be confined, as it has not, so far, been found as an impregnation in the country. The reefs vary from 2½ in. to 11 in. in width, and have been proved for lengths varying from 1 chain to 6½ chains, and in the latter case, with the exception of occasional short blanks, the wolfram persists for the entire length proved, while in other cases the metal is irregularly-distributed, lean in parts with occasional rich bunches. Further developmental work is necessary to prove the permanency of the deposits and whether they can be profitably exploited.

A party prospecting for molybdenite on Mount Marsden, about 17 miles south of Lithgow, have discovered a strike of payable ore in three places. The party are preparing to work in a larger way than hitherto. Another good molybdenite claim is that owned by the Havalah Molybdenite & Wolfram Co., some distance from Lithgow, in the direction of Mudgee. There are both molybdenite and wolfram in the lode, which generally are found together in the ore.

The sale to the Thermo-Electric Ore Reduction Corpn. of wolfram and molybdenite mines in Queensland was negotiated by Mr. Fred. G. Brown, who visited London for that purpose. The Thermo-Electric Co. proposes to instal up-to-date machinery for working the mines to their maximum capacity. Some of the mines have not been worked for years. The machinery to be installed would include four 250 H.P. Diesel oil engines, and a complete electrical installation. It is also intended to increase the reduction plant from the present 10 head to 40 head of stamps, and it is hoped thereby to increase the production of wolfram in the district alone from 200 tons to at least 1,000 tons per year, with a corresponding increase of molybdenite and bismuth. The company is also negotiating for the purchase of the Mount Carbine wolfram mines, situated at the back of Cairns. For two years prior to the outbreak of war these mines produced 600 tons of wolfram, but for two years after the opening of hostilities only 100 tons were produced. At these mines the minimum capacity would be 500 tons of wolfram per annum. The Thermo Corpn. proposes to spend £150,000 on the properties acquired at Wolfram Camp, and, if the place warrants it, the company would still further increase the productive powers of the mines. The world's output of wolfram is said to be about 8,000 tons, and of molybdenite about 400 tons.

Digitized by Google

MISCELLANEOUS.

Coal Prices.—The Controller of Coal Mines has taken the opportunity afforded by the introduction of the Coal Transport Reorganisation Scheme on Monday, Sept. 10, to cancel all contracts for coal for inland consumption on that date, so that there shall be a general review of colliery companies' and wholesale merchants' prices. We give below an abstract of the Wholesale Coal Prices Order issued by the Board of Trade on Sept. 5 :—

1. The price at which a factor or merchant may sell coal in railway wagon or barge load or cargo to a consumer . . . shall, except as hereunder provided, not exceed the pit price chargeable by the owner of the mine at which the coal was produced, or in the case of washed fuel the price chargeable for the fuel at the washery by the owner of the fuel by whom or on whose behalf it was washed, in addition to the actual cost of transport (in which cost no charge shall be made by the seller of the coal in respect of office expenses, salaries or other overhead charges or loss in handling) by more than the following amounts : (*a*) Coal purchased by railway companies in Great Britain for consumption on locomotives, 3d. per ton ; (*b*) coal purchased by railway companies in Great Britain for other purposes, and (*c*) coal consumed in national factories, 6d. per ton ; (*d*) coal consumed in gas and electric supply undertakings in Great Britain, 9d. per ton ; (*e*) coal sold to retail merchants in Great Britain for re-sale by them, 1s. per ton ; (*f*) all other coal, including all coal sold for consumption in Ireland, 1s. 3d. per ton, except that where coal sold direct to a consumer not having rail or wharf accommodation, who makes his own cartage arrangements, is delivered in railway wagon by the factor or merchant in quantities less than 30 tons, the amount chargeable in addition to the price at pit or washery and the transport charges as above defined shall be 2s. per ton, unless the consumer has ordered not less than 500 tons of the coal in question for delivery over the following 12 months Provided that (i.) where coal is dealt with by more than one factor or merchant before reaching the consumer or retail merchant the above amounts of 3d., 6d., 9d., 1s., 1s. 3d. or 2s. per ton respectively shall be divisible between the different factors and merchants, and each seller, except in the case of the final sale to the consumer or retail merchant, shall at the time of the sale inform the purchaser how much of the above amounts is included in the price, in order that the maximum price may not be exceeded ; (ii.) in the case of washed fuel, where loss of weight in transit is borne by the factor or merchant, a charge may be made by the factor or merchant in respect of such loss by way of addition to the price per ton at which the fuel is sold to the consumer, not exceeding in any case 2 per cent. of such price ; (iii.) where the seller himself provides water transport, otherwise than by the charter of a ship subsequent to the date of this Order, the transport charges shall not exceed the rate current at the date of this Order ; (iv.) where payment is not made by the consumer or retail merchant before the date on which payment is due to the original owner of the coal or within 30 days of delivery of the coal, whichever is the later, the factor or wholesale merchant may make a reasonable charge in respect of credit to the consumer or retail merchant. Provided also that the maximum charges specified in this article, including the transport charges, may be increased or reduced by the Board of Trade either (*a*) generally, or (*b*) as respects any particular class of business, or (*c*) as respects the business of any individual factor, merchant or consumer, or (*d*) as respects any individual contract or sale.

2. All contracts under which deliveries were being made or were due prior to Sept. 10 are abrogated, provided that notwithstanding such abrogation the seller shall, subject to any instructions which have been or may be given by or on behalf of the Controller of Coal Mines, continue to deliver to the purchaser, and the purchaser shall continue to receive, the coal during the period of the currency of the contract, and under the conditions and at the rates specified thereunder, unless otherwise agreed by both parties, and the price charged as from Sept. 10 shall not exceed the price chargeable under the contract in accordance with the provisions of the Price of Coal (Limitation) Act, and of this Order ; provided also that in no case shall the price be increased without the consent of the Controller of Coal Mines. Any party to such contract may apply to the Controller for the variation of or relief against any term or condition of such contract. 3. If, in consequence of the provisions of Article 2 hereof, the price to be paid by any person to whom coal is delivered is reduced by any amount, the price to be paid by any person to whom the coal is delivered in pursuance of any subsidiary contract shall be reduced by an equivalent amount unless the Controller otherwise orders. 4. This Order shall not apply to any sale of coal for export or any sale of coal for the manufacture of patent fuel for export or any sale of coal to be used on any ship. 5. No person shall sell or buy, or offer to sell or buy, any coal at a price exceeding the maximum price hereby fixed. 6. Where any dispute or difference arises between two or more factors or merchants as to the division of the amounts referred to in sub-paragraph (i.) of Article 1 of this Order, such dispute or difference shall be referred to the Controller. The decision of the Controller shall be final and binding, and the Arbitration Act, 1889, shall not apply thereto. 7. If any person acts in contravention of this Order, that person is guilty of a summary offence against the Defence of the Realm Regulations, &c. 8. The Controller . . . may suspend from time to time, and for any period, and in any district or part of a district, the operation of all or any of the articles of this Order. 9. This Order shall take effect as from Sept. 10, 1917.

E. C. C. Workpeople's Hospital Fund.—At the recent annual general meeting of the Electric Construction Company's Workpeople's Hospital Committee, £189. 16s. was allocated to local hospitals and institutions.

Inquest.—At Derby on Tuesday an inquest was held on Harold Canham, electrical engineer at Messrs. Newton Bros.

Evidence was given that deceased was connecting a motor to the source of supply for testing purposes, and was holding the copper bar with one hand and the framework of the switchboard with the other, when apparently he slipped and one of his hands came in contact with a live wire. Attempts at resuscitation proved unavailing.

John Husbands, test bed foreman, said the rule was that the current should be off before the operation in which deceased was engaged was commenced, and he thought that deceased must have turned the current on unthinkingly. The voltage was 400, which was not necessarily sufficient to kill a man.

A verdict of " Accidental death " was returned.

Liquid Soap.—In the case of large employers of labour the matter of soap supply often causes worry because of waste and the difficulty in regulating a sufficient quantity to each person. The adoption of liquid soap with the Automatic Distributor will, it is claimed, result in a satisfaction of these difficulties.

The automatic soap distributor is fixed to the wall in a convenient place over the wash-bowl, and it delivers into the hand a fixed quantity of soap every time it is tipped over. In addition to convenience, cleanliness is ensured, as it does away with the small pieces of tablet soap lying about and going down the drain-pipes. The soap, being a liquid, its application produces a more thorough action than solid soap, and at the same time removes the possibility or germs and poisons carried from one user to another. Liquid soap, which has been on the market over 10 years, is supplied by the Globe Liquid Soap Co., 35, Farringdon-street, E.C. 4.

Ministry of Munitions.—It is officially announced that the functions of the Finance and Contracts Departments of the Ministry of Munitions have been rearranged. Mr. John Mann, chartered accountant, has been appointed Controller of Munitions Contracts, and Mr. S. Dannreuther has been appointed Controller of Munitions Finance.

National Labour Supply.—The Secretary of the Ministry of National Service announces that the Minister of National Service has, by arrangement with the Minister of Labour, appointed Sir Herbert Edward Morgan, K.B.E., as Deputy Director-General of National Labour Supply.

Proposed New Association of Station Engineers.—A meeting of charge engineers of London electricity generating stations was held last week, with Mr. Chalmers Kearney in the chair, to consider the desirability of forming a new society to safeguard the interests of station engineers and technical assistants, and to expand their facilities for technical discussions and social intercourse.

Mr. HEALY gave a general outline of the proposed organisation of the society, which he suggested should be called the Society of Electrical Engineers, and its objects, which included those mentioned above, the abolition of the seven-day week, the provision of legal and financial assistance for members, &c. He moved :—" That this meeting, representative of station engineers, form itself into a society for the protection of their interests," on the lines laid down.

Mr. A. E. JONES gave particulars of the constitution and objects of the existing Association of Electrical Station Engineers, which he thought would fulfil all the requirements of the promoters of the proposed new society, and he moved as an amendment :—" That this meeting, consisting of representatives of the engineering staffs from electricity supply stations in the metropolitan area, considering that the need for their collective organisation is imperative, do hereby resolve to ally themselves with the London branch of the Association of Electrical Station Engineers."

Eighteen votes were recorded for the amendment and 15 for the resolution, and the former was declared carried.

Trade Union Congress.—The sittings of the Congress at Blackpool were continued until Saturday last.

The Whitley Report.—Discussing the interim report of the Whitley Commission on Joint Standing Industrial Councils, Mr. E. BEVIN considered the question of reconstruction too big for the Parliamentary Committee to undertake, and he proposed the appointment of a special committee to consider the matter.

Mr. R. SMILLIE said the Whitley report proposed to set up machinery to inquire into and settle disputes, if possible, before they reached the strike stage, and he could not see that any real good would come of their setting up a Commission of their own for further inquiry. Thousands of disputes might have been settled by negotiation if there had been machinery for bringing the parties together.

Mr. J. R. CLYNES, M.P., said the report offered the rank and file a chance of participating in the control of industry, and recognised that collective bargaining was essential.

It was agreed that the matter be considered by a sub-committee of the Parliamentary Committee.

Shop Hours.—Mr. J. W. BURROWS moved a resolution expressing satisfaction at the proposed extension of the Trade Boards Act to the retail and wholesale distribution trades, and expressing the opinion that rates of wages should be based on a 48-hour week. The resolution was carried.

The 48-hour Week.—A resolution, moved by Mr. J. JONES, that on the termination of the war steps should be taken to reduce the working hours in all trades to 48 hours per week, without reduction of the standard rates of wages, was carried.

Digitized by Google

Mr. J. H. THOMAS, M.P. said the National Union of Railwaymen would back all unions in the demand for a 48-hour week when the war was over.

Conscription of Wealth.—A resolution moved by Mr. J. LOVATT that it is necessary to conscript the wealth of the nation, and that the Parliamentary Committee endeavour to secure the passing of an Act to achieve that object, was carried.

Demobilisation.—Mr. HAVELOCK WILSON said the dock workers called for demobilisation to be based on co-operation of trade unions with employers' associations, and for State maintenance for returned and displaced workers until employed at full rates of pay.

Free Trade.—A resolution was moved by Mr. T. E. NAYLOR expressing the opinion of the Congress that the economic conditions created by the war had in no way weakened the case for Free Trade as the surest foundation for world prosperity and peace. On a card vote the resolution was carried by 2,339,000 votes to 278,000.

International Labour Organisation.—Mr. ARTHUR HENDERSON said he would rather consult with the German minority before peace than with the representatives of a discredited autocratic Government when military victory had been secured. The Stockholm proposal was not dead, and possibly before many days or even hours it would be found that the Parliamentary Committee of that Congress and the Executive Committee of the Labour Party had taken the first steps to secure a resurrection.

The President announced at a later stage that the Parliamentary Committee had met the Executive of the Labour Party and had arranged for a further meeting on Sept. 25 or 27 between the Executive of the Labour Party and the new Parliamentary Committee. The Parliamentary Committee would take their own decision.

Unemployment Insurance.—The Umpire has decided that contributions are payable in respect of

Workmen engaged wholly or mainly in the manufacture of accumulator cell boxes or of lead linings for such boxes.

Workmen engaged in making wrought or welded iron pipes for use as telegraph poles.

Contributions are not, however, payable in respect of

Switchboard attendants and workmen engaged wholly or mainly in minding, tending or driving electrical machinery in connection with uninsured trades.

Joiners engaged wholly or mainly in making by hand wooden drums for electric cables.

Workmen engaged wholly or mainly in making vulcanised fibre parts of electric light fittings which are not intended for use in war.

EDUCATIONAL.

King's College (University of London).—There are complete courses of study (extending over three or four years) in civil, mechanical and electrical engineering for the engineering degrees of the University of London and for the diploma and certificate of the College. The four years' course provides, in addition to the academic training, opportunity for practical training in "works." Considerable additions have been made to the engineering department, including a large drawing-office and lecture rooms for the mechanical and civil engineering departments, and lecture theatre and rooms for research, including wireless telegraphy, for the electrical engineering department. There are five well equipped laboratories for the purpose of teaching and research. The next term begins on Oct. 3. Full particulars may be obtained from the Dean, or the Secretary, King's College, Strand, W.C.

Armstrong College, Newcastle-on-Tyne.—The session 1917-18 will commence on Sept. 24. Full courses leading to the degree of B.Sc. in engineering are provided in mechanical, marine, civil and electrical engineering, naval architecture, mining and metallurgy, &c. Particulars can be obtained from the secretary, Mr. F. H. Pruen, M.A.

City and Guilds Technical College, Finsbury.—The next entrance examination will be held on Sept. 18. The training is adapted to the needs of pupils from secondary schools above the age of 15 and men who, having served a pupilage or apprenticeship in works, desire to go through a more systematic training. There are engineering, electrical, physical and chemical laboratories and dynamo rooms. The professor of electrical engineering is Prof. W. H. Eccles, D.Sc., A.R.C.S., M.I.M.E. Programmes may be obtained from the Registrar of the College, Leonard-street, Finsbury, E.C.

Royal Technical College, Glasgow.—The session 1917-18 begins on Sept. 25. The diploma of the college is granted in civil, mechanical and electrical engineering, mining, naval architecture, chemistry, metallurgy, &c. The diploma course extends over either three or four sessions. The college is affiliated to the University of Glasgow, and the degrees of the University in engineering and applied chemistry are open to its students. Prospectuses may be obtained from the Director.

Manchester Municipal School of Technology, University of Manchester.—At this school there are courses leading to the Manchester University degrees (B.Sc.Tech. and M.Sc.Tech.) in the Faculty of Technology in the departments of mechanical, electrical and sanitary engineering, chemical industries, textile industries, printing and photographic technology and architecture. Prospectuses may be obtained from the Registrar.

South-Western Polytechnic Institute.—Complete three years' day courses, leading to a diploma or university degree in electrical engineering, are provided at this institute. There is also a four years' evening course suitable for electrical engineering and electrical installation examinations of the City and Guilds' Institute, commencing with the next session on Sept. 24. Particulars may be obtained from the secretary, Manresa-road, Chelsea, S.W. 3.

Battersea Polytechnic.—In the electrical engineering department there are day courses for the B.Sc. (Eng.) of London University and for the Polytechnic diploma. There are also evening courses in d.c. and a.c., electrical design, generation and transmission, electrical costs, electric lighting and illuminating and electric traction. Sectional calendar 1d., post free 2d. Calendar of evening classes gratis on application to the secretary.

TENDERS INVITED AND ACCEPTED.

Incandescent Lamps.

The COMMISSIONERS OF H.M. WORKS, &c., invite tenders, from manufacturers only, for the supply of incandescent electric lamps during the period ending Sept. 30, 1918. Forms of tender, conditions of contract, &c., from the Controller of Supplies, King Charles-street, Westminster, S.W. 1. Tenders by 11 a.m. Sept. 18 to the Secretary, H.M. Office of Works, &c., Storey's-gate, London, S.W. 1. *See also an advertisement.*

Electrical Stores.

WESTMINSTER Guardians require tenders by noon Sept. 19 for six months' supply of electric lamps, fittings, &c., and engineers' sundries. Forms of tender from the Clerk, Princes-row, Buckingham Palace-road, London, S.W. 1.

MERTHYR TYDFIL Guardians require tenders by noon Sept. 24 for six months' supply of electrical accessories, oils, paints, &c. Forms of tender, &c., from the Master of the Workhouse or the Superintendent of the Cottage Homes.

Internal Telephones.

MANCHESTER Guardians require tenders by Sept. 17 for the installation of internal Telephones at their offices, All Saints', Manchester.

KEIGHLEY.—The Guardians have accepted the tender of C. Bell for electric wiring and fitting in the main block of the infirmary.

SHEFFIELD.—The Council has accepted the tender of the Staveley Coal & Iron Co. for 2,000 4 in. c.-i. cable pipes; and that of the British Electric Plant Co. for two boiler feed-pumps.

WOLVERHAMPTON.—The Council has accepted the following tenders for the Electricity Department:—

Alley & McLellan, valves for pumping plant, £226; Rees Roturbo Mfg. Co., two motor driven pumps, £384; Electric Construction Co., motors for boiler houses, &c., £1,271. 15s; Film Cooling Towers (Ltd.), cooling towers, £5,444; John Spencer (Ltd.), feed water pipes, £280.

APPOINTMENTS VACANT AND FILLED.

London County Council invites applications for the position of charge shift engineer at their East Greenwich generating station. Commencing salary £250, rising by £10 a year to £300. Applications, on official form to be obtained from the Clerk of the Council, Council Hall, Spring Gardens, S.W.1, must be in by 1 p.m. of Sept. 24.

A lecturer in mechanical engineering subjects and a lecturer in mathematics (preferably able to teach elementary physics) are required for Wigan and District Mining and Technical College. Salary in each case £150, rising to £180, with war bonus of 10 per cent. Applications to the Principal, from whom particulars can be obtained.

A whole-time teacher of engineering subjects is wanted at the L.C.C. Hackney Institute, Dalston-lane London E.8. Salary £200. Particulars from the Principal. Applications by 11 a.m. Sept. 19.

An advertiser requires a works electrician as working foreman for large controlled engineering firm in West London district. Must have knowledge of motors, telephones and lighting.

A head designer and an assistant designer are required for Admiralty establishment. *See advertisement.*

A teacher of technical electricity is required for the Walsall Municipal Institute. Particulars from Mr. F. E. Thompson, Municipal Institute, Walsall.

Mr. R. Collins, of Belfast, has been appointed engineer and manager of the Galway Electric Supply Co.

BANKRUPTCIES AND LIQUIDATIONS.

A supplemental dividend (1s. 6½d.) is payable at 26, Baldwin-street, Bristol, to the creditors of Geo. J. T. J. Parfitt, consulting electrical engineer, 11, Priory-road, Keynsham, near Bristol.

A meeting of creditors of Michael Pal & Co. (Ltd.) (in liq.) will be held at the offices of Messrs. Whickham, Hunt & Co., 44 and 45, Tower-chambers, Moorgate, London, E.C., on Sept. 18.

Digitized by Google

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Aldershot.—The electricity department's accounts for the year ended March 31 show total capital expenditure £32,987 (increase £98), of which £15,593 has been redeemed.

Revenue was £7,952 (£8,128), and total costs were £6,740 (£6,153), leaving gross profit £1,212 (£1,975). Interest required £437 (£629), and sinking fund £1,306 (£1,550), the net deficit being £530 (£204), or with £211 special expenditure in new buildings, &c., £741.

The engineer (Mr. F. Garside) says in his report, fuel, with cartage, cost 1·32d. (·99d.) per unit sold, total costs were 3·49d. (2·60d.) and average prices obtained were for private supply 3·94d., and for public lighting 4·09d. Maximum load on feeders was 267 kw., and load factor was 14·9 per cent. Units generated were 564,602 (decrease 111,618), and sold 460,252 (decrease 96,127).

Dundee.—The accounts of the electricity department for the year ended May 15 show total capital expenditure £477,829 (increase £9,066), of which £359,591 is outstanding.

Revenue was £76,355 (compared with £78,295 in previous year) and working expenses and special charges were £50,277 (£48,656), leaving gross profit £26,077 (£29,638). Interest required £15,716 (£13,635), expense of loans £546 (£493), sinking fund £13,672 (£12,971), proportion of expense of Dundee Boundaries Act, 1913, £280 (as in previous year), allowances to men on military service amounted to £1,033 (£1,065), and war bonus to £719 (£784), the total being £5,891 in excess of the gross profit. This is provided for to the extent of £3,244, by the balance from previous year, and £2,647 carried forward. Total maximum supply demanded 8,341 kw. Units generated 22,445,010, and sold 18,390,204.

The tramway accounts for the year ended May 15 show gross capital outlay £384,004, of which £110,902 has been paid off. The reserve or renewal funds amount to £97,820. Revenue was £76,347, working expenses were £51,016 (including £2,365 war allowances and bonuses), interest and income tax required £11,272, and sinking fund £7,260, leaving net profit £6,799, disposed of as follows:—renewals £3,600, depreciation £2,157, common good £1,000, reserve £42. Traffic revenue was 12·061d. per car mile, and working expenses, including power, were 8·554d. Passengers carried were 20,063,506 (compared with 19,626,640 in previous year), car miles run 1,430,120 (1,415,887), and units used 2,869,714 (=2·006 per car mile).

Hereford.—The accounts of the electricity undertaking for the year ended March 25 show total capital outlay £110,449 (increase £51,043), of which £28,642 has been repaid.

Revenue was £9,907 (compared with £8,615 in previous year), and working expenses were £7,857 (£6,694), leaving gross profit £2,049 (£1,921). Interest required £1,164 (£1,204), and sinking fund £2,613 (as in previous year), the net result being a deficit of £1,727 (£1,896). Average price obtained per uint was 1·673d. (1·554d.), coal and cartage cost 0·783d. (0·659d.), and total costs were 1·962d. (1·894d.), including interest and repayment of loans 0·637d. (0·686d.). Maximum load was 576 kw. (575 kw.) and load factor 28·15 (26·55) per cent. Units generated were 1,612,544 (1,596,599), and sold 1,420,674 (1,330,590).

Mr. W. T. Kerr, city electrical engineer, says in his report, average cost of coal was 19/2·4 per ton, including haulage, against 15/2 in previous year. Notwithstanding the increase of 25 per cent. on the sale prices during the last year, the average price was practically equal to the increased cost of production. Many developments have taken place, an extension of plant having been sanctioned by the Local Government Board, including a 1,000 kw. Fraser & Chalmer turbine with Siemens alternator and a rotary converter of 500 kw. This plant, with the necessary buildings, switchboard, transformers, boilers, mains and high-tension supply cables, cost £23,530. The extension was commenced in June, 1916, and the h.-t. a.c. supply was available by Oct. 4, 1916. Towards the end of September, 1916, further extensions were decided upon, including two further turbine generators of Ljungstrom type, each of 1,500 kw., four more Stirling type boilers with superheaters, economiser extension to 296 tubes, fan draught underfeed stokers and duplicate feed pumps. The extension also included a ferro-concrete coal bunker plant of a capacity of 600 tons, with tipping-hopper and bucket conveyer. The contract for the extension of the main h.-t. switchboard and other switchgear was placed with the British Thomson-Houston Co., the contractors for the rotary converter and the first section of the 3,300 volt switchgear under the first extension. A contract for two additional cooling towers, increasing the water capacity at the works to approximately 500,000 gallons per hour, was let to the Premier Cooler and Engineering Co., and two additional h.-t. feeders of 15 in. section were laid by Callender's Cable and Construction Co., this work having now been completed some months. The capital involved amounted to £86,948. Of this £51,042 had been expended at the end of the financial year. The capacity of the generating plant when these extensions are completed will be 5,000 kw. of 3,300 volt 50 periods a.c. and 1,310 kw. of 460 volts continuous current. Great attention has been called to the question of electricity as applied to agriculture, and the Hereford electricity works has a leading position. The department has been asked to aid in experiments in electro-culture for the Imperial College of Science, to be conducted by the staff of that College on behalf of the Development Commissioners. Although sanction was received somewhat late in the spring to proceed with the power line and apparatus, it is intended that the experiments will extend over at least three years.

COMPANIES' MEETINGS AND REPORTS.

BRITISH INSULATED & HELSBY CABLES (LTD.)—At an extraordinary meeting on Monday a resolution was unanimously passed in favour of the sub-division of the £5 preference and ordinary shares into five shares of £1 each.

Mr. JAMES TAYLOR, deputy-chairman, who presided in the absence through indisposition of Dr. E. K. Muspratt, said the reason for the proposed change was that £5 shares standing in the market at £14 were not easy to handle if anybody desired to sell or died.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—The report for the year ended March 31 last shows, after making provision for depreciation and for the reduction of investments to market value and for war taxation, a profit of £35,459. Dividends amounting to 10 per cent. have been paid (tax free) on the ordinary shares, and the directors now recommend a transfer of £20,750 to reserve fund and to carry forward £15,323.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—The report for the past year states that net earnings were £800,026. After providing for interest and premium on debentures £239,705 and for depreciation and income tax (£305,713), there remained £254,607 net profit, which, with £161,568 brought forward, made a total of £416,175. The directors have transferred £150,000 to reserve fund, leaving £266,175. A dividend of 6 per cent. (less tax) on the preference shares was declared in September for the year to Dec. 31, 1916. This absorbed £93,000, leaving £173,175, out of which the directors on June 21 declared a dividend of 5 per cent. (less tax) on the ordinary shares for the year to Dec. 31, 1916, and, as the preference shares are entitled to share pro rata with the ordinary shares in surplus profits distributed until the preference shares have received a total dividend of 10 per cent. the directors also declared a further and final dividend of 4 per cent. (less tax) on the preference shares in respect of the year to Dec. 31, 1916. The above dividends absorbed £100,750, leaving a balance to the credit of the profit and loss account of £72,425, which is carried forward. Since the last report there has been no additional generating plant installed in the company's stations. All the plant has been in commission and has been maintained in an entirely satisfactory manner.

NEW COMPANIES, &c.

AUTOMATIC & ELECTRIC FURNACES (LTD.) (148,419.)—Private company, reg. Sept. 7, capital £2,000 in £1 shares, manufacturers of and dealers in furnaces, plant and materials for the hardening or other treatment of steel and other metals, &c. Agreement with L. W. Wild and E. P. Barfield. First directors are:—E. P. Barfield (managing director) and such others as the shareholders appoint. Reg. office: 6, Old Queen-street, S.W.

CLEMENTS, JEAKES & CO. (LTD.) (148,312.)—Private company. Reg. Aug. 25, capital £25,000 in 3,000 5 per cent. cumulative preference shares of £5 each, and 10,000 ordinary shares of £1 each, to take over business carried on as "Clements, Jeakes & Co.," and to carry on the business of domestic, electrical and general engineers, electricians, founders, &c. First directors are J. H. Clements and G. B. Clements. Reg. office, 51, Great Russell-street, W.C.

TUNGSTEN PRODUCTS (LTD.) (148,344.)—Private company. Reg. Aug. 29, capital £25,000 in £1 shares Reg. office: Caxton House, S.W.

WATERCRAFT DETACHABLE POWER INSTALLATIONS (LTD.) (148,345) Private company. Reg. Aug. 29, capital £20,000 in £1 shares (12,500 preference), builders of and dealers in engines and power plant for the propulsion of watercraft of all kinds; electrical and general engineers, &c. First directors: E. W. Reid, T. H. Coggins and A. E. Hooke.

CITY NOTES.

BROMLEY (KENT) ELECTRIC LIGHT & POWER CO. (LTD.)—An interim dividend of 4 per cent. per annum (2s. per share), less tax, has been declared on the ordinary shares for the past half-year.

DUMBARTON BURGH & COUNTY TRAMWAYS CO. (LTD.)—The directors recommend a dividend of 3½ per cent. on the ordinary shares for the year, after transferring £1,673 to debenture stock redemption account, £5,000 to renewal fund and £2,000 to reserve, leaving £2,268 to carry forward.

DUNDEE, BROUGHTY FERRY & DISTRICT TRAMWAYS CO. (LTD.)—This company's profits for the year ended July 31 (including £165 brought forward) were £5,983. After providing for interest on debentures and dividend on preference shares, the directors propose a dividend of 3 per cent. (less tax) on the ordinary shares, transferring £500 to renewals fund and carrying forward £587.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—An interim dividend of 6 per cent. per annum (3s. per share), less tax, has been declared on the ordinary shares for the past half-year.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD.)—The directors have declared interim dividends for the half-year to June 30 at the rate of 6 per cent. per annum on the preference and at the rate of 8 per cent. per annum on the ordinary shares, payable on 29th inst.

Digitized by Google

THE ROUND TABLE.

By "KVA."

I quite agree with a correspondent who tells me that after the recent revelations he would rather not be a Swede—even an electrically cultivated one.

* * * *

France is said to have 10 million horse-power available for hydro-electric development as against Germany's one and a half million. What a blessing this is! When all the T.N.T. has been made and has banged its last bang and petrol has coughed its last cough, the Allies can still win the war by electrical means. Germany will then pen a hymn of hate against La Houille Blanche!

* * * *

According to the "Daily Mail," the streets of Berlin are to be left unlighted, so as to save coal and electricity. A correspondent of *Voss's Gazette* complains that soldiers on leave lose themselves in the dark streets. As a rule soldiers on leave do not mind losing themselves and are quite indifferent as to whether the streets are lighted by gas or electricity or are not lighted at all. Who cares for foot candles when he is on leave?

* * * *

AN INTERESTING "POINT" IN LAMPS.

"How Sharp the Point of this Remembrance is"—*Shakespeare.*

[From "Glover's Almanac."

* * * *

The following is reproduced by the "Sunderland Daily Echo":—

"No one visiting the vast Government buildings can fail to be shocked at the sight of the young girl messengers who are condemned to sit in windowless cupboards lighted by electric light all day, where they spend the time between their calls reading novelettes by this pernicious radiance and inhaling the gas fumes that escape from the ubiquitous tea-kettle boilers."—A commentator on the proposed Ministry of Health.

No matter how electricity and gas work together for the good of the country they get slandered in this fashion!

THIRTY-SEVEN YEARS AGO.

[From The Electrician, September 4, 1880.]

Portsmouth Dockyard.—On Tuesday the Lords Commissioners of the Admiralty began their official inspection, and after visiting the "Inflexible," they were taken to the adjoining electric shop. Here they saw the electric light, and witnessed the operation of electro-plating, and examined an ingenious piece of apparatus for numbering the revolutions of machinery by an electric contact.

Something Like a Mistake.—In the celebrated "Preliminary Discourse on the Study of Natural Philosophy," which forms one of the volumes in Lardner's "Cabinet Cyclopædia," it is stated that "all the phenomena of magnetic polarity, attraction and repulsion have at length been resolved into one general fact, that two currents of electricity, moving in the same direction repel, and in contrary directions, attract each other." As most of our readers are already aware, the words "repel" and "attract" should here change places.

Insulation of Wire.—As is well known, several suggestions have been made and tried with more or less success for insulating wire with substances that are easily liquefied, and can be poured into a tube containing the wire to be insulated. Messrs. Manly and Philips, of Philadelphia, point out that the ordinary process of pouring the insulating material into the top of the tube possesses several disadvantages which they decide will be overcome by forcing the substance from the bottom, and have patented an apparatus to do this work.

Swan's Lamp.—At the time Mr. Edison brought out his lamp it was stated that Mr. Swan, of Newcastle, had long ago tried a similar plan and found it a failure. He states, however, that he has now succeeded in devising a plan to keep the incandescent matter intact. It is to exhaust the containing vessel to a high degree, at the same time raising the carbon to as high or a higher temperature if possible than it is likely hereafter to be subjected. Whilst in this incandescent state the exhausted containing vessel is hermetically sealed. This operation is said to obviate the failure of the carbon by disintegration.

Commercial Intelligence.—The Council of the Association of Chambers of Commerce of the United Kingdom last week passed the following resolution:—

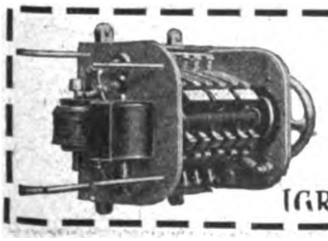
"That the Council, while endorsing the majority report of the Faringdon Committee, regards the proposals put forward by the Board of Trade and the Foreign Office in their joint memorandum on commercial intelligence as a 'compromise,' which, while open to objection, is a step in the right direction, and affords a foundation upon which other reforms may be based, and does not preclude development in the direction of a Ministry of Commerce."

Canadian Asbestos.—What promises to be an important discovery of high-grade asbestos has been made in Quebec, about 25 miles north-east of Ville Marie, on the shores of Mackenzie Lake. A number of veins, which are said to average about 4 ft. in width, have been traced for a considerable distance, and have been found to contain asbestos of a similar grade to that in the Porcupine district. Efforts are being made to induce the Government to build a road into the district. About a dozen claims have already been staked, on all of which it is said the showings of the mineral are very encouraging.

South Africa.—Pretoria Town Council recently decided, subject to the approval of the Administrator, to grant a lease for 20 years to Mr. C. F. Delfos to enable him to mine for and dispose of iron, iron ore, iron quartz, and iron-bearing minerals and metals, situate on a portion of the town lands of Pretoria. In the event of its being legally competent to do so, leases for further periods of 30 and 40 years respectively will be granted.

Engineers' Demands.—A conference of representatives of 25 trade unions in the engineering and allied trades was held at Leeds last week, to discuss the award of 3s. advance by the Committee of Production in July.

It was resolved to make a demand at once for a reduction of 50 per cent. in the prices of all necessaries of life, and, if this demand proved ineffectual before Oct. 15th, to form a national engineering and allied trades' joint committee and press for national minimum rates of wages throughout the engineering industry.



Manually-operated Motor Starters
for ALTERNATING CURRENT

STAR-DELTA STARTER.
No. 920.—Capacity up to 50 amps. Easily renewable parts. Robust construction.

CONTROL IGRANIC ELECTRIC DEVICES

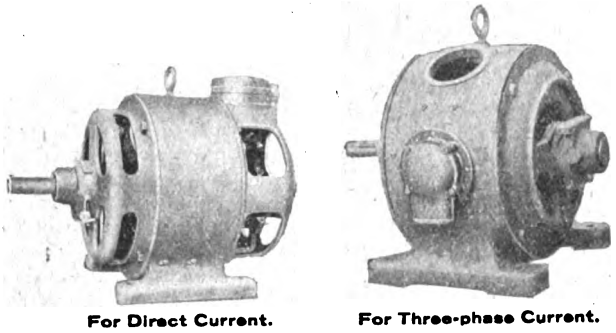
ROTOR STARTER.
No. 960.—Heavily rated for arduous service. Embodies latest improvements in design.

IGRANIC ELECTRIC Co LTD 147, Queen Victoria Street, LONDON.

Digitized by Google

SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current. For Three-phase Current.

for
ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350 Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

E. SHOWELL & SONS, LTD.,
STIRCHLEY, BIRMINGHAM.

SOLID FORGED BRASS WING NUTS.
Tapped Standard Whitworth and B.A. Standard.

Made from No. 1 tapped ¼" to No. 9 tapped ¼".

Sole Agent for the Electrical Trade:—
LIONEL ROBINSON, 3, STAPLE INN. LONDON, W.C.
TELEPHONE: Holborn 6323.

VULCANIZED FIBRE. ELECTRICAL. MECHANICAL.
DYMFYBR
LARGE STOCK. PROMPT DELIVERY.
J. BURNS, Ltd., 187 & 189, Central Street, LONDON, E.C.

ELECTRICITY SUPPLY FOR COUNTRY INSTITUTIONS.

In a recent issue of the "Electrical Review" (of Chicago) an interesting description is given of the very complete electric lighting and domestic power arrangements at the St. Stanislaus Seminary, Florissant (Mo.), about 18 miles north-west of St. Louis. As the domestic outfit seems to be very complete and up to-date we give below an abstract of the arrangements.

The institution consists of four large four-storey buildings, which afford living quarters for about 380 members, together with numerous small work buildings, &c. It has its own bakery, dairy, laundry, shoe shop, pumping station, cold storage plant, blacksmith's and carpenter's shops, &c., and outbuildings essential to a 900-acre farm. In 1915 the authorities of the seminary determined to adopt electricity for power and lighting, and on receiving a guarantee of a connected load of 60 kw. the Electric Co. of Missouri agreed to tap its 60-cycle 4,000-volt three-phase line at Pattonville, and run a three-phase line for six miles to St. Stanislaus. Accordingly, three 75 kw. delta-connected transformers were set up on four poles at the Pattonville end to boost the voltage to 13,200. No. 0 galvanised iron wire was used for the line wires (copper was not feasible on account of the condition of the market) and the Pattonville end was equipped with disconnecting switches and fuses. Standard 40 ft. cedar poles with V-braced cross-arms were used; on dead-end poles the V-brace was inverted to afford ample clearance for the line wires. For lightning protection, a fourth wire, grounded at every sixth pole, was carried on bayonets above the line wires. At the seminary end the line was equipped with three disconnecting switches and three horn gaps and run into three 25 kw. transformers, which step down the voltage to 220 volts. These transformers are hung on two poles in triangular fashion, one in front and two in back, thus simplifying the delta connection and giving good clearance for all high-tension wires. From the transformers the power and light lines are carried directly into the "Round House," the seminary's main distribution point, the 110-volt light circuits being taken from the middle taps of the delta connection on the transformers. All the interior wiring work was done by the students. For all large areas and outdoor approaches higher power Mazda type C lamps are employed. In all about 600, which total about 22,000 watts, are employed.

For the farm circuits two separate 220-volt lines were run from the Round House; for the portion of one that supplies the work buildings on the grounds proper steel armoured cable is laid underground, and from this line electric current is supplied to a 10 H.P. three-phase induction motor with compensator, which operates the laundry. A similar three-phase induction motor operates the ammonia compressor for the cold-storage plant and a 5 H.P. three phase motor a deep well pump. A De Laval electric separator is installed in the dairy. There are also a 10 H.P. corn grinder and a 10 H.P. circular saw. The electric company supplies 20 per cent. of the total connected power load for lighting, and therefore all the lighting circuits in the farm buildings were taken off the power line by means of a balance coil.

Some of the very latest electrical appliances have been installed at the seminary. A General Electric type S-3 range is set up in the kitchen, which is also provided with two 18 in. exhaust electric fans, and with outlets for the use of a vacuum cleaner. Electric heaters are being placed in the rooms and tests are being made for space-heating equipment. The community kitchen is equipped with a large electric potato peeler and a 2 H.P. induction motor running a countershaft that drives meat grinders, coffee grinders, &c. There has also been specified an electric baking oven, capable of baking 100 24 oz. loaves of bread per hour, and an electric range capable of cooking meals for 350 persons. This range will have four large ovens and two broilers which will broil 140 lb. of steak in an hour. The range will be used for ordinary cooking operations, but all vegetables, soups, &c., will be prepared in six large electric cookers, three of 25 and three of 30-gallon capacity, specially constructed and the best of their kind in the country. These cookers are made so as to prepare large quantities of vegetables economically by steaming instead of boiling. All meats will be roasted in a special oven, which will be separate from the range. The plate warmer (10 ft. by 3 ft.) is fitted with compartments, and an extension table (5 ft. long) will be provided. All water heating for cooking, dish washing and bathing will be done electrically by two

REWINDING AND REPAIRING
of ARMATURES, MOTORS & DYNAMOS.
PROMPT EXECUTION and MODERATE CHARGES.
A. BROWN, 1, Norgrove St., BALHAM, S.W. 12

BUYERS of every description of Scrap Metals, viz: ESTABLISHED 1867.
COPPER, BRASS, GUN METAL, BRONZE, ALUMINIUM, LEAD, ZINC, &c.
All descriptions of RESIDUES.
METALS. J. B. GARNHAM & SONS,
132, UPPER THAMES ST., LONDON, E.C.
Telegraphic Address: "Garnham Cannon London."
Cables .. .. .. "Garnham London."
Telephone.. .. .. Bank 5726.
ABC Code, 4th and 5th Editions and Lieber's Code.
ENQUIRIES SOLICITED.
SELLERS of
COPPER and BRASS SHEETS.
PLATES, TUBES, RODS, WIRE, &c., &c.

Digitized by Google

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite—Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1912 to 1917.

ATTWATER & SONS,

Telegrams: Attwaters, Preston. Telephone No. 1046 (2 lines).

Hopwood St. Mills, PRESTON.

Established 1868. Codes: 5th Edition A B C & Western Union.

J. P. DEVINE CO., BUFFALO.

MANUFACTURERS OF

Vacuum Drying and Impregnating Plant.

(PASSBURG SYSTEM.)

The Devine Co. are well known in the United States and Canada as the leading manufacturers and experts in Vacuum Drying and Impregnating Plant and have over 1,500 such plants in successful operation.

AIR PUMPS, COMPRESSORS,
VULCANISERS,
CONDENSING PLANT.

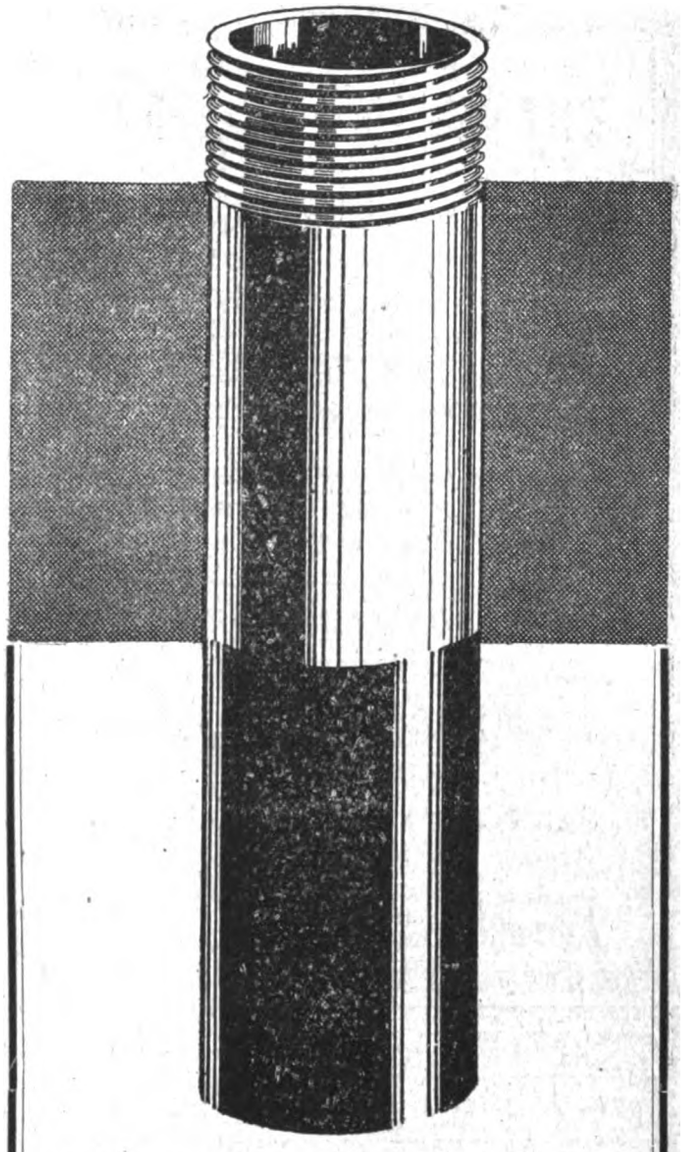
Solvent Recovery and Derisinating Plant a Speciality.

Sole Representative:

JAMES LIVINGSTON, LTD.,

IMPERIAL HOUSE, KINGSWAY, W.C.

Telegrams and Cables: "CINERARY, LONDON." *Telephone:* GERRARD 2360.



We have at our Birmingham Works a large Automatic Electro-galvanizing Plant operating on the "Zenex" process.

This plant is capable of dealing with many million feet of Conduit per annum together with some hundreds of tons of Fittings.

Simplex Galvanized Conduit is supplied to the War Office, Admiralty and Government Departments, also to the leading Railway Companies.

We can give good delivery

SIMPLEX CONDUITS LIMITED

GARRISON LANE, BIRMINGHAM.

LONDON— 113-117, Charing Cross Rd, W.C.
MANCHESTER— 16, Corporation Street.
GLASGOW— 72a, Waterloo Street.
NEWCASTLE— 61, High Bridge.
BRISTOL— 10 & 11, Denmark Street.
LIVERPOOL— 96, Whitechapel.
LEEDS— 6, White Horse St., Boar Lane.
SWANSEA— 14, Heathfield Street.
CARDIFF— 4, Westgate Street.
ABERDEEN— 1, Crimon Place.
SHEFFIELD— 281-3, Attercliffe Common.

Digitized by Google

LOAD AND EXPERIMENTAL
RESISTANCES
MADE TO ANY SPECIFICATION.
Particulars of Standard Types will be found in our List, to be had on application.
RAPID DELIVERIES GUARANTEED.
ISENTHAL & CO., Ltd.,
(DEPARTMENT 4)
Denzil Works, Willesden, London, N.W. 10.
Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, etc.

GLUE POT HEATERS
SOLDERING IRON HEATERS
WAX MELTERS, METAL POTS
CORE DRYING OVENS
ENAMELLING OVENS
IMMERSION HEATERS
HOT PLATES, AIR WARMERS
and all kinds of special Electrical Apparatus for Munition Works, Shell Filling Factories and all manufacturing purposes.
BELLING & CO.
DERBY ROAD WORKS,
Montague Road,
EDMONTON, N. 18.

If you wish to dispose to best advantage of your ACCUMULATION of
OLD and NEW SCRAP
EBONITE & VULCANITE SOLID SHAVINGS
RUBBER GLOVES, CABLES, TYRES, VALVES, &c.
GUTTA PERCHA CABLES BUCKETS
When writing for Price List return this advt. for Special Quotations to
J. SCHNURMANN, Downham Mills TOTTENHAM
(Proprietors: J. J. SHERMAN and S. P. CASSY)
LONDON, N. 17.
Branch Works: 49/51, Broughton Lane, Manchester.

300 gallon heaters, which will furnish approximately 1,000 gallons of water at 180 deg. every 24 hours. From these water heaters pipes will be run to the coffee and tea urns, which also will be heated electrically. The bakery is equipped with an electric dough mixer of one barrel capacity, and is operated by a 2 H.P. induction motor. Three electric ovens have also been installed, each with a capacity of 100 24 oz. loaves per hour, and built so that direct connection can be made with a 220-volt three-phase line. So far only two ovens have been required, and the output of the two has easily equalled the combined capacity of the three as rated by the manufacturer. In each oven three heats (high, medium or low) can be employed, and with the old brick ovens 24 hours' previous heating was required to obtain the proper temperature for baking, but for the electric ovens only 1½ hours are necessary. Hitherto kerosene lamps have been used for lighting, and great economies have been effected in both lighting and power, as will be seen from the following typical cases :—

DEEP WELL PUMP.

Oil Engine Operation : Consumption 2 gallons per hour at 13 cents × 10 hours = $2.60 per day.

Electrical Operation : 5 H.P. motor consumes in 10 hours 37·3 units at 3 cents = $1.12, showing a saving of $1.48.

(This does not take into account the fact that an a.c. motor scarcely ever needs repairs ; on an oil engine there are habitual repairs. The electric motor paid for itself in the first month of operation.)

LAUNDRY.

Steam Operation : Coal consumption (10-hour day), 1,575 lb., $1.95 per day ; cartage of coal, $0.50 ; lubrication, $0.30 ; total, $2.75.

Electrical Operation : 10 H.P. motor consumes in six hours 44·6 units, at 3 cents, $1.34 ; miscellaneous, $0.17 ; total, $1.51, or a saving of $1.24.

AMMONIA COMPRESSOR.

Steam Operation = $2.40 per day.

Electrical Operation = $1.23, or a saving of $1.17.

THE STANDARDISATION OF TRADE LITERATURE.

The question of standardising the sizes of trade literature, catalogues, &c., has recently received considerable attention from the electrical industry in the United States, and it is anticipated that some definite action will be taken before long.

It is reported by the "Electrical World" that the committee appointed by the Associated Manufacturers of Electrical Supplies has submitted the following report and recommendations :—

Your committee on the standardisation of letter paper, catalogues, price lists, &c., has tabulated the replies received from various manufacturers and begs to submit herewith the results attained. The sizes of letter paper given are taken from actual measurements made by the committee, and while the dimensions, 8½ in. by 11 in., are those given by a majority of the manufacturers for letter paper and are also the dimensions recommended by the Electric Power Club, your committee proposes to recommend to the Manufacturers' Council that the dimensions of 8 in. by 10½ in. for letter paper, catalogues, bulletins, contract forms, specifications and engineering forms be adopted for the following reasons :—

1. A large portion of the manufacturers in replying to the request for data stated that they would be glad to adopt any standard dimensions recommended by the committee.

2. The 8-in. by 10½-in. sheet has approximately 10 per cent. less paper than the 8½-in. by 11-in. and in times of conservation of resources it is believed that economy is an important consideration from a general welfare point of view. One manufacturer estimates that this item alone will save his company $12,000 a year.

3. Our investigations indicate that these dimensions have been adopted as the United States government standard.

4. As a rule photographs of electrical apparatus are made on 8-in. by 10-in. plates, and it being a simple matter to trim the finished prints 8 in. by 10½ in., this size of photograph lends itself to binding with other papers of these standard dimensions.

5. The American Institute of Architects has recommended the size of 8 in. by 10½ in. for all catalogues of building material, and this size of sheet permits the advantageous listing and displaying of electrical wiring devices and other building materials. A thin catalogue of this size when folded once will fit readily the average pocket.

6. The Electrical Supply Jobbers' Association has adopted as the standard for its loose-leaf catalogue a page 8½ in. by 10 in., and the same plates used for printing a bound 8-in. by 10½-in. catalogue can be very satisfactorily used for printing on the 8½-in. by 10-in. sheets of the Electrical Supply Jobbers' Association, thus leaving ample room for binding on the binding edge.

7. This size of sheet for letter paper, catalogues, &c., will file much more readily in standard letter files than will the larger size.

8. In addition to the actual saving in paper there would be an addi-

For Effective Impregnation use "LACWATT"
Black or Golden Brown.
JENSON & NICHOLSON, Ltd., Insulating Varnish Department, Goswell Works, Stratford, E.15.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

HAVE YOU OVERLOOKED THE FACT THAT, AS SHOWN IN THE ADJOINING LIST, WE ARE MANUFACTURERS OF

COTTON COVERED WIRES?

Let us have your enquiries at our Prescot Works.

BRITISH INSULATED & HELSBY CABLES. LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

GUARANTEED **SECOND HAND**

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.

Phone: Victoria 4026. Grams: Vicelastor, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.

ELECTRICAL MACHINERY

Engineers, Edinburgh. *See our Illustrated Advt. Aug. 31.*

Digitized by Google

tional saving in envelopes and a very great saving in postage, due to reduced shipping weight of catalogues. The manufacturer referred to above estimates that this additional saving in his case would amount to approximately another $12,000.

In conclusion: It has been argued that the paper mills adhere to certain long-established standard sizes for their kinds and grades of paper. On the other hand, those manufacturers who are using 8-in. by 10½-in. cut sheets have no difficulty in obtaining their paper at considerable saving, and the adoption of these dimensions by an association of the size of the Associated Manufacturers of Electrical Supplies will immediately lead paper mills to produce paper of proper size to cut up to these dimensions. With regard to price lists, your committee recommends the dimensions of 4 in. by 7 in.,

ELECTRICAL PROGRESS IN THE WEST INDIES.

The Canadian Trade Commissioner has recently prepared a report on the use of electric power in the West Indies.

Though electric supply is available in Jamaica, the Barbados, Trinidad and Britsh Guiana for lighting, power and traction, it has not come into general use, and there is a wide field for its expansion for lighting and domestic purposes. At present electric street car services are found in only three cities—in Kingston (Jamaica), Port of Spain (Trinidad) and Georgetown (Guiana). In the last two cases the operating companies are Canadian. Just before the war the mule operated lines in Barbados was sold to a United States company under promise that an electric system would be installed, but the difficulties arising since that time have prevented fulfilment of the promise.

Throughout the larger islands telephone systems have been installed, and electric motors are gradually being introduced into the large sugar factories, engineering works, cotton ginneries and minor establishments where electric current can be obtained. The annual import of electrical apparatus into the islands is valued at only £35,000, but this excludes machinery, electric cables and wires for the tramway, electric lighting and telephone companies. The value of machinery (including electrical machinery) averages over £400,000, and that of wire, though not separately recorded, would considerably exceed the value of what is classified as electrical apparatus.

Of the requirements for electrical goods the United States is at present the largest supplier. Before the war the bulk of these goods were supplied by the United Kingdom. The United States has now practically all the trade of Trinidad and Bermuda of this description, about two-thirds that of Jamaica, and more than half that of British Guiana. The United Kingdom comes next, supplying the greater part of the trade of Barbados, about one-third that of Jamaica and practically all the trade of the Windward and Leeward Islands. Canada supplies a very small part of electrical goods at present, but numerous inquiries are being made by her manufacturers about the openings for this class of trade. The Canadian preference granted by some of the West Indian islands gives an advantage in duty by 20 per cent. over goods from foreign countries.

CONVERSION OF STEAM INTO ELECTRO-PNEUMATIC HAMMER.

The Cumberland County Power & Light Co. (Portland, Me.) recently converted a steam hammer to electro-pneumatic service. It appeared that the plant of the Marine Hardware & Equipment Co. included a 1,200-lb. Bement-Niles steam hammer which required steam at about 90 lb. per sq. inch for many hours daily, and to avoid condensation troubles it was necessary to run the hammer practically all the time. As the electric drive had been adopted for other purposes in the works it was found possible to do away with the demand for continuous high-pressure steam by adapting the steam hammer to air operation and installing a motor-driven compressor to supply air for this purpose and other requirements.

According to the "Electrical World" the valve of the hammer was rebuilt for a fit of 0·0025 in. compared with a previous fit of 0·005 in. under steam service. The Hardware Company purchased a 50 H.P., 220-volt, three-phase Westinghouse squirrel-cage induction motor designed for 900 revs. per min., and belted it to a 12-in. by 7-in. by 12-in. Sullivan compressor delivering air at 90 lb. per sq. inch. An idler pulley was employed as the maximum distance between the motor and compressor pulley was only 6 ft. 4 in. Connected with the compressor is a storage tank 8 ft. high and 48 in. in diameter, from which air is supplied. The hammer is supplied with air through a 2-in. main and it exhausts through a 3-in. pipe into a 1½-in. reduction outlet at the roof of the factory. A branch exhaust terminating in two ½-in. pipes is led down the frame of the hammer to outlets directed upon the working anvil surface, so that all chips and scale are immediately blown away in operation. It has been found that harder and quicker blows can be struck than under steam conditions. Control of the hammer is obtained by a foot valve and lever. The success of the installation has led to the prospective early application of electro-pneumatic service to four hammers in another plant where one 1,000-lb., one 1,200-lb. and two 2,000-lb. hammers will be supplied with air furnished by a 150-H.P. motor-driven compressor with a 12-in. by 48-in. storage tank.

THE GREAT CENTRAL RAILWAY passes from the Metropolis Northwards through the centre of industrial England, throwing out its branches Eastward and Westward to the Coast.

¶ Its Lines run over the Great Midland Coalfield (of over 4,000 square miles area) which extends into the Counties of York, Nottingham, Derby and Lincoln. This Coalfield is the largest in the British Isles, and is estimated to contain not less than forty-nine thousand million (49,000,000,000) tons of coal.

¶ The important Coalfields of Lancashire and North Wales are also traversed by the Company's lines.

¶ There is thus afforded an easily accessible source of fuel supply.

¶ The New Eastern Port of Immingham should particularly attract traders, as its modern equipment and accessibility at any time of the day or night, irrespective of tides, are important time and labour saving factors.

¶ Adjoining the Great Central Railroad at various parts of the system are situated Valuable Sites for Works, where, by the introduction of siding accommodation, goods can pass right into and directly out of the works, which greatly assists the Manufacturer to attain his desired position in the World's Markets.

¶ For information please communicate with the G.C.R. Publicity Office, 216, Marylebone Road, London, N.W.

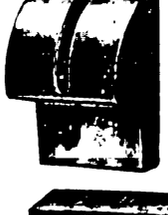
¶ Owners and Agents of LAND and BUILDINGS for SALE or TO BE LET near the Great Central Railway are requested to send particulars to the G.C. Estate Office, 12, Paton Street, Piccadilly, Manchester.

SAM FAY, General Manager.

ADMIRABLE SITES FOR NEW WORKS, FACTORIES, &c.

H. Weidmann, Ltd., Rapperswil, Switzerland.

MAKERS OF PRESSPAN AND INSULATING MATERIAL.



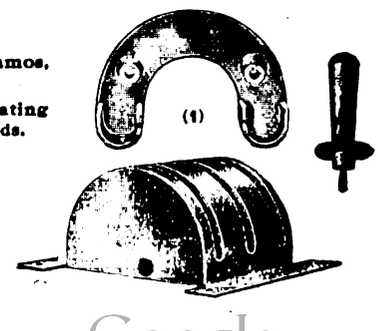
Pressboard (Presspan) in Sheets, Rolls and Tapes, Oiled Presspan, Black Presspan, Presspan Tubes and Stampings.

Amianite (Vulcanised Asbestos) Coil Frames, Spools for Apparatus, Dynamos, Motors and Transformers. Insulating Blocks, Tubes, Plates, Boxes, &c.

Bakelite & Cornite (high tension material) Handles of Switchgear and Heating Apparatus, Controller Insulation, Moulded Pieces, Terminal Covers of all kinds.

Asbestos-Cement in Plates, Arc Shields for Controllers, &c.

Mica and Substitutes, Insulating Pearls, Transformer Spools.
Japanese Felt and Paper in rolls and tapes.
Oil-Varnished Linen, Diagonal Tapes, Oil-Varnished Silk & Paper.
Artificial Leather Discs for Friction Drive.
Insulators for Electric Furnaces, Tramways, &c.



Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,053. [Vol. LXXIX. No. 25] FRIDAY, SEPTEMBER 21, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES 957
Arrangements for the Week 959
Municipal Tramways Association —Sixteenth Annual Conference. 960
The High-Tension Magneto with Special Reference to the Ignition of Aeroplane Engines. By A. P. Young. Illus.—*Continued*.. 963
The Electrification of a New Section of the Chicago, Milwaukee & St. Paul Railway (U.S.A.) 966
Combination Coal and Gas Firing. By Alex. W. Morgan. Illus... 967
The Pressure of the Trolley on the Overhead Wire. By E. Stocker. Illustrated 969
RECONSTRUCTION 970
REVIEW 970
On the Calculation of the Coupling Coefficient of Two Coaxial Flat Spiral Coils. By P. Baillie, L.Sc. Illustrated 974
The Electrical Properties of Silver Sulphide. Illustrated 976
CORRESPONDENCE 977
Sheffield Electricity Supply 977
Patent Record 978
Volunteer Notices 978
COMMERCIAL AND INDUSTRIAL SECTION 981
Electricity Supply 982
Tenders Invited and Accepted 985
Financial Matters 985

NOTES.

Combined Coal and Gas Firing.

IT sometimes happens that coal-firing and gas-firing are ready alternatives in a power station, or that they may be used in combination. It is of interest then to determine whether combined coal and gas firing is advantageous as a means of increasing the rating and efficiency of boilers. A case of this kind is discussed on another page of our present issue. The plant in question is in a station of the Toledo Railways & Light Co., in the United States. As the erection of a new power station was about to be undertaken, it was felt inadvisable to put down more boilers in the existing station. Coke oven gas was available and consequently experiments were carried out upon combined coal and gas firing in order to determine whether the output of the boilers could be increased by this method. It is noticeable that in the combined method no primary air was supplied to the gas and that consequently the gas had to rely for its combustion upon secondary air passing through the fuel bed. The results show that the amount of coal burned per hour with the combination firing was practically the same as the amount burned when coal alone was fired. The output of the boilers, however, was increased by 31 per cent. On the other hand, the amount of combustible in the ash was greater with the combination than with coal alone, which we think may be taken to show that the complete suppression of primary air was a mistake. The boiler efficiency was slightly higher, but it is noticeable that the efficiency with gas alone was higher than with either the combination method or with coal alone. The conclusion is drawn that the cost of steaming for the conditions holding at this station is 8 per cent. higher with the combination than for coal alone and 21 per cent. higher for gas alone than with coal alone, but that the added capacity for the combination was obtained at 50 per cent. less investment than would have been required with the coal. Although interesting data are given we should like to have seen rather more of the results that are commonly stated in boiler tests. Generally speaking we think it will be felt that the combination of coal and gas firing, except as a temporary expedient, is a doubtful policy to follow. It is difficult to obtain the best conditions under such circumstances, because the conditions that are best for coal firing are not likely to be the best for gas, and vice versa, and consequently the combination probably lacks the high efficiency that is obtainable with either coal or gas alone.

The Position at Sheffield.

As our readers are aware the demands on the electricity undertaking at Sheffield have increased very rapidly during the last year or two owing partly to the development of the electric furnace in the manufacture of steel, such furnaces requiring a large supply of electrical energy for their operation. In order to meet the needs of the case a new power-station is being laid down. This, in the minds of some of the City Councillors, has created uneasiness, as was shown at the last meeting of the Council, when Councillor GRAVES brought forward a motion that no further steps should be taken with respect to the purchase of the new plant. The chief objections put forward by Councillor GRAVES are mostly based on the fact that the growth at the present time is too rapid for the undertaking to be stable. A special feature of the case is the fact that a large proportion of the output is taken by only two consumers. This, no doubt, is a feature which is not desirable, as it necessarily renders the future to some extent uncertain. On the other hand, provided that the municipal undertaking is run on up-to-date lines so that electrical energy can be supplied at a low price, there need be little fear that these large consumers will give up taking their supply from the municipality. There is, of course, the contingency that the needs of any consumer may diminish after the war. No safeguard, however, can be taken against this contingency. Moreover, the general feeling is that there will be expansion rather than falling off when peace comes. Another point raised by Councillor GRAVES was the inadequacy of the depreciation, stating that this was limited by the Government. We have not details by us of the depreciation that has been allowed; but it may be said that, although limits are laid down from the point of view of income tax, there is nothing to prevent any municipality from placing its undertaking on a sound basis, either by setting aside reserve funds, or by paying off the loans in a shorter period than that allowed by the Local Government Board. Statutory undertakings have definite obligations and they must necessarily be prepared to run certain risks. At the present time if the demand for electric power at Sheffield is developing rapidly it appears to us that it is the duty of the Council to provide for the demand without delay, and, in fact, that they should congratulate themselves on the position.

Combination in Trade.

WE are glad to see that the Department of Commercial Intelligence of the Board of Trade (due, doubtless, to the new Joint Department of the Foreign Office and the Board of

Digitized by Google

Trade which is now in process of formation) is beginning to take a more active interest in the trade of this country. A meeting of the Brass Masters' Association was addressed this week by Mr. L. PAISH, representing the Department, who insisted upon the importance of combination. One great advantage of combination in a given trade is the greater facility with which foreign markets can be investigated, and Mr. PAISH went so far as to say that his Department was prepared to co-operate, even with financial assistance, in sending out representatives to develop foreign trade. It is significant that the Department is desirous that a trade association of brass masters should be formed. There is no doubt that if this country is to hold its own in the near future combination will be essential, and the insane competition between manufacturers must come to an end. We all know that certain evils may arise through combinations, but we trust that some middle course may be found which will make it possible to avoid these evils and at the same time put an end to the cut-throat competition which has often led to a poor return on capital and to orders going abroad rather than to manufacturers in this country.

Technical Training of Apprentices.

IN another column we give the syllabus of a course which the Northampton Polytechnic Institute has prepared for the technical training of electrical apprentices. We are glad to see that this step has been taken, and we are particularly gratified to note that at least part of the instruction is to be given in working hours. The Northampton Institute is well placed for such a purpose, and there is no question that such a course fills a very distinct want. We understand that Messrs. Marryat & Place have felt the need, which we have frequently emphasised, for this innovation, and that they are sending some 20 students to the course which will begin next month. We only hope that other firms will follow this example, for such classes cannot flourish unless it is shown by a large student roll that they are appreciated and fill a want.

Association of Supervising Electricians.—We have received a programme of the meetings of this Association for the Session 1917-18. This includes several interesting topics. The Session begins on Tuesday next when Mr. J. S. Highfield will deliver his Presidential Address.

"Repetition of E.M.F. in Armature Windings."—ERRATUM.—We regret that two errors crept into this article. The title of Fig. 3, instead of "$m=2m$ prime to u_1" should read "$m=2$, m prime to u_1." In the title of Fig. 4, W_1 should be u_1.

A Ferro-Concrete Floating Dock.—We notice that a shipping company at Jutland, Denmark, is building a floating dock of ferro-concrete. It is now being erected on a wooden foundation, 100 ft. long and 69 ft. broad, on which is mounted a skeleton of 340 iron pillars; the outer and inner walls and the bottom of the dock will be 4 metres thick, and, when complete, it will weigh some 700 tons. It is stated in "Engineering" that owing to shortage of materials the work can hardly be completed before the end of the year.

Japanese Research Laboratory.—IN THE ELECTRICIAN of June 1, we gave some particulars of the steps taken to organise a scientific and industrial research laboratory in Tokio. According to the "Economista d'Italia," for Aug. 30, the promoters of the scheme have now elected a committee to collect funds. The Government has been authorised to make a grant to the laboratory of 2,000,000 yen (about £200,000) payable in instalments over ten years, and the Imperial household has already given donations amounting to £100,000. A sum of about £290,000 has been collected, so that the available funds of the laboratory will exceed half a million pounds.

Visible and Audible Winding Shaft Signals.—In a recent Paper on the above subject before the Lancashire, Cheshire and North Staffordshire branch of the Association of Mining Electricians, Mr. V. Heyes described a form of visible indicator complying with the Home Office rules for mines. He added, however, that reliance should not be placed upon visual indicators alone, but only in conjunction with an audible signal, such as a bell, clapper, &c. In cases where visual apparatus was installed there was a danger that the enginemen in general did not use both senses, either the audible or visible signal being disregarded. But the combination of the two forms was desirable in the interests of safety and each had its respective advantages.

Application of Radio-Active Salts to Batteries.—A recent French patent, due to M. H. G. C. Thofehern, is concerned with the use of radio-active material for the purpose of facilitating the chemical action taking place in accumulators. For this purpose radium barium sulphate is suggested. The material is insoluble in the electrolyte, and does not appear to enter into chemical combination with the lead oxide or the metallic lead of the plates. Its presence, however, is assumed to render the chemical action more complete during charge and discharge; otherwise the process is normal. About 0·2 microgrammes of radium per pound of lead oxide is used, the radium compound being merely incorporated in the oxide used on the grid of the plates.

Mineral Wool from Basalt Rock.—According to "Engineering," a pure white mineral wool is being manufactured at Yarraville, a suburb of Melbourne, from basalt rock, or "bluestone," vast masses of which are found in the neighbouring Footscray district. This is a new industry in the Commonwealth, and has been started by an American firm. The mineral wool has a staple of about 1½ in. to 2 in. It is said to be pure white with a fine metallic lustre showing through it, and in texture it is soft and pliable. It is easily adapted for engine packing, and is already in use in the Yarraville factories. It can also be moulded into sheets like asbestos. Only the shortness of the staple militates against its use for weaving. There is said to be an increasing demand for this product as an insulator for packing machinery or ice-chests, and as a substitute for asbestos.

An Illuminated Fish Trap.—A rather ingenious contrivance was recently installed at the Devil's Lake, N.D., in the United States, for the purpose of testing the varieties of fish therein. According to "Popular Mechanics," the State Bureau of Fisheries had placed about 20 million pike, yellow perch, and black bass fry in the lake. Twenty years ago fish were very plentiful, yet at the present time some varieties are very scarce. In order to ascertain whether the chief varieties stocked still remain, a special trap, consisting of a box with a wire-mesh funnel was lowered into the lake. This box carried an electric lamp which could be lighted by the action of a switch operated by an observer. By inspection of this trap from time to time it was proved that many of the varieties still existed, though it is possible that large quantities of fish may have escaped by some subterranean channel.

Method for Welding Thin and Scaly Metals.—The "Electrical World" describes an invention of Carl B. Auer, of Wilkinsburg, Pa. (patent No. 1,229,700), for the welding together of the sheets and ribbons of metals which quickly tarnish in the air and which, therefore, become covered with a film or scale, such as interferes with ordinary welding methods. Thin metal sheets and ribbons may be easily welded together by ordinary processes of incandescent electric welding if their surfaces are clean. However, great difficulty is found in cleansing ribbons of nickel-chromium alloys which are now extensively used in making electric resistance elements, for the reason that the oxide scale on these alloys frequently cannot be removed by ordinary rubbing with emery paper. By the expedient of embossing the thin strips by means of a pair of pliers furnished with closely studded small projections the surfaces can be readily welded together.

Digitized by Google

A Congress of Sanitation and Safety.—A Congress of Sanitation and Safety is to take place in New York during September 10-15, and delegates from various parts of the world are expected. The main idea of the conference is to standardise safety methods in factories, railways and all industries involving hazardous occupations. The questions to be debated are of special importance in view of the drafting of skilled men into the army and their replacement by emergency labour with less experience. An exhibition of safety devices, accompanied by demonstrations, is to be opened in the Grand Central Palace.

British Sources of Potash.—As is well known, potash was before the war largely obtained from the deposits at Stassfurt in Germany, and, apart from its value in glass manufacture, is also a valuable element in soil. Potash can be obtained in appreciable quantities from the flue dust of blast furnaces, and some particulars of the possibilities of this source of supply are given by Mr. H. T. Cranfield in a recent number of the "Journal" of the Board of Agriculture. It is stated that analyses of typical specimens of such flue dust show from 1·25 to 9·25 per cent. of potash in a form soluble in water, in addition to forms soluble in acid. It is calculated that if all the blast furnaces in this country were tapped for potash, as much as 50,000 tons might be produced annually, of which probably half would be of the variety soluble in water.

An International Industrial Institute.—The movement for the prevention of accidents and the general supervision of safety in the United States, is illustrated by the formation of an International Industrial Institute in Boston, presided over by the Hon. Dudley M. Holman, who has been a member of the Massachusetts Industrial Accident Board from its inception, and Dr. W. Tolman, who was the founder of the American Museum and Safety. The Institute conducts classes in Safety Engineering. The need for such work is shown by the fact that over 32,000 persons are killed in industrial employment in the States annually; while over 250,000 men and women are permanently removed from industry by accident, and over three million injured more or less severely. It has been calculated that only 10–20 per cent. of such accidents can be prevented by mechanical safeguards; the rest of the problem is educational.

Tungsten Deposits in Rhodesia.—The present war has drawn attention to the value of the sources of tungsten within the British Empire. It may not be generally known that deposits of this metal exist in Southern Rhodesia; of these the "Journal" of the Royal Society of Arts gives a brief account, with their history and prospects. The deposits were prospected in 1906. In the ensuing two years a fair amount of ore was produced, but in 1909 production ceased, and although some interest in the region was shown subsequently, little was done to re-open the deposits until 1916. About 85 tons of concentrate, valued at £7,165, have been marketed. On the few reefs so far examined investigation has only been made at a depth of a few feet. The minerals existing are, however, very varied, and it is quite possible that further investigations may reveal more important possibilities.

"Journal" of the Leeds University Textile Association.—The issue of the above "Journal" for July contains a considerable amount of useful information. Among articles dealing with various forms of research of value in the textile industry, we note contributions by Mr. W. Harrison on "Carbonisation of Wool Containing Vegetable Matter" and by Mr. R. Christiansen on "Experiments in Producing Cotton-Felt for the Paper-making Trade." Mr. W. A. Stewart gives an account of the first Egyptian Industrial Exhibition. We also notice an enterprising feature, the printing of an article on "Cloths, wool, cotton, silk, &c.," in four languages in parallel columns. The work of the university has evidently penetrated to Ruhleben Camp, for the "Journal" contains a letter from a representative of the Woollen and Worsted Society at Ruhleben, describing the work of this Society, and asking for technical books and samples of material. Among articles of a more general character there is a contribution from Prof. A. F. Barker on "The Future of British Industry and Commerce."

Licences for the Use of Tar Oil as Fuel for Diesel Engines.—In view of the recent Orders made by the Ministry of Munitions regulating the use of creosote and other oils produced from the distillation of coal, the Diesel Engine Users' Association have taken action to provide for the necessary supplies of tar oils for their members. With the more extended experience now being gained in several quarters the difficulties involved in the substitution of tar oil for petroleum residual oil are gradually being overcome, and the discussion of the subject at a recent meeting of the Association was evidence of the wide interest which is being taken in this development of Diesel engine practice. At present "Creosote Licences" are only being granted for a period of two months, but it is hoped that members may shortly be able to obtain licences for the use of tar oil for longer periods so as to facilitate arrangements in making contracts for regular supplies. The Honorary Secretary of the Association has collected particulars of the requirements of the various members who use, or who contemplate using, tar oil, and these, together with other information, have been submitted to the Director of Munitions, Petroleum Supplies.

Benefits of Good Lighting: A Return on Investment.—In a series of articles in the "Electrical World" Mr. C. E. Clewell recently gives some interesting instances of good illumination in factories leading to saving in expenditure of time and effort. He shows that the cost of light per man during a working day amounts to only a small fraction of his wages; in fact, the lighting expenditure would be more than covered if it enabled him to save only two minutes in the course of the working day. It would be very instructive if, as Mr. Clewell suggests, the value of lighting could be presented in the form of a return on investment. It is obvious, however, that any such figures could only be presented for a particular trade, and with due regard to the local conditions. Another point is the proportion of cost formed by lighting equipment in comparison with the cost of plant and buildings. In the case of motor-car shops Mr. Clewell finds that illumination is responsible for about 3-9 per cent. of the total cost of equipment and erection. It is, therefore, undesirable to economise unduly in arranging the lighting; the provision of proper illumination adds but a small amount to the total expenditure and the benefits as regards effect on output and quality of work, and diminution of accidents, quite outweigh this expenditure.

OBITUARY.

H. M. DORMAN.—We regret to record the death of Sapper Harold Mark Dorman, R.E., only son of Mr. and Mrs. C. M. Dorman, of Brooklands, Cheshire. Sapper Dorman was accidentally drowned in the Thames near Maidenhead on the 9th inst.

J. H. KNIGHT.—The death is announced of Mr. John Henry Knight, one of the pioneers of the motor car industry. He was trained as an engineer and he devoted considerable attention to the development of the oil engine. He was one of the founders of the Self-Propelled Traffic Association and of the Royal Automobile Club. In addition to writing on motor engineering subjects, he was the author of a small book, entitled "Electric Lighting for Country Houses."

PERSONAL.

Sir Arthur Whitelegge, K.C.B., H.M. Chief Inspector of Factories and Workshops, will retire next month under the age limit rule, and Mr. H. M. Robinson, senior deputy chief inspector will succeed him. Mr. R. E. Graves will become senior deputy chief inspector, and Mr. G. Bellhouse junior deputy chief inspector.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Sept. 21st (to-day).

MUNICIPAL TRAMWAYS ASSOCIATION.

11 a.m. At Savoy Hydro, North Shore, Blackpool. Annual General Meeting.

TUESDAY, Sept. 25th.

ASSOCIATION OF SUPERVISING ELECTRICIANS.

7.15 p.m. At St. Bride Institute, Bride-lane, E.C. Presidential Address by Mr J S. Highfield, M.Inst.C.E.

Digitized by Google

MUNICIPAL TRAMWAYS ASSOCIATION.

SIXTEENTH ANNUAL CONFERENCE.

This conference was held yesterday at Blackpool, when Mr. H. Mozley delivered his Presidential Address, and two Papers were read, of which we give abstracts below. Apart from these there was a discussion on "Rule of Footpath," which was introduced by Mr. J. Dalrymple, and one on the "Development of Tramways," introduced by Mr. A. Ellis.

PRESIDENTIAL ADDRESS.

BY MR. HENRY MOZLEY.

(General Manager, Corporation Tramways, Burnley.)

One of the duties connected with the office of president which I have the high honour to fulfil is to address the members at the annual conference upon subjects which appertain to the special department of municipal activity represented by tramway committees and their managers.

This association has performed useful duties in the past, but has a much more important future in store, for the development of the tramway and the omnibus industry has not by any means reached its highest expansion in this country. In each of our areas there are local branch lines or connecting lines with other districts which are waiting only for an enterprising municipality to bring about their construction, and great and inevitable changes must be expected. It is an absurdity to repay the whole capital, within very limited periods, of an industry like that of the tramways, which is ever growing in value. Why should the first generation of inhabitants make a present to the second generation of property bringing in thousands a year, when this can only be done by burdening themselves with heavy charges annually instead of taking a legitimate toll or dividend for the money expended? The policy of municipal authorities providing sinking funds for everything alike, whether for a pure business undertaking such as a tramway or works necessary for the conveniences of life such as streets, sewerage, parks, &c., is wrong. It is the business of this association to get the law on this point altered, and this subject deserves early attention.

Certain undertakings have felt the inconvenience of the sinking fund during the war especially. Unlike the railway companies, municipal authorities after securing certain statutory fares began to give very much cheaper fares both for workpeople and ordinary passengers, and at present in some cases this policy is being continued with disastrous consequences to the financial stability of the undertaking. The cost of carrying a passenger three miles is considerably in excess of one penny, and the loss is made up from the shorter journey passenger. Before taking any steps to secure legislation, however, the undertakings concerned might well put into operation the power they already possess of increasing fares.

In recent years the tramway industry has benefited by standardisation of material used in common, and in the immediate future we may hope for further help in this direction. For convenient and economical working all cars should be alike in design and dimension on separate undertakings, and in the case of those with connections with neighbouring tramways and light railways more economical working and the interchange of rolling stock should be facilitated; neighbouring tramways might thus assist each other in ordinary development and emergencies.

From time to time we hear of difficulties and inconveniences arising owing to the long period which has elapsed since the Tramway Act of 1870 became law. It should be the business of this association in combination with the association representing company undertakings, to take up the revision of the conditions brought about by that Act. There should be one tramway authority in combined areas to control all traffic problems and developments with representative boards. In these days of manufacturing syndicates what an advantage it would be if combined tramway undertakings could buy their material in bulk. The power to do this should be secured by law.

In common with the rest of the business community it behoves us to prepare for the great changes which are bound to come after the war. Amongst other subjects the questions suggested by the Whitley Report, issued by the Reconstruction Committee should receive the immediate attention of the association. Here at least we are in a position to carry out without delay one of the principal recommendations, viz.: "That the establishment for each industry of an organisation representative of employers and workpeople, to have as its object the regular consideration of matters affecting the progress and well-being of the trade from the point of view of all those engaged in it." Our organisation being national and areas being provided in most cases with local associations, we have only one step forward to take—that is, to invite representatives of the workpeople to share our conferences and responsibilities.

It is to be hoped that notwithstanding the times in which we have our present being, we shall continue the good work of meeting annually, and if it were better understood the managers' section would resume their annual conferences, which have now been suspended for three years.

During the past year, as the report of the Executive Council will show, a vast amount of business has been transacted of the highest importance to the industry, and I have to thank those members of the council and the hon. secretaries for their helpful support during my year of office.

DIFFERENTIATION IN FARES FOR WORKMEN AND OTHER PASSENGERS ON TRAMWAYS.

BY WM. MURRAY.

(Tramways Manager, Walthamstow Urban District Council.)

There is taking place in these days an almost imperceptible, but, at the same time, a very real change, in the position of many municipal tramway undertakings throughout the country. This change is a third phase in the history of tramway development. In the early days we had horse-haulage, high fares, and, speaking generally, profitable financial results. With the advent of electric traction we secured greater speed, better vehicles, increased comfort for passengers, immense popularity and satisfactory returns. Now, at the present day, we, in London at least, are being seriously challenged in the matter of speed; are meeting with keen competition in regard to fares; and are being brought face to face with enormously increased expenses.

The tramcar still "holds the field" as the most efficient mode of street passenger transport for towns and large urban districts; but it may be considered that there should be a departure from the recognised policy hitherto followed, of granting special and privileged terms to certain classes of passengers.

Differentiation in tramway fares in favour of bona fide workmen has been made compulsory by all Special Acts and Provisional Orders granted under the Tramways Act of 1870. Now, admirable as the intention of these Acts may have been, the method adopted was distinctly open to criticism. It was simply a decision to confer benefits on one section of the community at the expense, and to the disadvantage of the other.

While tramways were in the hands of private owners it was recognised that to run a service of cars at the compulsory workmen's rates meant running at a loss; therefore, such services were kept within the very narrowest possible limits. In many cases one car on each route, running a single journey only—at about 6 a.m.—was all that was provided, the ordinary service coming into operation about eight o'clock. At the same time efforts were made to prevent passengers other than workmen from profiting by these cheap fares. In many cases women were not recognised as "workmen"; and constant friction resulted from the companies insisting that all whose appearance seemed to indicate that they were something other than working men, should pay the ordinary fares.

With the coming of municipally owned tramways an entire change of policy was initiated in regard to this matter. Encouraged by the low operating costs of electric tramways, with a desire to relieve housing congestion in central districts, and to enable working class people to live in the outskirts, these services were increased to an extent never before dreamed of, and fares were reduced to a level much below the compulsory limit. The increase in the one case, and reduction in the other, has continued until to-day in certain districts of London there is a continuous stream of workmen's cars between 3.30 a.m. and 8 a.m.; and special cars are run out between noon and 2 o'clock and again between 5 p.m. and 7 p.m., to cope with this traffic; and a rate of 10 miles for 2d. seems to be about the average. In one instance, passengers on these cars can travel for a distance of 19 miles at a cost of 2d.

Moreover, many tramway systems allow all passengers boarding cars before 8 a.m. to purchase return tickets at workmen's rates. In many towns still further concessions have been granted, such as cheap fares for school children, free passes to the blind, free travelling for tramway employés, policemen, special constables, hospital nurses, wounded soldiers and others.

Now, I submit that the only true basis for the fixing of tramway fares is the cost of providing the service rendered, and that all who avail themselves of that service should be required to pay on a uniform scale.

Digitized by Google

What the public and, I fear, even some town councillors, seem to forget, is that travelling facilities cost money to the department furnishing these, just as really as any article of commerce costs money to those producing or selling it. Because of this, there is no more reason why the department should be called upon to supply free travelling facilities than free beer, or free anything else. In providing these facilities the undertaking has to buy cars, construct permanent way and overhead equipment, purchase or generate electrical energy, and hire labour. Now, having done all this, why it should be asked to sell the finished product at less than cost price—or worse still, give it away for nothing at all—I cannot understand. I know of no other great industry, or branch of commercial enterprise, in which habitual selling under cost price has come to be recognised as the correct thing. In some businesses it may be that one article is sold at cost price or less in order to entrap customers, and with the hope of making a profit out of other goods, which they are almost certain to purchase. Thus, in peace times, a grocer may sell sugar at or under cost *knowing* that customers will assuredly buy other goods also on which more or less profit is made. In such a case, although the morality of the procedure is doubtful, the result may be considered to justify the means. At any rate, the purpose is clear and understandable. With municipal tramways, however, *no such temptation exists*, as under-selling in one direction does not lead to increased profit in another, and from the same customers. It merely leads to a loss, for which the department proceeds to try and recoup itself by overcharging other sections of the community. To my mind, this is not only bad business, but, from a moral standpoint, is simply indefensible. I am glad to think that, as shown by the various discussions which have taken place recently on tramway fares in general, it is clear that many gentlemen connected with the business are beginning to realise the folly and injustice of the course hitherto pursued, and to feel that a change of some kind is almost imperative. The fact that many of the larger tramway concerns have been so wonderfully successful as to be able to bear the burden, is apparently the only reason why the evil has been tolerated so long, and why it has been allowed to grow to such an amazing extent. I think that, if ever stress of circumstances compels us to stir ourselves in this matter it will be all to the good.

In the foregoing notes I have assumed, for the moment, that workmen's fares must of necessity involve a loss to any tramways undertaking. While, however, this is generally true, I do not know that it is absolutely so. Fares which result in a loss in one town may conceivably yield a profit in another. No universal dictum can be laid down in this matter. For example, we are accustomed to hear it stated, very emphatically in some quarters, that half-penny fares never pay; and yet I think it must be clear to most people that, given a sufficient number of them, and an all-day spread-over of the traffic, ½d. fares are capable of yielding a very handsome return. Newcastle-on-Tyne furnishes an example in proof of this statement. A private owner runs a service of horse-drawn brakes over the high level bridge which spans the river, conveying passengers from Newcastle to Gateshead, and vice versa. Only one fare is charged—viz., ½d. per head; and on each journey, in either direction, the proprietor has to pay a toll of 4d. to the owners of the bridge. In spite of this handicap, this service, *supported entirely by ½d. fares*, has been maintained for many years, and presumably does something more than merely pay its way. This owner, at least, has evidently found that ½d. fares are all right—provided you can get plenty of them.

The question of what pays and what does not pay must be decided entirely by local conditions, and the answer seems to be as difficult to arrive at as that to another I have sometimes had put to me, quite seriously, too—viz., "How much does it cost to stop and re-start a tramcar?" The fact is that the old adage that "circumstances alter cases" still holds good. In my own case I have adopted a very simple formula, as follows:—

Let C = total cost of operation, including interest and repayment of loan.

M = total number of car-miles run.

P = total number of passengers carried.

X = cost per passenger, per car-mile.

Then $\frac{C}{M}$ = average cost of operation per car mile, and

$\frac{P}{M}$ = average number of passengers per car-mile;

Therefore—

$$X = \frac{C}{M} \div \frac{P}{M}$$

$$X = \frac{C}{P}.$$

Thus, in Walthamstow, we ran last year 1,128,029 miles, at a total cost of £48,952, and carried 12,367,778 passengers. Under the formula given this represents: Cost of operation per car-mile, 10·415d.; number of passengers carried per car-mile, 10·964d.; therefore, cost of operation per passenger per car-mile, 0·95d. Of course, last year was altogether abnormal; and, but for the increased expenses, including payment of war bonuses, &c., the cost of operation would have been very much less.

More than 12 months ago we raised our workmen's fares to the limit allowed by law—*i.e.*, ½d. per mile—but even on this basis, it is clear from the above figures that we are still losing nearly ½d. on every car-mile run at workmen's rates. We ran last year 200,000 such miles, and this, I reckon, involved a loss to the undertaking of about £3,750. If this is so on a small system such as ours, what must the loss be on some others?

In face of these facts, what then ought to be done? First of all, in my humble opinion, steps should be taken by all municipal tramway authorities—but more especially by those whose undertakings are having a difficulty in making ends meet—to raise workmen's fares to the legal limit of ½d. per mile, to cancel all free passes, and to withdraw all special rates. This is a change which can be affected at once, without waiting for the doubtful results of organised legal agitation. An alternative would be for the Council concerned to purchase from the tramways department tickets or tokens, at face value, and distribute them at a reduced price, or entirely free, as they may consider desirable.

An arrangement of this kind would have several distinct advantages. It would free the tramways department from a very serious, and a very unfair, handicap in the conduct of its business; it would remove the injustice of fleecing one class of passenger in order to benefit another; and, perhaps most important of all, it would enable the public and members of the council themselves, to appreciate the cost of such concessions—a thing which very few indeed seem to realise at the present moment.

Then I submit that the Executive of our association ought to seriously consider what steps can, and should, be taken to secure an alteration in the laws regarding workmen's fares.

If tramways must go on bearing this burden of preferential fares for working men and women, them, in common fairness, they ought to be protected from competition which is unequal, unnecessary, and grossly unfair. Electricity, gas and water undertakings, whether owned by municipalities or private companies, are protected from such competition. Why then should tramways not only have the competition but be handicapped by impositions and restrictions which are altogether unreasonable and out-of-date?

Injustices such as I have pointed out, and others which are familiar to us all, are so glaring that it should be possible to secure redress, notwithstanding the vested interests, or official red tape, which may seek to block the way.

As I have already indicated, up to a certain point we can help ourselves. Beyond that point we look to the association to see us through.

NOTES ON TRAMWAY FINANCE.

BY MESSRS. J. BARNARD (BOLTON), G. W. HOLFORD (SALFORD), AND J. PRIESTLY (OLDHAM).

In view of the abnormal conditions through which we are passing it is proposed to call attention to the main features of the "Income" and "Expenditure" sides of our various undertakings.

We will first refer to the "Income" side of our accounts. The following are the principal sources of revenue: (1) Tram fares, (2) Parcels, (3) Advertising, (4) Investments, &c.

It is desirable to deal with the above items seriatim, namely:—

(1) TRAM FARES.

These may be sub-divided into (*a*) tram fares for ordinary passengers, (*b*) tram fares for workmen, &c., and (*c*) children's fares.

(*a*) *Ordinary Passenger Fares.*—The usual for fares charged to ordinary passengers as stipulated in the Acts of Parliament is 1d. per mile. How, then, can their revenue be increased? Some may suggest that if the fares were cheapened there would be more riders. This may result to a limited extent, but it is not always an easy matter to cheapen a 1d. fare successfully. If Parliament can be induced to raise the rate per mile chargeable by tramway operators there is a possibility of larger revenue being obtained. This matter is at the present time receiving attention at the hands of the executive councils of both this Association and the Tramways and Light Railways Association. Many tramway undertakings, who were charging less than the statutory limits, have recently increased their fares, and in most cases the authors understand the results have been satisfactory.

Digitized by Google

(*b*) *Workmen's Fares, &c.*—The general basis of charge allowed by Act of Parliament for workmen's fares stipulates that during certain hours of the morning and evening workmen shall be carried at fares not exceeding ½d. per mile, but usually the operator is not called upon to charge a less fare than 1d. Many undertakings to-day are charging workmen's fares at the highest possible rates allowed.

Others allow workmen and early morning riders to travel at cheaper rates than those stipulated in the Acts of Parliament. If the balance sheets of these undertakings show reasonable profits, then this action may be justified, but if not they should revise their charges so as to agree with those provided by Act of Parliament. In general "early morning" passengers are actually being carried at a loss.

(*c*) *Children's Fares.*—The system varies in numerous undertakings with regard to the age limit for children's fares. These fares would well repay revision.

Many concessions of varying character have been granted in tramway undertakings in the past in the shape of contract tickets, pre-paid tickets, &c., sometimes granted in response to appeals from various sections of the community. Revenue would be increased if these concessions were withdrawn and the proper scale of fares enforced.

(2) Parcels.

A number of undertakings obtain revenue from the carriage of parcels. It is difficult to suggest a method by which the revenue under this heading can be increased, as prices are fixed, as a rule, under by-laws or other regulations.

In some cases additional revenue has been gained by charging passengers for all excess luggage. This system does not involve any extra expenditure and can be carried out by the conductors in their ordinary course of duty.

(3) Advertising.

This source of revenue is not common to every undertaking, and difference of opinion exists in many towns as to the wisdom of utilising tramcar vehicles for advertising.

In any case the period we are passing through offers very little prospect of higher revenue being obtainable.

In the experience of the authors the value of a tramcar as an advertising medium has been on the down grade for several years.

(4) Income from Investments.

This is an item which is hardly controllable by the management of an undertaking. Much depends upon the system in operation in the various cities and towns. The tramway fund should be credited with all the interest accruing from its investments.

We will now turn to the main items of "Expenditure" under the following headings: (1) Power, (2) Traffic, (3) General, (4) Accident Insurances, &c., (5) Repairs and Maintenance.

(1) Power Expenses.

This item in our accounts is very important, not only with regard to the consumption of current per car mile run but also as to the price paid for the supply of electrical energy, or the cost of production in undertakings where the generation of the energy is in the hands of the tramways department. The consumption per car mile should, of course, be as low as possible, but in practice is of a very varying character. Many factors have to be taken into consideration, such as: The system of feeding; the type and weight of cars used; the number and degree of gradients; the type of electrical equipment; the length of service of the motormen, &c.

In many undertakings the arrangements with regard to the price charged by the electricity department to the tramways department appears to be of a somewhat unfair character; the tramways department having to bear the cost of cables and all losses of transmission from the generating station to the section boxes, as compared with the method of charging manufacturers, who are not usually called upon to bear the cost of cables, and further, are charged for the current consumed as registered in their works, which relieves them of transmission losses, and frequently the actual price to be paid is lower than that charged to the tramways undertaking.

In other instances, considerable economy could be obtained if the feeding arrangements were improved. Some arrangement might be arrived at between the tramway and electricity departments whereby this expenditure could be shared and the ultimate result would be beneficial to both departments. As soon as the price of coal begins to cheapen the price of electrical energy should be reduced in many undertakings; in fixing such price a sliding scale with regard to the price of coal should be provided for.

As regards the human element it is a fact that the experienced and careful motorman can and does save in the use of electrical energy. Careful watching on the part of experienced inspectors will often be found very beneficial in reducing waste to a minimum Systematic examination of the electrical equipment of the cars is an absolute necessity. No time ought to be lost immediately things become more normal, in thoroughly overhauling all electrical and mechanical working parts of the car equipments, and renewing defective or worn equipments.

We strongly recommend the use of car meters having practical experience of their great value in checking the excessive use of current on the cars. The best results can only be obtained if the records of each car and each man are carefully registered and studied from time to time.

(2) Traffic Expenses.

Under this heading are grouped many familiar items of expenditure, namely: Wages of traffic employees; cleaning and oiling of cars; the salting and sanding of track; fuel and lighting of depots; ticket check; uniforms, &c. These items usually represent the largest proportion of the expenditure of a tramway undertaking. The rates of wages are not properly matters to be left to the decision of the management, but are usually decided by the committee in charge. It is hoped that in the near future some system of standardisation of wages will be brought into operation; there should be a properly constituted authority appointed for the various localities, with power to settle the matters in dispute. At present practically all undertakings are burdened with large payments in respect of war bonus. Each undertaking should carefully observe that no more labour is employed than is absolutely necessary; lists of spare men, stand-by men, &c., being kept at the lowest limits. With respect to material for cleaning and oiling cars, and salting and sanding track at the present time we are called upon to pay abnormal prices. The only way to meet this expenditure is by reducing the quantities used to as low a figure as possible. The adoption of inferior qualities is a true economy. Similar remarks apply to materials required for salting and sanding of track, for fuel, &c., for depots, tickets and uniforms.

(3) General Expenses.

This heading includes many items which are not controllable by the management such as rates and taxes, insurance charges, &c., and due economy in other directions, such as printing, &c., is no doubt practised in all undertakings.

(4) Accident Insurances, &c.

The method of dealing with claims arising out of accidents differs in various undertakings. Some carry their own risks, whilst others prefer to pay premiums to insurance companies to relieve them of their liabilities. It will usually be found more economical and more satisfactory for the undertakings to carry their own risks. Certain undertakings pay bonus to employees for freedom from accidents.

(5) Repairs and Maintenance.

This is an important item, including repair and maintenance of permanent way, rolling stock, overhead equipment, and sundry other plant and vehicles. Here again we have to meet abnormal expenses for war bonus to the different trades engaged. Materials are excessively dear to purchase, and we can only meet this problem by practising the utmost economy. Much work on the permanent way is held up at present, but must be carried out in the near future.

Our general conclusions may be summarised as follows:—

1. That increased revenue may be obtained—

(*a*) By an alteration—if Parliament or the Board of Trade will permit—in the maximum charges fixed by statute for the carriage of passengers; this applies where the undertakings are already charging statutory rates.

(*b*) That in other undertakings further revenue may be obtained by increasing the fares charged and abolishing all forms of concessions and privileges.

2. That expenditure can only be reduced—

(*a*) By the employment of the minimum number of employees required, and by the utmost economy in the quantities purchased of the materials necessary for the reasonable maintenance of the various branches of tramway undertakings.

(*b*) By a careful review by each undertaking of the several items referred to in our previous remarks which may offer opportunities for reducing expenses in particular instances, and that municipal tramway undertakings should at all times be regarded as commercial enterprises and be dealt with strictly on these lines, and that provision should invariably be made for depreciation and renewals on sound financial basis before contributions are demanded from the undertaking towards relief of rates or for any other purpose.

Digitized by Google

THE HIGH-TENSION MAGNETO WITH SPECIAL REFERENCE TO THE IGNITION OF AEROPLANE ENGINES.*

BY A. P. YOUNG.

(*Continued from p.* 924.)

Summary.—The author explains the principles underlying high tension magnetos for aeroplane work and discusses various points in the design, as affecting the efficiency of performance and the nature of the spark. Curves are presented showing the variations in the flux and the importance of remanence and coercive force in the magnets are emphasised. The relation of the flux to the energy of the spark is considered, and some details are presented to illustrate the need for careful mechanical design and accurate workmanship. Finally the author gives some instructions as to the care of magnetos and their upkeep in practice.

PART II.

AEROPLANE TYPE MAGNETOS.

The greater number of the magnetos built in this country since the outbreak of war have been used on aeroplanes and it is generally recognised that an aeroplane magneto has to operate under more severe and exacting conditions than obtain on any form of motor vehicle.

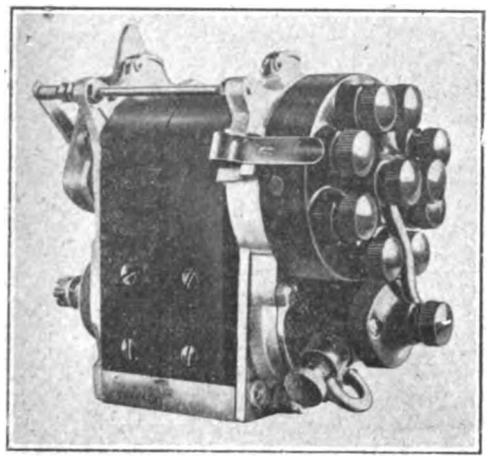


FIG. 6.—B.T.-H. MAGNETS.

The mantle of responsibility was borne during the early stages of the war by the firm of Thomson Bennett, in Birmingham; the B.T.-H. Co., in Coventry; and the M.L. Magneto Syndicate, in Coventry. At the present moment there are no less than 15 manufacturers engaged on this most important work.

The author then gives a brief account of the magnetos of the M.L. Magneto Syndicate and the Thomson Bennet A.D. 4 Type, after which he deals more fully with the B.T.-H. variety, with which he

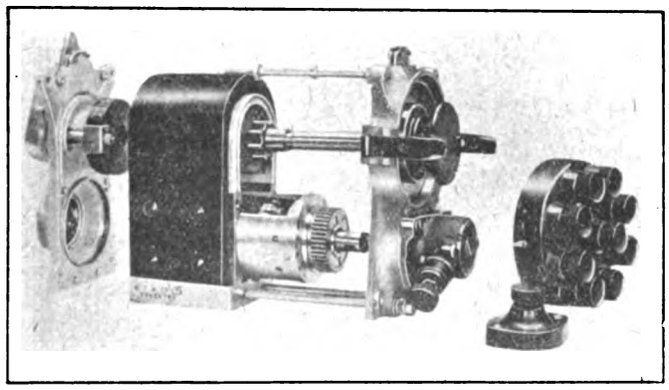


FIG. 7.—B.T.-H. MAGNETS.

is more familiar and which serves to illustrate the general principles of design.

B.T.-H. EIGHT-CYLINDER TYPE A.8.S. SLEEVE INDUCTOR MAGNETO.

This magneto is of the sleeve inductor type with fixed armature. It is designed to give four sparks per revolution, and is therefore fundamentally different from the ordinary rotating armature type of magneto, which cannot give more than two sparks per revolution. A six-cylinder machine (Type A.6.S.) is also built on the same principle.

Two photographs of the machine are reproduced in Figs. 6 and 7, which show the construction of the various component parts, such as rotating sleeve, fixed armature, distributor, condenser, end plates, and brush holder. In the contact breaker a pivoted steel bell crank lever arm carries at one end a fibre block, which is actuated by a rotating eight-part hardened steel cam rigidly fixed to the distributor brush spindle, while at its other end the movable platinum contact screw is secured. A very strong steel spring fixed at one end to the contact lever arm and at the other end to the base plate serves to force the movable contact tightly against the adjustable fixed contact when the cam is not in engagement with the fibre heel.

The contacts are opened eight times during each revolution of the cam shaft, which rotates at half the speed of the sleeve inductor, thus giving four breaks per revolution of the latter.

The manufacture of such a magneto on a large scale is attended with considerable difficulties, because there are no less than 397 parts of different design, and a total of 860 parts are actually used. Nevertheless magnetos of this type are being produced in very large quantities.

ANALYSIS OF OPERATION CHARACTERISTICS.

(*a*) *Action of the Rotating Sleeve Inductor.*—The flux through the armature core reverses its direction *four* times during each revolution of the sleeve, and by virtue of this fact it is possible to obtain four sparks per revolution. A magneto of this type is sometimes referred to as a *two-cycle* machine, because the flux wave, when plotted for one revolution of the rotating part, can be split up into two equal parts, each comprising a positive and negative portion.

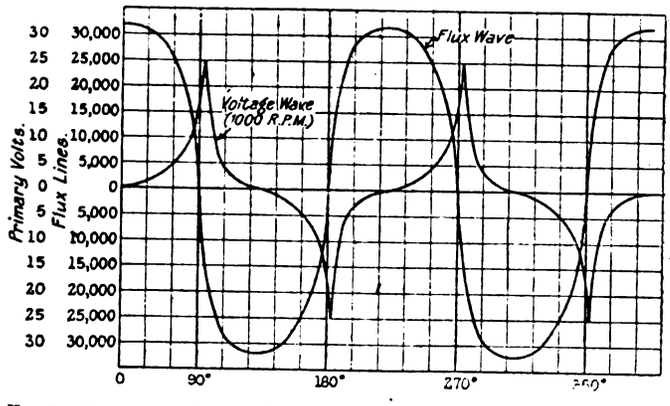


FIG. 8.—FLUX AND VOLTAGE WAVES OF AEROPLANE TYPE A.8.S. MAGNETO.

The maximum value reached by the flux wave is approximately 32,000 lines. This is the actual flux which links itself with the primary and secondary windings carried by the fixed armature core. Assuming a leakage coefficient of 1·4, the magnet flux works out at 45,000 lines.

The following figures are of interest:—

Flux density in magnets = 5,900 lines per sq. cm.
Flux density in armature core = 8,500 lines per sq. cm.

These figures are very high for an inductor type of magneto, although they are lower than the figures worked to in a magneto with rotating armature. The difference is accounted for by the fact that in the type "A" magneto—as in all inductor type machines—there are four air gaps in that portion of the magnetic circuit lying between the pole faces, as compared with only two gaps in the two-spark rotating armature type of magneto. The increased reluctance due to the larger number of air gaps naturally means that the available flux is smaller, using magnets of corresponding size and strength.

(*b*) *Induced Voltage due to Rotation.*—Having determined the flux wave, it is an easy matter to compute the induced voltage wave resulting simply from the rotation of the sleeve, it being assumed that the contact breaker is inoperative and that the primary is open-circuited continually. Vice-versa, the flux wave can be calculated from the voltage wave, and in Fig. 8 this has actually been done, the voltage wave being a reproduction of an actual oscillogram giving the induced primary voltage at 1,000 revs. per min.

* Abstract of a Paper read before the Aeronautical Society.

Digitized by Google

In the secondary a voltage is induced by the rotation of the sleeve which conforms in shape with the primary voltage wave. The maximum point reached by the wave will, however, be k_1 times the maximum primary voltage. The ratio k_1 for this particular magneto is very large, so that, considering the machine as a simple alternator, the maximum secondary voltage will be in the neighbourhood of 3,000 at very high speeds.

We have assumed that when the axis of the rotating sleeve is exactly at right angles to the magnetic axis, the flux is zero. This means that the induced voltage due to rotation reaches its maximum value just after the sleeve has passed through this critical position, which I shall call the "dead centre." Actually, the forward phase displacement of this maximum point amounts to 3 deg.

(*c*) *Primary Current at "Break"* (I_B).—Adopting the graphical method of calculating the primary current curve during the period that the contacts are closed, I have been able to plot a number of

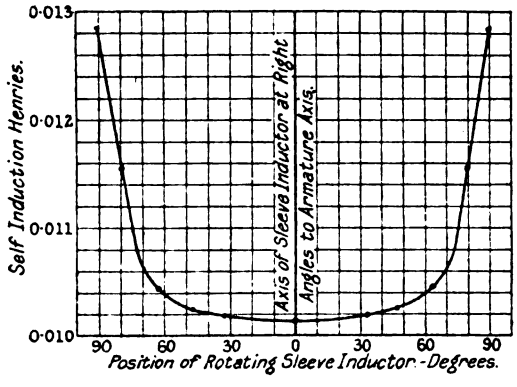


FIG. 9.—TYPE A.8.S. MAGNETO. VARIATION OF PRIMARY SELF INDUCTION WITH SLEEVE INDUCTOR POSITION. CURVE OBTAINED EXPERIMENTALLY ON ALTERNATING CURRENT 50 CYCLES WITH 3 AMPERES IN PRIMARY.

curves for six different speeds ranging between 100 revs. per min. and 3,000 revs. per min. Typical curves are shown in Fig. 10, the basis of the calculation being the open circuit primary voltage curve as determined by an actual oscillograph test, reproduced in Fig. 8, and the primary self-induction curve given in Fig. 9.

These curves show that the maximum value of the primary current increases with the speed: very rapidly at low speeds, but hardly at all when the speed is high. In fact, at abnormally high speeds the maximum value will actually fall off, owing to the damping caused by the eddy currents induced in the rotating iron segments, which has

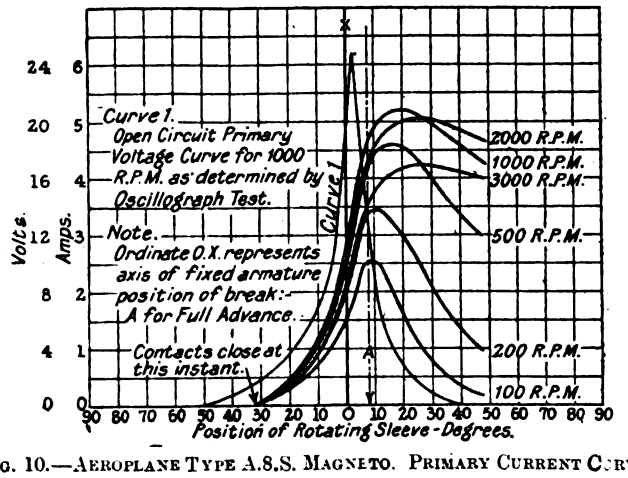

Curve 1.
Open Circuit Primary Voltage Curve for 1000 R.P.M. as determined by Oscillograph Test.
Note.
Ordinate O.X. represents axis of fixed armature position of break:-
A for Full Advance.
Contacts close at this instant.
2000 R.P.M.
1000 R.P.M.
3000 R.P.M.
500 R.P.M.
200 R.P.M.
100 R.P.M.
Curve 1
Volts.
Amps.
90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90
Position of Rotating Sleeve - Degrees.

FIG. 10.—AEROPLANE TYPE A.8.S. MAGNETO. PRIMARY CURRENT CURVES COMPUTED FOR VARIOUS SPEEDS.

the effect of preventing the flux in the stationary armature core rising to its proper maximum value after each reversal. The maximum point on the current curve is displaced forward in the direction of motion as the speed is increased.

In Fig. 10 is indicated, by means of a chain dotted line, the position of the rotating sleeve at "break," so that by determining where this line intersects these six curves it is easy to arrive at the value of I_B for each speed corresponding to the fully-advanced position of the timing lever. Similarly, the position of "break" for the fully-retarded position can be indicated. Below are given in the form of a table the values thus deduced for the six speeds under consideration:—

Speed R.P.M.	Advance. Max. current 1 amp.	Advance. Phase displacement ω.	Advance. I_B amp.	Advance. Ratio $\frac{I_B}{I}$	Retard. Max. current 1 amp.	Retard. Phase displacement ω.	Retard. I_B amp.	Retard. Ratio $\frac{I_B}{I}$
100	2·55	8°	2·54	0·996	2·57	9·5°	1·52	0·591
200	3·45	11°	3·41	0·988	3·47	12·0°	2·8	0·807
500	4·62	17°	4·26	0·922	4·47	16·5°	4·3	0·962
1,000	5·23	20°	4·55	0·870	4·88	20·0°	4·87	0·998
2,000	5·08	25°	4·24	0·835	4·77	25·0°	4·76	0·998
3,000	4·22	27°	3·5	0·829	3·97	27·0°	3·94	0·992

(*d*) *Sparking Voltage and Energy Output.*—The maximum voltage will be approximately proportional to the value of I_B, so that if we

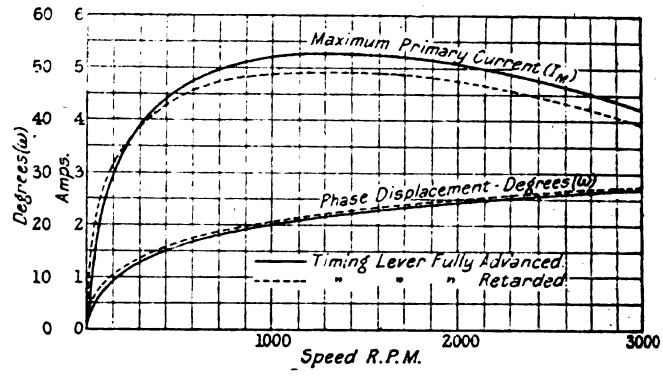


FIG. 11.—AEROPLANE TYPE A.8.S. MAGNETO CURVES CONNECTING MAXIMUM PRIMARY CURRENT (I_M) AND THE PHASE DISPLACEMENT OF THIS MAXIMUM (ω) WITH THE SPEED.

plot this factor against the speed we shall obtain a curve that is substantially representative of the way in which voltage increases with the speed. This is done in Fig. 12, a second curve being added to represent the variation in the maximum available energy with the speed, as calculated from the formula:—

$$\text{Maximum available energy} = \tfrac{1}{2}LI_B^2.$$

The whole of the maximum available energy does not appear in the high-tension spark, as already explained, owing to certain losses.

RESULTS OF TESTS.

(*a*) *Voltage and Energy Curves.*—Maximum sparking voltage and spark energy curves obtained by experiment are plotted in Fig. 13.

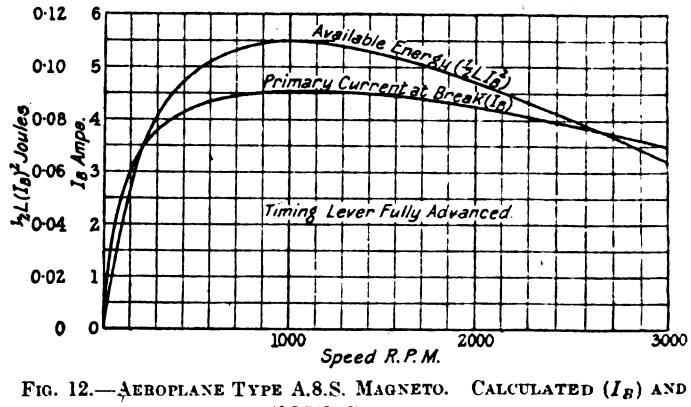


FIG. 12.—AEROPLANE TYPE A.8.S. MAGNETO. CALCULATED (I_B) AND ($\frac{1}{2}LI_B^2$) CURVES.

NOTE.—All curves have been calculated.

Experiment has shown that under normal working conditions a new sparking plug requires about 3,500 volts to cause a spark to jump between the electrodes when the piston is in the firing position and the compression is about 80 lbs. per square inch. It is therefore interesting to note that this voltage is given by the magneto at the very low speed of 60 R.P.M., the point being indicated on the curve. The normal running speed is 1,800 R.P.M. One would expect a magneto having these characteristics to give satisfactory ignition at the moment of starting, and this is borne out in practice.

Digitized by Google

The energy output per spark at each speed was determined by a calorimetric method, the test extending over an appreciable time. The curve plotted from these results conforms very closely in shape with the maximum available energy curve ($\frac{1}{2}LI_B^2$) given in Fig. 12, although the measured energy for each speed is about 80 per cent. of the calculated maximum value. The remaining 20 per cent. of the energy is dissipated in the iron masses in the magnetic circuit and in the windings.

In further illustrations in the original Paper, the author gives a number of oscillograms for a magneto of this type; these show that the actual value of I_B agrees substantially with the calculated value in every case.

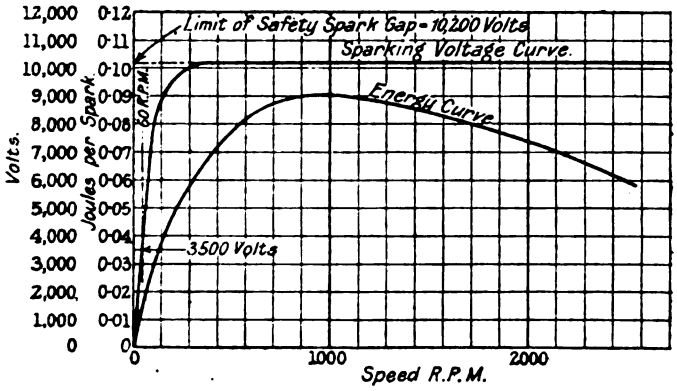


FIG 13.—AEROPLANE TYPE A.8.S. MAGNETO. SPARKING VOLTAGE AN ENERGY CURVES PLOTTED FROM RESULTS OF TESTS.

(b) *Variation of Armature Core Flux with Speed.*—By integrating the open circuit primary voltage half wave for each speed, it is an easy matter to determine the corresponding values of the armature core flux (N).

Another method of determining the value of the armature core flux at different speeds, which has the advantage of simplicity, is to connect a Kenotron valve between the insulated end of the primary and earth, in series with a very large non-inductive resistance and a micro-ammeter of the moving-coil type.

It is not surprising to find that the value of N gradually diminishes as the speed is increased. This falling off of the flux N results from the eddy currents set up in the rotating and stationary iron masses in the magnetic circuit, which have the effect of damping back the flux at high speeds.

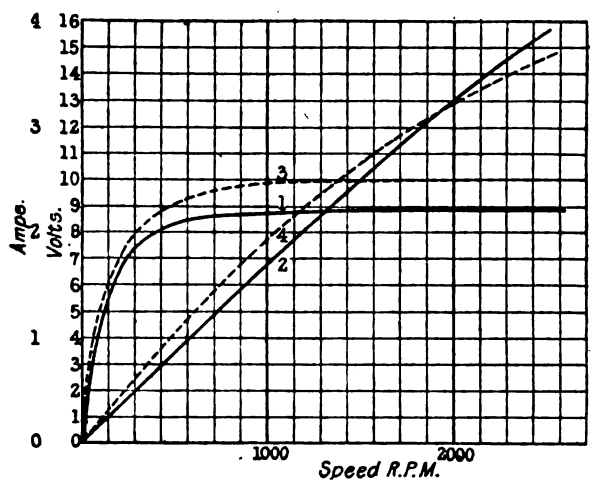


FIG. 14.—AEROPLANE TYPE A.8.S. MAGNETO
Curve 1.—Short circuit current curve.
Curve 2.—Open circuit voltage curve.

NOTE.—Curves 3 and 4 are similar curves for corresponding Bosch type magneto (*HLB*).

The rotating armature type of magneto as standardised by Bosch is a very bad offender from this standpoint, and oscillograph tests recently carried out on one of the Bosch Company's latest machines—built since the war—showed that at 4,000 revs. per min. the drop in the armature core flux N amounted to as much as 23 per cent.

(c) *Primary Current and Voltage Curves.*—Curve 2 in Fig. 14 shows the relationship between the root mean square value of the open circuit primary voltage and the speed. Curve 1 shows the variation in the short-circuit primary current, as measured by an ammeter. The shape of the voltage curve also shows that the armature core flux N diminishes as the speed is increased, because if N remained constant curve 1 would be a straight line. The dotted curves 3 and 4 are for a Bosch magneto of corresponding type (*HL*8).

A very good idea of what the operation characteristics of a magneto are likely to be can be gathered from the value of the open circuit primary voltage at some definite speed. It is the practice of the B.T.-H. Co. to measure the voltage given by every magneto at 2,000 revs. per min. immediately after magnetising. It must not be less than a certain minimum figure. In addition, the machine is then run at 2,000 revs. per min. with the secondary short-circuited and the voltage again measured.

A minimum percentage drop in voltage is allowed, which must not be exceeded. Generally speaking, this percentage drop affords some indication of the magnetic quality of the magnets; the larger the drop the lower the coercive force, and vice versa.

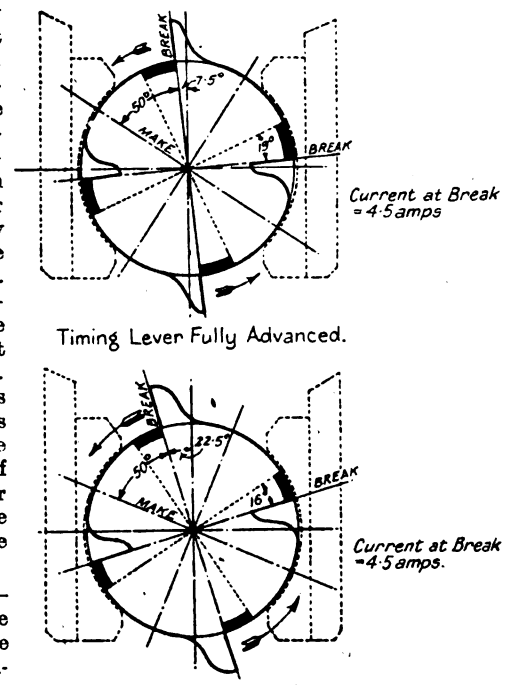


FIG 15.—DIAGRAM SHOWING THE VARIATION OF PRIMARY CURRENT FOR A B.T.-H. A.8.S. MACHINE RUNNING AT 1,000 R.P.M.

(d) *Circle Diagram.*—Fig. 15 shows some circle diagrams, the duration of the high-tension spark being indicated. One can thus trace the growth of the currents induced in both primary and secondary during one revolution of the sleeve inductor. Similar diagrams can be constructed for any type of magneto if sufficient data is available.

(e) *Overall Efficiency.*—By measuring the power required to drive a magneto at different speeds it is an easy matter to calculate, from the spark energy output, the overall efficiency of the machine. Three curves are given in Fig. 16 for the type "A" magneto, curve 1

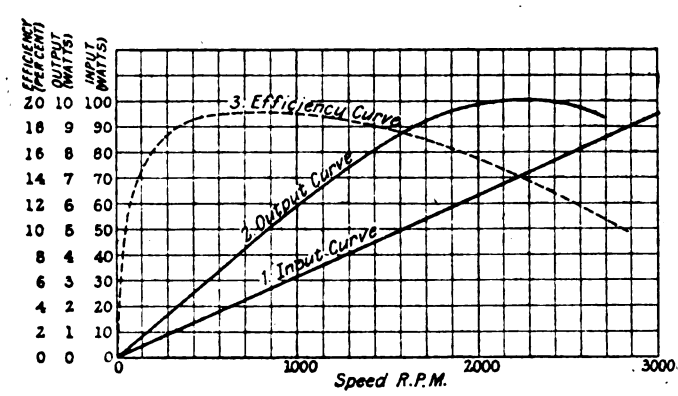


FIG. 16.—AEROPLANE TYPE A.8.S MAGNETO. INPUT, OUTPUT AND EFFICIENCY CURVES PLOTTED FROM RESULTS OF TESTS

showing the variation in the driving power (watts) with the speed; curve 2 the variation in the output, in watts; and curve 3 the variation in efficiency.

The efficiency values are, of course, abnormally low, and chiefly of academic interest; but, on the other hand, a curve of this kind affords a ready means of comparing the characteristics of different magnetos of the same type.

THE SPECIAL "SPARK GAP" DISTRIBUTOR.

When discussing the question of the voltage rise in the secondary at "break," I referred to the advantages likely to result from the use of a distributor brush that is designed to allow a very slight clearance between the face of the brush and the distributor segment. Such an

Digitized by Google

arrangement is used in the type "A" magneto, and it has proved to be thoroughly reliable and satisfactory.

The distributor brush is made of steel, and has V grooves in its active face with a central slot for taking the square head of the locking screw. It is of rectangular section, and it is free to move in a brass tube moulded into the insulation. A spring forces the brush outwards against the head of the locking screw.

Obviously, the screw is automatically locked, and the air gap between the face of the brush and the track of the distributor can be readily adjusted by first depressing the brush until the head of the screw is clear and then turning the latter either one way or the other. A quarter of a turn on the screw, which gives the minimum adjustment, alters the air gap by 0·002 in. When properly adjusted, the air gap should be between 0·01 in. and 0·014 in.

The amount of wear on the face of the brush after continuous use is so small as to be almost negligible. We have run a brush of this kind on a magneto at 2,500 R.P.M. for 300 hours, and at the end of that time the face of the brush was, for all practical purposes, as good as that of a new brush. There was no sign of any pitting.

MECHANICAL CONSIDERATIONS.

It does not seem to be generally appreciated that the manufacture of magnetos can only be undertaken successfully if very skilled labour is available, and the necessary steps are taken to machine all the component parts to extremely fine limits. In the type "A" magneto the clearance on each side of the sleeve inductor is only 0·006 in., and in the manufacture of this type of magneto no less than 716 limit gauges are employed.

The finest limits worked to are for the hole in the contact breaker cam and the end of the distributor brush spindle, on which the cam is fitted. These limits are :—

Hole in cam	Maximum diameter	13·005 mm.
	Minimum ,,	12·995 ,,
	Tolerance	0·01 ,,
End of spindle	Maximum diameter	12·995 ,,
	Minimum ,,	12·988 ,,
	Tolerance	0·007 ,,

The B.T.-H. Co. has recently developed a polar inductor type magneto, more especially for 12-cylinder working, although it is proposed to standardise an 8-cylinder machine of exactly the same design by simply changing the distributing mechanism and gearing; this is believed to be the first 12-cylinder magneto to be developed and standardised in this country. It is designed to give four sparks per revolution, and the 12-cylinder model runs at 1-1/2 times engine speed.

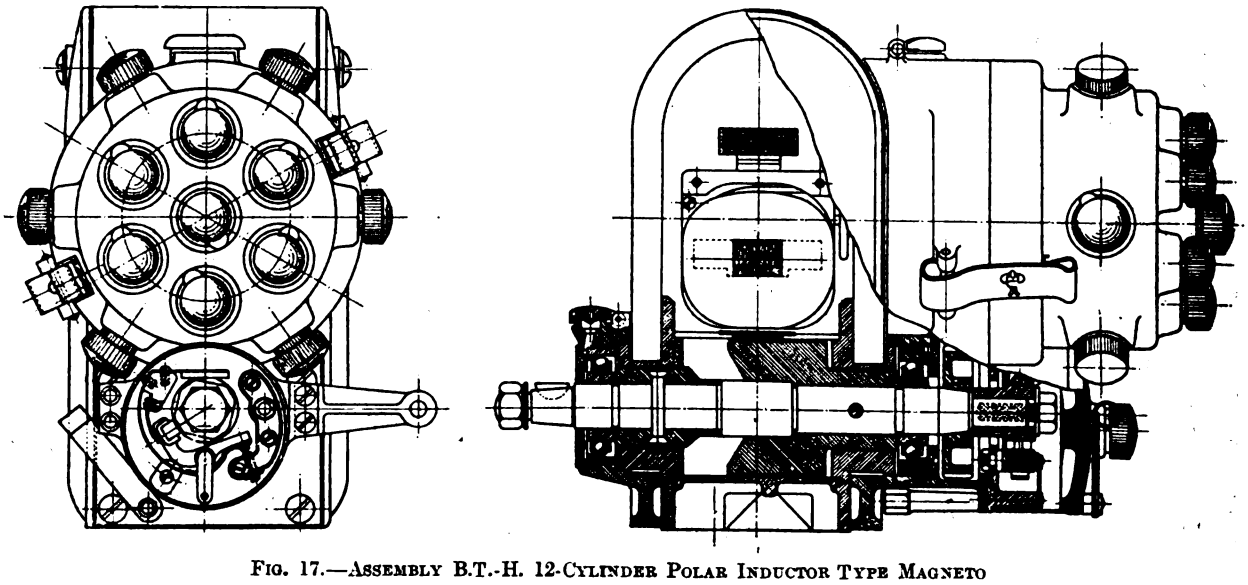


FIG. 17.—ASSEMBLY B.T.-H. 12-CYLINDER POLAR INDUCTOR TYPE MAGNETO

This magneto is inherently of much simpler construction than the sleeve inductor machine already described. Of this new type the Author also gives a brief description in the original paper, and presents curves, corresponding with those presented earlier for the other magneto, showing sparking characteristics and energy output, primary voltage and current curves, and primary voltage kick at break, efficiency, &c.

The results are considered very promising.

(To be concluded.)

THE ELECTRIFICATION OF A NEW SECTION OF THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY (U.S.A.)*

The Chicago, Milwaukee and St. Paul Railway has undertaken the electrification of a new division at the western end of its trans-continental line. The new work comprises 98·7 route-miles between Othello and Cle Elum, 89·9 route-miles between Cle Elum and Seattle, and 28·3 route-miles between Black River Junction (about 10 miles south of Seattle) and Tacoma.

The total route mileage of 216·9 as given above consists mainly of single track, exclusive of track mileage for yards and sidings. It has not yet been decided how much of this class of trackage should be electrified. At present, therefore, only route mileages can be given.

The coming electrification of 216·9 miles, plus the 437·6 miles at present electrified between Harlowton and Avery, makes a total of 654·5 route-miles electrically operated by the St. Paul. This is not only the longest electric route in the world, but will undoubtedly be also the longest in single-track mileage. The electrified trackage in the Seattle and Tacoma yards may bring the grand total close to 1,000 miles.

About half of the coming electrification covers heavy mountain grades, including a number of tunnels.

The power will be generated principally in the Washington Water Power Company's plant on the Spokane River, some thirty miles north-west of the city of Spokane, and at the Snoqualmie and other plants belonging to the Stone & Webster system of western Washington.

The railway company's own transmission line along the right-of-way will be 100,000 volts, 60-cycles, three-phase, built to about the same standards as its present lines in Montana and Idaho. The transmission wires will be No. 00, six-strand copper with hemp core, and the aerial ground wire and individual pole grounds of ⅜-in., seven-strand, Siemens-Martin galvanised wire. This transmission system will extend from Taunton, near Othello, to Cedar Falls, a distance of 140 miles. This will serve the eastern end of the new electrification. The extreme western end, or the section lying west of Cedar Falls, will have its substations tied in with a network of hydroelectric lines operated by the companies supplying the energy to the railway.

SUB-STATIONS, FEEDERS AND BONDS.

All substation and feeder capacities are based on a trailing train load of 3,000 tons eastbound and westbound, except for an 18-mile westbound grade of 2·2 per cent. just west of the Columbia River, where the train load is reduced to 2,000 tons. The ruling grade

* Abstract of an article in the "Electric Railway Journal."

Digitized by Google

eastbound is 1·74 per cent., and it extends for 20 miles east of Cedar Falls to the summit of the Cascade Mountains.

The order and capacity of substations beginning at the east end are given in the following table:—

Sub-stations	Motor-Generators.
Taunton, 9·2 miles from Othello	Two 2,000-kw.
Doris, 34·9 miles from Taunton	Three 2,000-kw.
Kittitas, 23 miles from Doris	Three 2,000-kw.
Cle Elum, 31·6 miles from Kittitas	Two 2,000-kw.
Hyak, 29·0 miles from Cle Elum	Three 2,000-kw.
Cedar Falls, 21·7 miles from Hyak	Three 2,000-kw.
Renton, 27·4 miles from Cedar Falls	Three 2,000-kw.
Tacoma, 30·5 miles from Renton	Two 2,000-kw.

The Renton station serves the 10-mile double-track line that extends from Black River Junction west to Seattle. There is a distance of 2·4 miles between Renton and Black River Junction, and this is included in the section listed in the run to the Tacoma substation. The foregoing substation ratings are based upon 150 per cent. load for the motor-generator sets for a period of two hours, and 300 per cent. load for a period of five minutes. All substation buildings will be of brick, with concrete foundations.

Each rail of the main-line track will have one 250,000-circ. mil expansion bond on grades of 1 per cent. or less and two 250,000-circ. mil bonds for grades exceeding 1 per cent. These bonds will be tied in with an overhead negative return of No. 0000 bare copper at intervals of approximately 8,000 ft. This construction is designed to protect trackmen against large differences in rail potential in case of defective bonds.

3,000-Volt D.C. Distribution.

The d.c. distribution system will be practically a duplicate of the present installation between Harlowton and Avery, as this has proved to be entirely satisfactory during the last year's experience with it. Cedar poles will be standard except for a limited number of steel bridges over multiple track sections and at terminals.

Throughout, the present catenary standards will be followed exactly. The messenger cable will be of ½-in., seven-strand, galvanised Siemens-Martin steel, with hangers of ¼-in. galvanised steel rods. As the double trolley wire has proved so successful in giving a flexible non-arcing contact, it will be used in the new construction in all cases except at sidings, where only one wire will be suspended from the catenary.

Locomotives.

It will be recalled that the present St. Paul electric locomotives used for passenger service are really standard freight locomotives that have been provided with passenger gearing. The manufacturers have now been asked to bid on designs specifically intended for passenger service. This passenger type will then be made standard for such service, while the present machines will be used only for freight service. No change is contemplated in the pantograph collectors.

COMBINATION COAL AND GAS FIRING.*

BY ALEX. W. MORGAN.

Because the addition of more boilers in its Water-street station was inadvisable with a new station on another site in prospect, and because the increasing load demanded immediate additional plant output the Toledo Railways & Light Company equipped some of the boilers already in its Water-street station with apparatus for burning coal and coke-oven gas at the same time. By this expedient it was possible with the existing equipment to increase the boiler output economically, and thus to care for the growing load. Particular interest attaches itself to the results of this venture, because of the present high price of coal, and because of the applicability of the plan to other plants which have producer gas or other suitable gas available.

Conditions Influencing Operation.

The conditions which made this solution of the problem possible were as follows: The Toledo Furnace Company installed a by-product coke oven and contracted to sell the entire gas output to the Atlas Chemical Company. The latter concern under its contract is receiving about 9,000,000 cubic ft. (247,208 cubic metres) of rich gas each 24 hours in excess of its needs. The chemical company needs only the lean gas for its operations. Therefore the rich gas, which has an average heating value of about 600 B.Th.U. per cubic foot (21,429 B.Th.U. per cubic metre), and which is the "first-run gas" from the ovens, is being delivered to the Toledo Railways & Light Company through a 20 in. (50·8 cm.) main, which was approximately 4 miles (6·4 km.) long.

Experiments were tried with several different methods of combining gas and coal firing, but it is now thought that burning coal and gas at the same time in the same furnace proves most economical. The company has therefore equipped a large number of its boilers for the combination operation.

Arrangements for Burning Gas Alone.

At first gas alone was burned under six type S 475 H.P. Stirling boilers equipped with McKinzie grates, which, owing to limited area, could not be operated much above rating. In these furnaces the grates were partly covered with asbestos. A space 12 in. (30·4 cm.) wide was left uncovered for a secondary air port. The front of this air port was 40 in. (101·6 cm.) from the burner tips and flush with the nose block of the ignition arch. Over the entire grate surface was spread firebrick crushed to the size of an egg, the layer varying in thickness from about 2½ in. (6·4 cm.) at the burner tips to 7 in. (17·8 cm.) at the bridge wall. This covering deflected the flame, and prevented it from striking the tubes directly.

The burner consisted of a 6 in. (15·2 cm.) air mixer, 14 in. (35·4 cm.) long, swedged down to 5 in. (12·7 cm.) at the outlet. This arrangement was successful for operating up to 175 per cent. of rating, but would not do for higher boiler output. It was not so flexible as was desired. To increase the overload that might be carried the grates were removed and one boiler was equipped with a Dutch oven. It was possible to get 263 per cent. rating from this unit. The installation, however, was inflexible.

To burn the gas directly above the coal and in combination with it, a special tile with a 2·5 in. (6·4 cm.) hole was developed and set so that the gas when introduced into the firebox was directed down against the coal. This tile was placed in the ignition arch next to the grate. All primary air was shut off and the gas in the firebox had to depend upon secondary air coming through the fuel bed for its combustion.

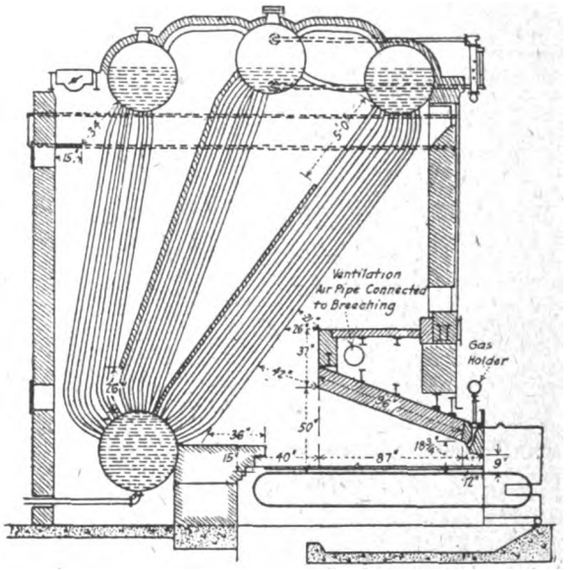


FIG. 1.—TYPE OF ARCH AND BAFFLE CONSTRUCTION MADE USE OF IN TEST BOILER.

After these preliminary experiments had been carried out arrangements were made for conducting tests to determine accurately the performance of the newly equipped boilers. The boiler used for these tests is of the Stirling type. It has a heating surface of 6 680 sq. ft. (620·6 sq. metres), a superheating surface of 256 sq. ft. (23·8 sq. metres), and is designed to deliver steam at 200 lb. per square inch (14·06 kg. per square centimetre) pressure and 100°F. (37·8°C.) superheat at rating. It is equipped with a Bailey boiler meter and a Greene type *K* chain-grate stoker, 10 ft. (3·05 metres) wide and 11 ft. 7 in. (3·53 metres) long, giving 115·85 sq. ft. (10·8 sq. metres) of firing surface. The ratio of air space through the chain to the solid portion is approximately 21·5 per cent. The speed of the chain can be varied from 4 in. to 9 in. (10·2 cm. to 22·9 cm.) per minute under normal operation. A flat-inclined ventilated arch is used in a form slightly modified so as to be practical for combination firing. The gas burner, which consists of a 1·5 in. (3·8 cm.) pipe with a cap drilled with seven 7/16 in. (11·1 mm.) holes, is inserted in the top of a channel in the

* From the "Electrical World," slightly abbreviated.

Digitized by Google

special tile. No particular overhauling was given the boiler, grate or setting prior to the test. Taken as a whole, the unit was said to be in average operating condition.

The object of the series of tests conducted was to ascertain what advantage, from an increased rating and economy standpoint, the combination of burning coke-oven gas a ove coal has over burning straight coal or straight gas in a furnace primarily constructed for

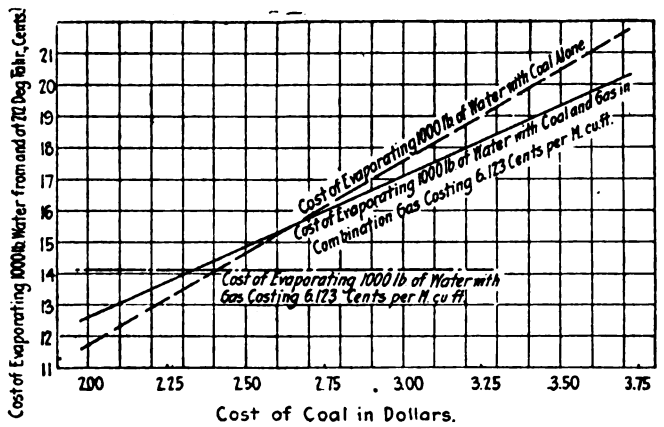


FIG. 2.—CURVES SHOWING POINTS AT WHICH COMBINATION COAL AND GAS FIRING IS ECONOMICAL.

burning coal. Five tests were run as follows: First, coal alone operating the boiler for maximum rating; second, coal and gas together operating the boiler for maximum rating; third, coal alone as a check on test No. 1; fourth, coal and gas in combination as a check on test No. 2; fifth, gas alone operating the boiler for maximum rating as used on night load. The results of these tests, together with the heat balance, are given herewith.

Comparison of Boiler Performance Burning Coal and Gas Separately and Combined.

—	Coal* alone.	Coal and gas.*	Gas† alone.
Pounds of coal used per hour	4,374	4,426·3	...
Pounds of equiv. coal used p. hour	...	1,278·5	2,006
Equivalent pounds coal burned per square foot of grate surface	37·8	49·4	17·45
Cubic feet of gas burned per hour	...	29,163·0	47,785·00
Cubic feet of gas burned per pound of dry coal	...	6·61	...
P.c. of ash and refuse to total coal	18·89	21·43	...
Per cent. of rating developed	162·25	213·0	88·7
Temperature of flue gases leaving boiler (in deg. F.)	640·1	683·5	516·6
Draught over fire	0·363	0·2875	0·0316
Draught in uptake under damper	0·920	0·820	0·0573
Efficiency of boiler grate and furnace in per cent.	61·4	61·6	72·95
Efficiency of boiler and furnace in per cent.	66·1	68·9	72·95
Pounds of combustible in ash	385·7	517·9	...
Per cent. combustible in ash to total coal burned by weight	8·8	11·7	...
Speed of chain in inches per min.	6·64	6·94	...
Cost to produce 1,000 lb. of steam from and at 212°F. (in cents)	11·65	12·58	14·10
Heat Balance—per cent.—			
CO_2 in flue gas	10·43	12·37	6·75
O in flue gas	10·50	4·85	7·85
N in flue gas	79·07	82·78	85·40
Over ventilation	102·0	29·1	53·5
Heat absorbed by boiler	61·38	61·62	72·95
Loss by moisture in coal	0·34	0·30	...
Loss by burning hydrogen in coal and gas	4·13	6·16	12·58
Heat lost by dry chimney gases	16·87	13·72	9·59
Heat lost by unconsumed carbon in ash	9·50	9·76	.a
Heat lost by apron water	0·72	0·59	0·15
Heat unaccounted and unaccounted-for losses	7·06	7·85	4·73

An analysis of the results obtained shows that the amount of coal burned per hour with the combination firing was practically the same as the amount burned when coal alone was fired. Therefore, the additional rating developed was the result of the introduction of gas in the furnace. The rating developed by the gas and coal in combination was 337 boiler H.P., or an additional rating of 31 per cent. over that obtained with coal alone.

* Average of two tests. † Average of one test.

The temperature of flue gas leaving the boiler was 43·4°F. (6·3°C.) higher with the combination than with coal alone. The stack temperature was considered to be too high on all tests, and it is thought that it could be reduced by changing the baffling from a three-pass to a four-pass arrangement. It was found that better results came from getting a lower stack temperature with the combination than from coal alone. The consequent reduction in draught in the uptake amounted to 10·9 per cent. and over the fuel bed to 20·7 per cent.

Not much better efficiency of the boiler, furnace and grate was obtained with the combination fuel than with coal alone. The efficiency with gas alone was 11·35 per cent. higher than with either the combination fuel or coal alone. The efficiency of the boiler and the furnace with the combination fuel was 2·8 per cent. higher than with coal alone, and the efficiency with gas alone was 6·85 per cent. higher than with coal alone.

The amount of combustible by weight in the ash was greater with the combination than with coal alone. The increase in this combustible amounted to 2·9 per cent. of the total coal supplied to the furnace. Expressed in per cent. of increase of combustible in the ash, this amounts to an increase of 33 per cent. The speed of the chain grate was only increased 4·52 per cent., so that the increase in combustible must be charged against inability to burn owing to the introduction of the gas above the coal. However, taking into account the heat supplied by the gas as well as that supplied by the coal, the percentage of total heat lost by unconsumed carbon in the ash was practically the same for the combination as for coal alone, amounting to 9·76 per cent. for the former and 9·50 per cent. for the latter. It was considered that this loss was too high, and steps were taken to effect a reduction in it.

Owing to the low ultimate CO_2 (10·8 per cent.) obtained by complete combustion of coke-oven gas, the ultimate CO_2 for combination of coal and gas will be lower than the ultimate for coal (20·9 per cent.). When 6·11 cubic ft. (0·172 cubic metre) of gas is burned in addition to each pound (0·45 kg.) of coal, the ultimate is 16·9 per cent., while 7·11 cubic ft. to each pound (0·046 cubic metre per kilogramme) of coal is 15·4 per cent.

CONCLUSIONS ARRIVED AT.

From the foregoing results it was concluded that the cost of evaporating 1,000 lb. (45·4 kg.) of water from and at 212°F. (100°C.) is 8 per cent. higher for the combination fuel than for coal alone, and 21 per cent. higher for gas alone than with coal alone. These figures were, of course, based on the cost of fuel as it was at the time of the tests; that is, November, 1916. Nevertheless, it was calculated that the added capacity with the combination fuel was obtained at 50 per cent. less investment than would have been required with the coal.

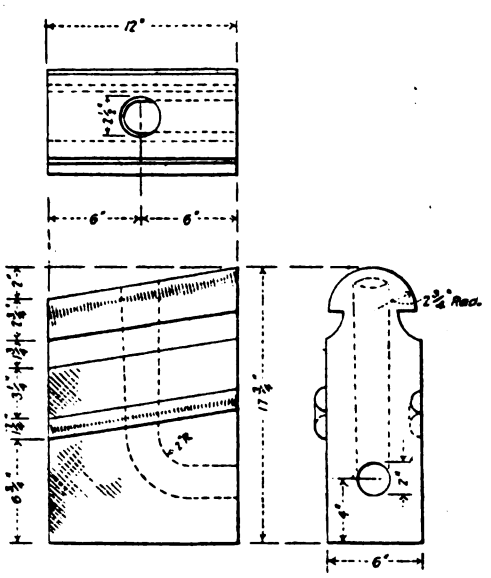


FIG. 3.—SPECIAL GAS NOZZLE TILE USED TO CONDUCT GAS INTO FIREBOX OVER COAL.

Viewed from an operating standpoint, it will be observed that the company obtained 31 per cent. added capacity with an 8 per cent. increase in the cost of producing a pound (0·45 kg.) of steam. With the increased cost of coal becoming operative, this increase in cost over the cost of coal to produce a pound (0·45 kg.) of steam would be offset (Fig. 2). With these facts taken into consideration, it was believed that this method of obtaining increased rating is ideal where coke-oven gas or other gas is available at a reasonable price, and where a plant needs more boiler capacity and yet has not enough room to permit of the installation of additional boilers.

Digitized by Google

THE PRESSURE OF THE TROLLEY ON THE OVERHEAD WIRE.*

BY E. STOCKER.

The following investigation relates to the case in which the overhead wire is approximately suspended vertically above the car. Contact is therefore effected by the pressure of a spring, which is sufficient for the purpose without causing excessive friction. A well-designed collector ought to maintain a constant pressure between the rubbing surfaces, independently of the speed of the car or any variation in the height of suspension of the overhead wire. If we take an ordinary collector, we have to distinguish between the case when the car is at rest and the case when the car is moving.

Let M_F be the turning moment of the spring;

G be the weight of the movable part of the bow;
$2l$ be the length of the bow;
M_G be the moment due to the weight of the rotary portion of the bow;
M_R be the resultant of M_F and M_G;
a be the angle between the trolley arm and the vertical;
D be the pressure between the rubbing surfaces;
μ be the coefficient of friction; and
R be the force of friction.

When the car is at rest, $M_R^* = Dl \sin a$; when the car is moving, friction must be taken into account, and we have

$$M_R' = D'l \sin a + Rl \cos a.$$

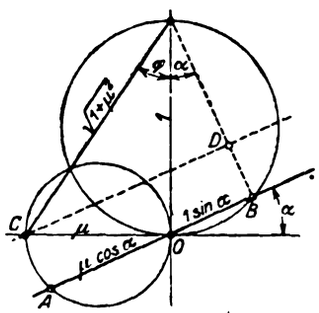


FIG. 1.—GRAPHICAL REPRESENTATION OF THE MOMENTS.

Supposing the deflection to be the same in the two cases, it will be seen at once that D' must be less than D; in other words, the pressure between the surfaces is less when the car is in motion than when it is stationary.

This relates to the case of the simple bow collector, but the case is different with coupled collectors. Here the effects of the friction of the overhead wire and of the wind pressure on the one collector are neutralised by the reaction of the other. Take the case of a pair of coupled collectors, such as are used on a polyphase locomotive. Here the coupling is effected by means of a chain and sprocket wheel. The resultant moments cause the collectors to be pressed against the overhead wire. It will be seen that the moments, due to friction, balance one another. The case is very similar with the pantograph

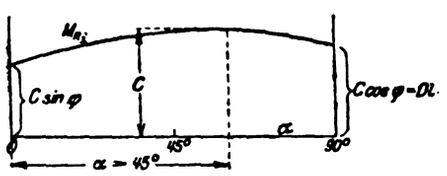


FIG. 2.—GRAPHICAL REPRESENTATION OF CHARACTERISTIC CURVE OF THE RESULTANT MOMENT.

collector. Here a horizontal force on the sliding shoe causes tensions in the coupling, but has practically no effect on the pressure against the overhead wire. Here the pressure during motion is the same as when the car is at rest, provided that the geometrical configuration of the pantograph is the same in the two cases. Collectors of this type can therefore be tested while the car is at rest.

But, as aforesaid, with the simple bow collector, the conditions at rest and in motion are different. The problem, therefore, is to determine these differences. We may, for instance, determine how the value of M_R ought to change if the pressure is to remain constant for all positions of the bow. The equation is $M_R = Dl \sin a + Rl \cos a$ where D is to remain constant.

Now $R = D\mu = D \tan \varphi$.

Therefore $M_R \cos \varphi = Dl (\sin a \cos \varphi + \cos a \sin \varphi)$,

or $M_R = Dl\sqrt{1+\mu^2} \cdot \sin (a+\varphi)$

The graphical method, shown in Fig 1, leads to the same result. Let us describe two circles with diameters unity and μ, and with their centres on the two axes of co-ordinates, and intersecting at the origin. Draw the line AB through the origin, making an angle a with the horizontal Then $AO = \mu \cos a$, and $AB = \sin a$, and $AB = \sqrt{1+\mu^2} \cdot \sin (a+\varphi)$.

Then $M_R = C \sin (a+\varphi)$, where $C = Dl\sqrt{1+\mu^2}$.

But μ is less than unity, and φ is, therefore, less than 45 deg.

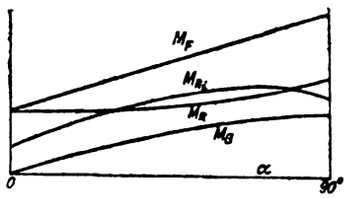


FIG. 3.—CHARACTERISTIC CURVE OF SIEMENS-SCHUCKERT BOW

M_R is a maximum when $a+\varphi = 90$ deg., in which case a lies between 45 deg. and 90 deg. If $a = 0$, then $M_R = C \sin \varphi$; and if $a = 90$ deg., t en $M_R = C \cos \varphi$, which is greater than $C \sin \varphi$.

In Fig. 2 these things are graphically represented. The coefficient of friction in a given case depends on the specific pressure, and on any want of adjustment in the position of the sliding shoe; it also depends on atmospheric conditions, and on any lubrication that may be present. Still, it can be shown that considerable variations in the value of the coefficient of friction have little effect on the charac-

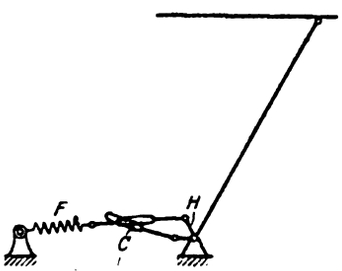


FIG. 4.—CONSTRUCTION OF BASLE COLLECTOR.

teristic curve, showing the variation of the resultant moment. M_R can be determined as a function of a by multiplying the tangential force on the shoe by the effective length of the bow. The designer can thus easily compare the experimental and theoretical characteristic curve.

It is now proposed in this way to examine two types of collector. Let us take a Siemens-Schuckert bow with one axially arranged spring. Then M_F is proportional to the deviation of the spring, to which an initial tension can be given. The characteristic curve of the resultant moment is obtained from the moments due to the pull

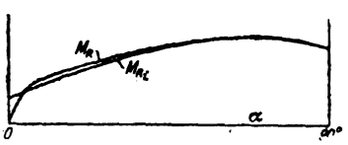


FIG. 5.—CHARACTERISTIC CURVE OF BASLE COLLECTOR.

of the spring, and to the weight of the bow, which latter follows a sine-shaped curve depending on the angle of deviation. The characteristic curve of the resultant moment is shown in Fig. 3. The second case is that of the collector at present used on the tramways in the town of Basle, which is a near approximation to the ideal case. The general construction is shown diagrammatically in Fig. 4. By a suitable choice of the spring F and the length of the lever H (the whole being designed on the system first suggested by Sprague), the characteristic curve shown in Fig. 5 is obtained. By proceeding on these lines, the designer will be able to see the results which will be obtained in practice with any given construction of the details of the collecting devices.

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 31, 1916.

Digitized by Google

The Electrician.
FRIDAY, SEPTEMBER 21st, 1917.
Editorial and Publishing Offices:—
8, BOUVERIE STREET, LONDON, E.C. 4.
Telephone: City 9853 (4 lines). Telegrams: "Bentrotric Fleet London."

RECONSTRUCTION.

Now that a Ministry of Reconstruction has been formed it behoves all those who have a real interest in the trade and industry of this country to consider the many questions with which such a Ministry should deal. We hope that one of the first points which will be decided will be the desirability of having a Ministry of Commerce. We were long ago dubbed a nation of shopkeepers, but, actually, what has the Government done to assist the shopkeeper (taking this term in its widest possible sense)? During the past century the trade and industry of this country has flourished rather in spite of Government action and support than as a result of any beneficent Government action. In fact, such matters have generally been beneath the attention of the politician. This attitude, however, must change, and thus we hope to have a Minister of Commerce whose function it will be to see that the commerce of this country is not hampered, or carried on under conditions which compare disadvantageously with those holding in other countries.

To the importance of Labour in all problems of reconstruction we have often referred. The Whitley report, in which it is proposed to have Labour representatives on Joint Standing Industrial Councils is, we believe, a milestone in industrial progress. The representatives of Labour will sit along with those of the trade associations, and it is hoped that much good will result by the joint deliberations of Capital and Labour. Success in this direction must depend largely upon the Councils being thoroughly representative. One method of securing this end is by means of voting, as far as the trade element is concerned, assuming that practically all those engaged in a trade join the corresponding union. Whether this is a satisfactory solution is, perhaps, open to question, for there are both virtues and vices in the vote. The chief difficulty is that the voter does not necessarily understand for what he is voting. Therefore, it may very well happen that the representative who is elected as the result of popular voting is not really the most suitable man for representing the needs of the industry. The qualification of a representative to serve on these councils is that he should know the industry thoroughly and that he should be sufficiently broadminded to realise what is good for the industry, and be free from strongly personal views.

In considering this subject we think there is often a tendency to forget that all industry does not consist simply of manufacturing. In other words, there is a vast deal of industry in which Labour plays a comparatively small part. We refer to traders, or those who buy and sell. Those who only produce the goods merely carry us part of the way. The selling organisation is equally important, be it that of the manufacturer himself or of those who are engaged purely in trade. There is a tendency to forget the importance of the merchant, as was rendered evident by a recent report by the Merchants' Committee of the London Chamber of Commerce. Production is, of course, extremely important, but satisfactory selling is equally so, and there is no question that the well-being of the trader is quite as important as the well-being of the manufacturer.

It is, moreover, highly desirable that the representatives of any industry should realise that the claims of that industry can only be considered in combination with the claims of other industries and in so far as they are compatible with the national good. It is quite conceivable that the representatives of a particular industry would like to arrange matters so as to improve the position of that industry, but that if the necessary steps were taken in that direction they would have a seriously harmful effect upon other industries. In such cases a powerful industry might be able to promote its interests at the expense of other industries. As a familiar example, it may be said that many industries would like a large protective tariff provided that they alone were given this protection.

There is no doubt that much good can be done by assisting the industry and commerce of this country, and it may even be the case that our industries would profit by a certain amount of control, but we think it will be generally agreed that the less control and the more assistance the better. Such control as may be necessary should be with a light hand, but assistance should always be available.

In conclusion, if a word of caution is necessary, we would urge the advisability of taking no action hurriedly. The assistance and control of trade and industry is such a vast and complicated subject that the desirability of any scheme can only be proved by very careful investigation. It may well happen that a scheme which appears highly satisfactory at first sight may prove unsuitable in many details when all the circumstances have been investigated and when all legitimate interests have been considered.

REVIEW.

The Theory of the Submarine Telegraph and Telephone Cable. By W. H. MALCOLM, M.A. (London: Benn Brothers, Ltd.) Pp. xi.+565. 18s. net. THE ELECTRICIAN Series.

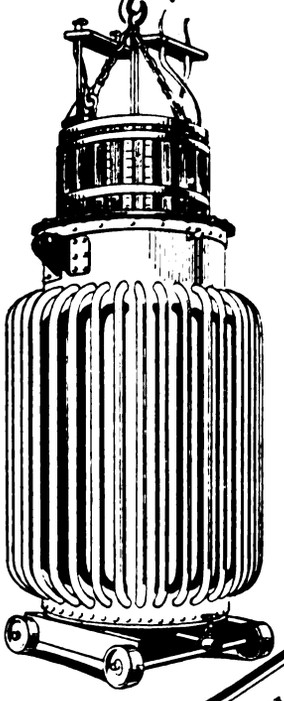
There are not many technical books to which the term epoch-marking can appropriately be applied. In the electrotechnical domain those which might come under this heading are Prof. Ayrton's "Practical Electricity," Prof. S. P. Thompson's "Dynamo-Electric Machinery;" Prof. Steinmetz's "Alternate-Current Phenomena," and Prof. Fleming's "Principles of Electric Wave Telegraphy." To these must certainly now be added Dr. Malcolm's new book, although it will appeal to a narrower circle than most of the others, owing both to the complexity of the subject and to the fact that developments in cable work must naturally lie chiefly in the hands of those who have access to these costly and much occupied means of communication.

Nothing in the range of electrotechnical science is more fascinating than the development of electric signalling, which has manifested the phœnix-like property of renewing its youth whenever a limit appears to have been nearly reached. The invention of duplex, quadruplex and multiplex, of automatic transmission, with its various methods of signalling, of recorders, type printers, relays and magnifiers, of re-transmitting and re-punching devices, and latterly of cable loading, has each in turn extended the powers of the circuit, and, instead of imposing limits of speed, as was done twenty years ago by Sir Wm. Preece in his insistence on the famous KR law, we are now anticipating all kinds of improvements in cables and in transmitting and receiving devices which will materially extend both the speed and the certainty of transmission. In fact, we have already arrived at a point in most cases where the volume of messages which can be delivered by the cable is in excess of the facilities for checking and correcting them in re-transmission, and the improvement of the cable is required not so much for increasing the speed as for diminishing the critical character of the adjustments and reducing the risk of error.

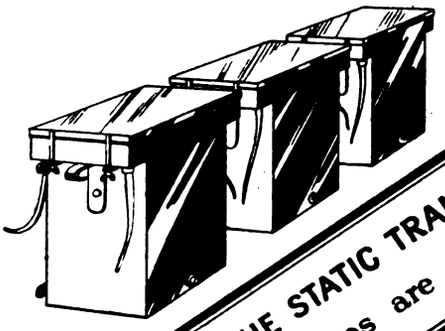
There can be no doubt that it is chiefly the development of telephony and of radiotelegraphy which has given the inspiration for the modern improvements in cable telegraphy, and which has brought the whole problem of electrical signalling into proper perspective. The two great factors are

Digitized by Google

BERRY Transformers

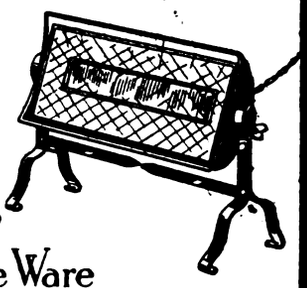


The
BRITISH
ELECTRIC
TRANSFORMER
Co LTD
HAYES
MIDDX ENG.
and at
The Tricity House
48, OXFORD ST.
· LONDON. ·
W.



Users of Transformers should ask for "THE STATIC TRANSFORMER" book before all the 4th Edition Copies are sold out.

Write for
Descriptive
Tricity Pamphlet



Tricity
TRADE MARK REGISTERED

Cookers
Flaming Fires
Dainty Table Ware

SIMPLEX
Wires and Cables

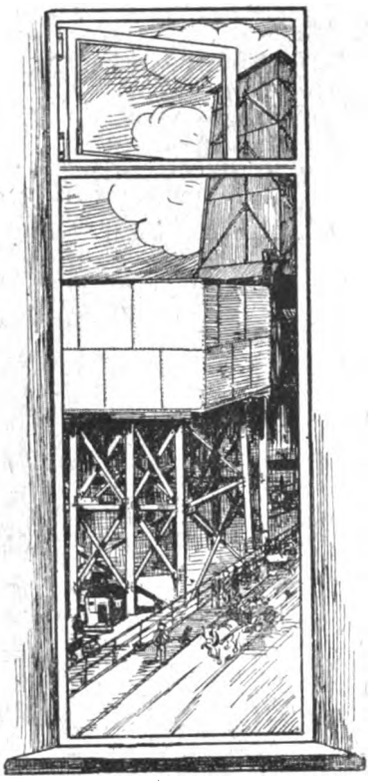
FOR ELECTRIC DISTRIBUTION OF ANY SORT

RUBBER, PAPER OR CAMBRIC INSULATION

Satisfactory service and quick deliveries

SIMPLEX WIRE & CABLE Co
MANUFACTURERS
201 DEVONSHIRE ST. BOSTON
CHICAGO SAN FRANCISCO
U. S. A.

Digitized by Google



SILVERTOWN

WATER-LEVEL APPARATUS

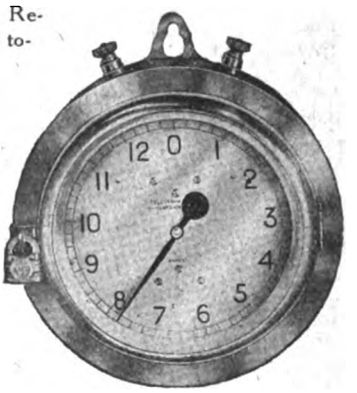
shows in your office or engine house the water level in distant tanks or reservoir.

It consists of two parts—the Transmitting Apparatus and a dial Indicator, or Recorder with chart, which are connected together electrically by a single wire.

The battery power required by the Instruments is very small; 6 "Silvertown" Leclanche Cells would suffice to work an Indicator several miles away.

The Transmitter is made of non-corrosive metals, and solidly constructed. The Indicator is provided with a silvered dial and enclosed in a metal case.

Further particulars and prices on application.



Indicator No. A 953.

The India Rubber, Gutta Percha & Telegraph Works Co., Ltd.

(The Silvertown Company).

Head Office:
106, Cannon Street, London, E.C. 4.

Works:
Silvertown, London, E. 16.

Model 268 Switchboard Volt-Ammeter.—ACTUAL SIZE.

WESTON

MINIATURE PRECISION D.C. INSTRUMENTS

MODEL 268.

THIS Model normally indicates amperes, but upon pressing the contact button the pointer indicates volts so long as the button is held down.

Volt-Ammeters are very useful in all cases where space is limited or where first cost is a material factor.

The Switchboard form is well adapted for use in electrolytic work, charging and discharging small batteries, and for service in connection with D.C. ignition systems.

It is suitable for all classes of work in which a single instrument is sufficient for indicating either potential difference or current.

The List Price of this Model is **£3 12s.** in all standard ranges.

For full particulars write for List D 3,

Weston Electrical Instrument Co.

Audrey House, Ely Place, Holborn,
LONDON, E.C. 1.

Telephone: Holborn 2029. Telegraphic & Cables: "Pivoted London."

Digitized by Google

those of energy and distortion. The difference between radio and cable signalling is closely illustrated by the difference between shouting a message into the air (aided at most by the feebly directive properties of a megaphone) or into an india-rubber speaking tube. In the former case the intensity of the energy diminishes very rapidly with the distance, so that the range depends chiefly upon the intensity of the sound and the sensitiveness of the receiver; but the velocity of all waves is approximately the same, and there is little distortion. In the case of the elastic walled speaking-tube the energy received is greatly increased by concentration; but the velocity of propagation is different for different frequencies, and great distortion may result.

In telephony, distortion is only of moment in so far as it damps out the higher harmonics, but it is all important in any system of telegraphy in which the signals depend upon the form of the impulse. The power delivered in direct recorder working is of the order of a microwatt, which is probably twenty to thirty-fold that in radiotelegraphy; but this does not compensate for the difficulties of distortion.

Two methods of attacking the problem from the theoretical side have been before us. First we had what may be termed the transient or impulse theory of Lord Kelvin and O. Heaviside, which has been the standard method of cable telegraphists for years, and latterly we have had the periodic or alternate-current theory of Blakesley, Steinmetz, and latterly Kennelly, who has developed it to the highest perfection for cable telephony. Neither of these methods are sufficient in themselves to solve the problems of cable telegraphy with complex transmitting and receiving circuits; but they are mutually complementary, and it is the special merit of Dr. Malcolm's book that it shows no signs of adhesion to either school, but deals with both methods equally and impartially, and unites them where necessary. It is this, combined with the author's practical acquaintance with cable signalling work, and the examples he has drawn therefrom, which makes his book such an exceptional contribution to the subject.

The volume commences with a brief but useful mathematical recapitulation, introducing the more important and unfamiliar methods employed in the theory of cables, such as hyperbolic trigonometry, complex exponential and hyperbolic functions, development in series, and determinants. The second and third chapters are also of an introductory character, dealing respectively with the construction and fundamental constants of cables and with the transient and periodic phenomena in inductances and capacities and non-distributed combinations.

We then come to Part II., devoted to purely periodic phenomena, or the theory of the telephone cable, dealt with on the lines of Blakesley and Kennelly, and which the present writer had the privilege of examining in proof. Chapter V., on the loading of cables, is of special interest, as it not only gives the theory and illustrations of the methods of continuous and of coil loading, but also the technical data and performance of a large number of loaded cables. Of great importance also is the treatment of discontinuities and reflections in Chapter VI. which is probably the first systematic theoretical investigation of the important effect of the disturbances caused by the abrupt changes from deep-sea to shore cable or to land line. The author expresses the effect of the discontinuity in terms of a certain length of actual or of standard cable. In this connection more attention might have been devoted to the important question of the spacing of the coils in discontinuous loading in relation to the dominant wave-length of the signals. As Fleming has shown so vividly by his cord and bead models, the reflection caused by a local inductance may practically suppress the transmission of a certain wave-length. It was this which made the early attempts at loading unsatisfactory until Pupin developed the theory.

The last chapter of this section is devoted to practical measurements on cables and experimental verification of the theory, and describes the chief instruments and methods of testing.

In Part III. we are introduced to the transient phenomena of telegraphy, commencing with the Kelvin solution for a cable with resistance and capacity only (which the author deduces by a simple method), and the form of the arrival curves for different letters obtained by superposition. This method, which has usually been followed by cable engineers, is of very limited application, and all who are concerned with the actual problems of signalling will be intensely interested in Chapter IX., in which Dr. Malcolm evolves his own proof of Heaviside's expansion theorem, and gives a most powerful and comparatively simple general method of deducing the transient solution from the periodic one by expressing the latter in the form of the quotient of a rotating vector by a function of the frequency. The exponential series, representing the arrival curve, is then given by equating the above function to zero, and also differentiating it, and by inserting the roots of the equation in the differential. By this method the author gives solutions for the arrival curve in a large number of practical cases, including those of signalling condensers and of an inductively shunted recorder.

Chapter X. is devoted to sending phenomena and the influence of leaks, with reference to duplex working. It also gives examples of actual arrival signals.

Part IV. deals with the different methods of signalling, from the plain Morse or recorder code to the Gott, Picard and other modifications, and the two-power method of Raymond-Barker. A chapter is devoted to sine wave transmission and the work of Squier and Crehore, coming to the conclusion that telegraphy by alternating currents has advantages which should lead to its general adoption.

The concluding section of the book is concerned with the future progress of cable telegraphy, and commences with an investigation of distortion, passing from mesh circuits to the distributed case. The present methods of overcoming distortion by curbing, signalling through condensers, inductive shunts, &c., are then considered as well as the use of various magnifiers, such as those of Heurtley and Orling. Dr. Malcolm considers that the difficulties of accurate duplex balancing bar the way to much further progress in this direction, and after a study of duplex working devotes his final chapter to the loaded telegraph cable. He points out that theory and practical experiment have been in close agreement in most cases where compared, and considers that future progress will chiefly depend upon theory, as experiments are not only difficult to make, but are frequently misleading, owing to the difficulty of varying one factor without simultaneously altering others. While the author does not anticipate the rapid adoption of loaded telegraph cables, he points out that their ultimate employment seems certain, and he warns us of the risk of allowing other countries to be the first in the field and to rob our country of its supremacy in the telegraphic sphere. The competition of radiotelegraphy is also not to be despised, especially as it has enlisted the best talent on its side, owing to the relative freedom with which it can be taken up. But the author is none the less confident that if the problems are attacked with the necessary energy and theoretical ability cable telegraphy will "enter upon a period in which all its past achievements will be excelled."

It is impossible to overrate the importance of Dr. Malcolm's treatise, or sufficiently to admire the immense amount of work and ability it has involved. The constant introduction of numerical examples and graphical illustrations is of great service, and will render the book of use to those who are not able to follow the mathematical working. A useful series of appendixes giving data of various cables and instruments, &c., is attached. Unfortunately, these appendixes bring out the curious fact that very little data appears to have been collected concerning the siphon recorder, a fact which probably accounts for the discrepancy between the theoretical and experimental results of Crehore and Squier on the Coney Island cable given on p. 246. It must be remembered that the effective inductance and resistance of a coil moving in a powerful magnetic field, as in a siphon recorder, are functions of the frequency and of the inertia, suspension and friction, and some experimental investigations at signalling frequencies are much needed. It is to be hoped that when the next edition of Dr. Malcolm's book appears this lacuna will have been filled, and that more experimental verifications of theory will be included.

CHARLES V. DRYSDALE.

Digitized by Google

ON THE CALCULATION OF THE COUPLING COEFFICIENT OF TWO COAXIAL FLAT SPIRAL COILS.

BY P. BAILLIE, L.SC.

Since flat spiral coils are more and more extensively used to form tuning and coupling inductances in wireless apparatus, it is often required to know the coupling coefficient of two such coils. It is the object of the present article to give a comparatively quick method of calculating that coefficient in the case where the coils have the same axis.

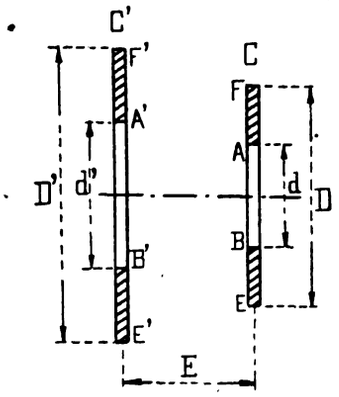


FIG. 1.—CROSS SECTION OF COILS.

Let C and C' be the coils (Fig. 1) and let us denote by :—

L self-induction coefficient of coil C.
L' self-induction coefficient of coil C'.
D external diameter of coil C.
d internal diameter of coil C.
D' external diameter of coil C'.
d' internal diameter of coil C'.
e axial distance between coils.
M mutual inductance of coils.

The coupling coefficient is then $K=\dfrac{M}{\sqrt{LL'}}$. Its dimension being zero, K depends upon four parameters : D/e, d/e, D'/e and d'/e, but not at all upon the number of turns per unit length ; we may assume this latter to be the same for both coils. K would depend upon two parameters only D/e D'/e, should d and d' be zero. The most general case can be solved in terms of inductances (self and mutual) of coils wound to the centre for which d and d' are zero. A plane abac will be provided for coils depending upon two parameters in terms of D/e and D'/e.

We shall have to consider the following coils :—

Coil.	External diameter.	Internal diameter.	Self-induction coefficient.
AB	d	0	l
$A'B'$	d'	0	l'
EF	D	0	λ
$E'F'$	D'	0	λ'

We can write :

$$M(\lambda\lambda')=M(ll')+M(lL')+M(Ll')+M(LL'),$$

where $M(\lambda\lambda')$ denotes flux through coil λ' due to unit current in coil λ, &c.

with $M(\lambda l')=M(Ll')+M(ll')$,
and $M(l\lambda')=M(L'l)+M(ll')$.

Hence

$$M(LL')=M(\lambda\lambda')+M(ll')-M(\lambda l')-M(l\lambda'),$$

and

$$K=\frac{M(\lambda\lambda')+M(ll')-M(\lambda l')-M(l\lambda')}{\sqrt{LL'}}.$$

Let us denote by :

n_1 number of turns per unit length of coil C,
n_1' number of turns per unit length of coil C',
a Nagaoka's factor corresponding to $\dfrac{\text{length}}{\text{diam.}}=1$. ($a=0{\cdot}688423$).

We have :

$$\lambda=\pi^2.n_1^2.\frac{D^3}{8}.a=0{\cdot}8493.n_1^2.D^3,$$
$$\lambda'=0{\cdot}8493.n_1'^2.D'^3,$$
$$l=0{\cdot}8493.n_1^2.d^3,$$
$$l'=0{\cdot}8493.n_1'^2.d'^3,$$

and

$$M(\lambda\lambda')=K(\lambda\lambda').\sqrt{\lambda\lambda'}=K(\lambda\lambda').\sqrt{0{\cdot}8493.n_1^2.D^3.0{\cdot}8493.n_1'^2.D'^3}.$$

or $M(\lambda\lambda')=0{\cdot}8493.n_1.n_1'.\sqrt{D^3.D'^3}.K(\lambda\lambda')$.

and $M(ll')=0{\cdot}8493.n_1.n_1'.\sqrt{d^3.d'^3}.K(ll')$.
$M(\lambda l')=0{\cdot}8493.n_1.n_1'.\sqrt{D^3.d'^3}.K(\lambda l')$,
$M(l\lambda')=0{\cdot}8493.n_1.n_1'.\sqrt{D'^3.d^3}.K(l\lambda')$,

hence :

$$K=\frac{0{\cdot}8493.n_1.n_1'.[\sqrt{D^3D'^3}K(\lambda\lambda')+\sqrt{d^3d'^3}K(ll')-\sqrt{D^3d'^3}K(\lambda l')-\sqrt{D'^3d^3}K(\lambda' l)]}{\sqrt{LL'}}$$

It should be noted that factors n_1 and n_1' can be omitted provided L and L' are changed into L/n_1^2 and $L'/n_1'^2$, *i.e.*, inductances of coils C and C' when wound with one turn per cm., such as given by certain tables or curves.

The determination of K is then effected by calculating four expressions, such as $\sqrt{D^3D'^3}K(\lambda\lambda')$, where the coupling coefficient refers to coils wound to the centre.

Putting $R=\dfrac{M(\lambda\lambda')}{n_1.n_1'}$, $S=\dfrac{M(ll')}{n_1.n_1'}$,

$T=\dfrac{M(\lambda l')}{n_1.n_1'}$, $U=\dfrac{M(l\lambda')}{n_1.n_1'}$,

we have

$$K=\frac{n_1n_1'}{\sqrt{LL'}}[R+S-T-U].$$

A quick method of calculating R, S, T and U will be given later.

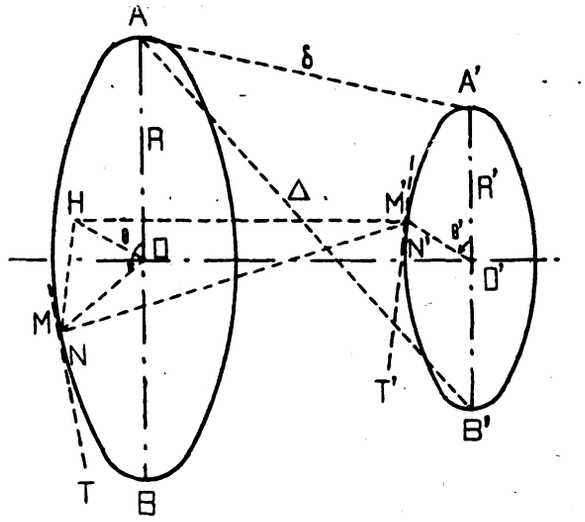


FIG. 2.

When coils have identical dimensions (no matter what the windings) we have

$$D=D',\quad d=d',\quad K(\lambda l')=K(l\lambda'),\quad T=U,$$

and $$K\frac{\sqrt{LL'}}{n_1.n_1'}=R+S-2T.$$

When one of the coils is wound to the centre, C' for instance :

$$l'=d'=0,\quad \lambda'=L',\quad S=T=0,$$

and $$K\frac{\sqrt{LL'}}{n_1.n_1'}=R-U.$$

We now have to find the coupling coefficient of coils for which internal diameter is zero.

Digitized by Google

First consider (Fig. 2) two coaxial turns of wire 0 and 0′. the radii of which are R and R', and separated by $00'=E$.

The mutual induction coefficient m of two such turns has been calculated by Neumann's formula :

$$m=\int\int\frac{ds.ds'.\cos u}{MM'},$$

where y is a function depending only upon k :

$$y=\int_0^{2\pi}d\theta'\int_{\frac{\theta'-\pi}{2}}^{\frac{\pi'+\theta}{2}}\frac{2(2\sin^2 v-1)dv}{\sqrt{1-k^2\sin^2 v}}.$$

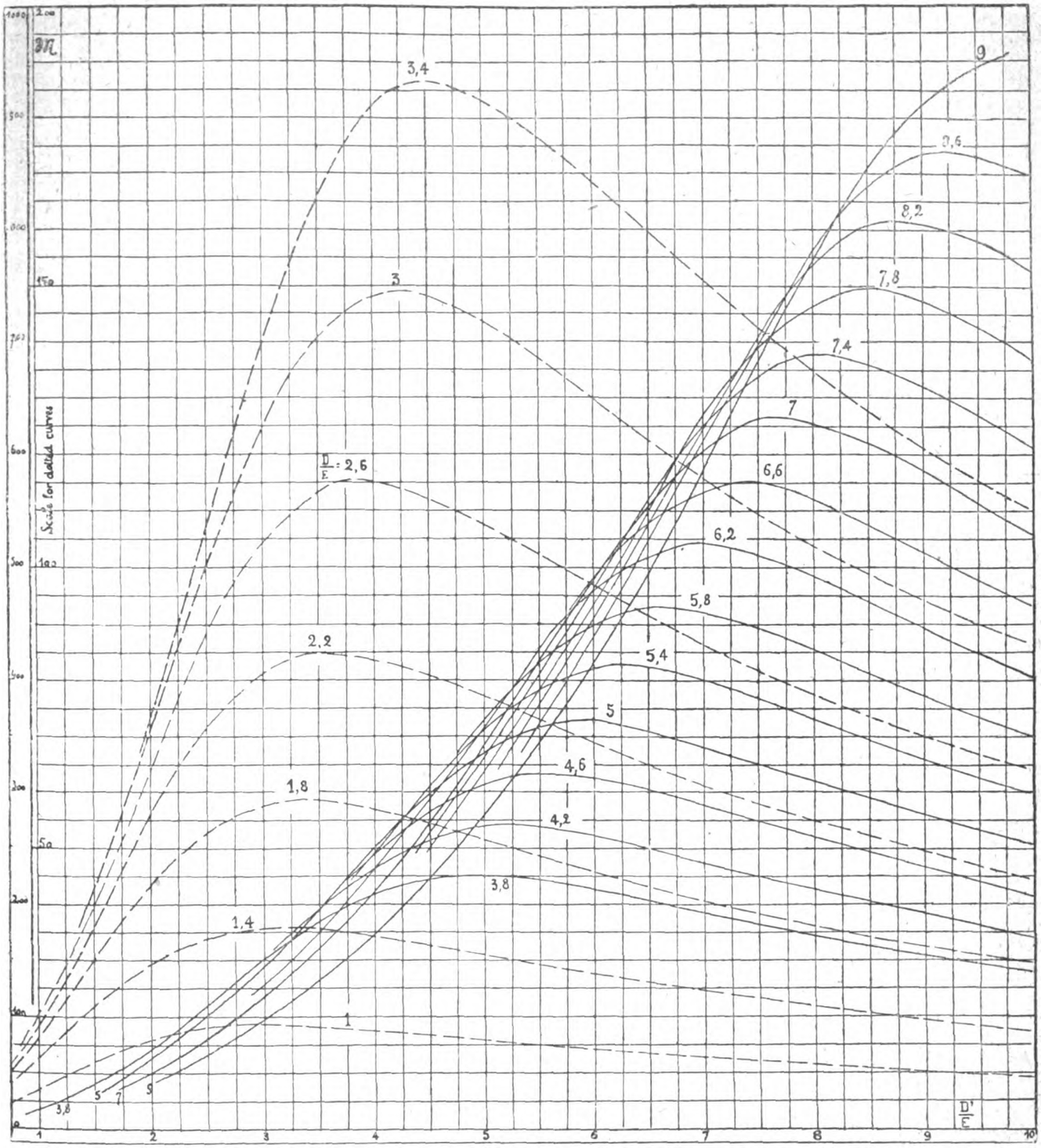


FIG. 4.—CURVES GIVING MUTUAL INDUCTION COEFFICIENT OF TWO CIRCLES IN TERMS OF D/E AND D'/E.

where ds and ds' are lengths and u the angle between two wire elements MN and $M'N'$.

We obviously have :

$$ds=R.d\theta,\quad ds'=R'.d\theta',\quad u=N\hat{O}H=\theta-\theta'.$$
$$\overline{MM'}^2=\overline{MH}^2+\overline{HM'}^2=R^2+R'^2+E^2-2RR'\cos(\theta-\theta').$$

Putting $$k^2=\frac{4RR'}{E^2+(R+R')^2}=\frac{\overline{AB'}^2-\overline{AB}^2}{A\overline{B'}^2}$$

and $v=\frac{1}{2}\pi-\frac{1}{2}u$, it is easily seen that m may be written

$$m=\sqrt{RR'}.y,$$

That function y has been calculated by separating the first integral into terms like

$$\int\frac{dv}{\sqrt{1-k^2\sin^2 v}}\quad\text{or}\quad\int\frac{\sin^2 v.dv}{\sqrt{1-k^2\sin^2 v}},$$

Those integrals are respectively the first-class elliptic integral X=function of k and v; and Jacobi's second-class elliptic integral :

$$Z(X)=\int_0^X Sn^2X.dX\quad\text{with}\quad\sin v=SnX.$$

Digitized by Google

Integrating with regard to θ' has been effected by measuring the area with limits from 0 to 2π by a curve plotted with values of the previous integral as ordinates.

Values of $y=m/\sqrt{RR'}$ calculated in such a way are given by the curves in Fig. 3, not in terms of k but (for greater convenience) in terms of the ratio $\delta/\Delta=\overline{AA'}/\overline{BB'}$, which is related to k by

$$k^2=\frac{\overline{AB'}^2}{\overline{AB'}^2-\overline{Ab}^2}=\frac{\Delta^2}{\Delta^2-\delta^2}=\frac{1}{1-(\delta/\Delta)^2}.$$

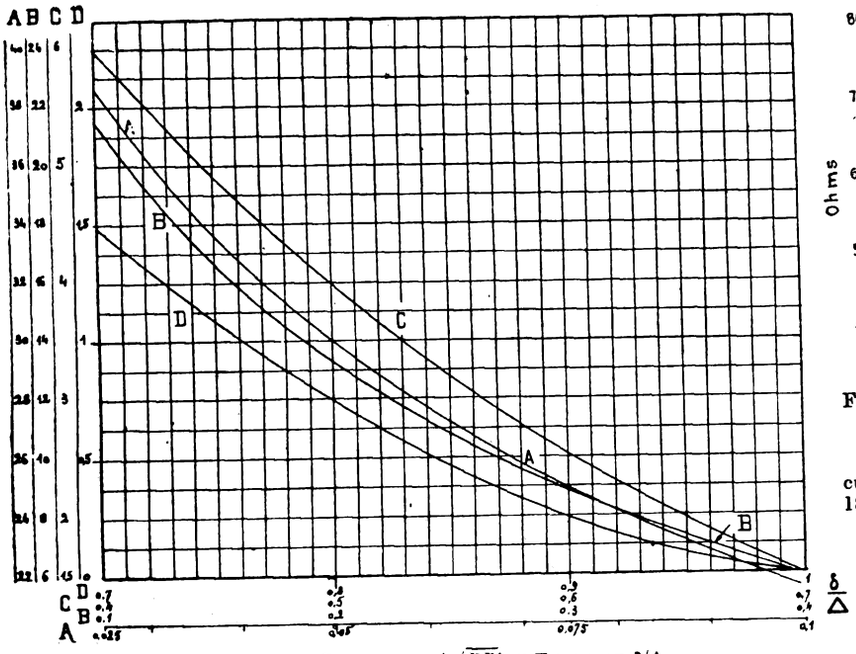


FIG. 3.—CURVES GIVING $y=m/\sqrt{RR'}$ IN TERMS OF δ/Δ.

Approximate formulæ have also been given ("Bulletin" of Bureau of Standards, Jan. 1, 1912) and the curves in Fig. 3 agree with values of y worked out from Prof. Nagaoka's formulæ.

Values of the coefficient of mutual induction m between two coaxial circles are given by curves Fig. 4 in terms of ratios D/E and D'/E.

(To be concluded.)

THE ELECTRICAL PROPERTIES OF SILVER SULPHIDE.*

According to investigations made by George W. Vinal, assistant physicist of the Bureau of Standards, silver sulphide may be prepared in the form of short wires or thin strips like a metal. The wire, which must be drawn hot, has been found to conduct electricity like a metal of high specific resistance and practically zero temperature coefficient. A strip of the sulphide rolled at room temperature has a large negative temperature coefficient and shows metallic and electrolytic conduction at the same time. It has a volt-ampere current characteristic of a pyroelectric conductor.

The resistance of these strips has been nearly always found to be higher with alternating than with direct current. The passage of a small alternating current at a frequency as low as 60 cycles increased temporarily the resistance of the sulphide, while a small direct current produced the opposite effect. However, hot-drawn silver sulphide wire did not show the same peculiarities as the strip. The melting point of silver sulphide is about 825°C. Below 175°C. the sulphide is an electrolytic conductor; and above this temperature it is a metallic conductor, the transmission being marked by an abrupt change in the electrical resistance as the temperature passes this point in either rising or falling.

Although the rolled strip and drawn wire of silver sulphide exhibited marked differences, it is not easy to explain why the mechanical working makes so radical a change in electrical properties. Possibly rolling the sulphide at room-temperature may produce minute cracks.

The effect of passing alternating currents through a strip of silver sulphide for short intervals is indicated in Fig. 1. The downward tendency of the single lines indicates that the effect produced is not permanent.

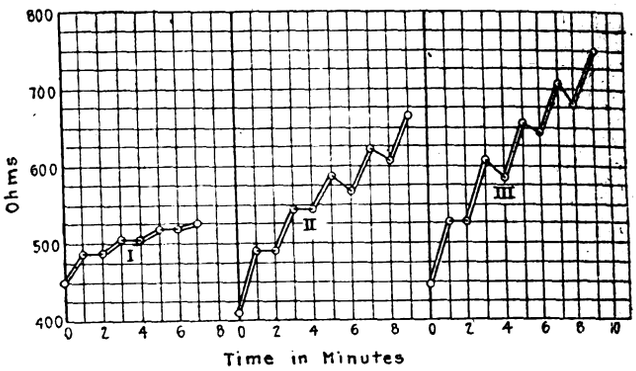


FIG. 1.—EFFECT OF PERIODICALLY IMPRESSED ALTERNATING CURRENTS ON SILVER-SULPHIDE STRIP.

Curve I. represents conditions with 8·8 milliampere currents, curve II. with 14 milliampere currents, and curve III. with 18·6 milliampere currents.

A strip of silver sulphide subjected to alternating and direct currents behaves like a pyroelectric conductor. With a small current the resistance is very high, but with relatively large currents becomes very low. The results of the test are shown in Fig. 2. Measurements of the specific resistance of sulphide wire at 25°C. indicated a value of 17,300 microhms per cubic centimetre, or about 10,000 times the specific resistance of copper.

In studying the electrochemical decomposition of silver sulphide due to the electrolytic conduction of the strips of this material, it was found that a myriad of shiny silver crystals appeared on the black surface of the sulphide after the current through it was increased gradually from 50 milliamperes to 300 milliamperes. The crystals appeared in various forms, some of which suggested that they had been expelled from the interior of the sulphide by considerable force.

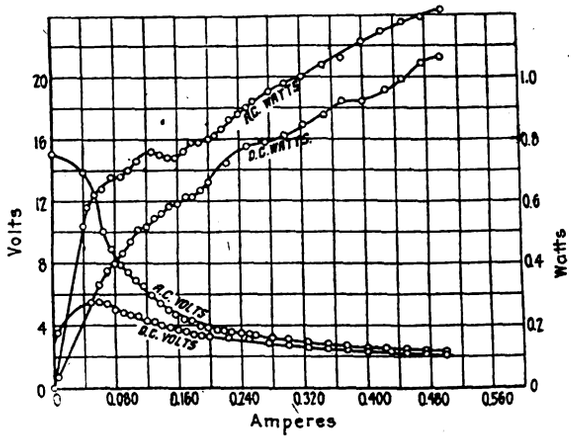


FIG. 2.—CHARACTERISTICS OF SILVER-SULPHIDE STRIP WITH ATERNATING AND DIRECT CURRENTS.

Similar experiments with alternating currents increased to 600 milliamperes produced no visible decomposition of the sulphide. Other experiments indicated some microphonic action when two pieces of the sulphide were pressed together and in circuit with a telephone receiver and battery. No data were obtained on the stability of silver sulphide. However, it is stated to be less stable than the sulphides of copper, lead and mercury.

* Abstract of an article in the "Electrical World."

Digitized by Google

CORRESPONDENCE.

THE TECHNICAL PRESS AND NATIONAL SERVICES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Though we are far from desiring to see the British Government everywhere adopting or initating the innovations of Allied or other Governments, we think the Premier might well take a leaf out of the book of Governor Whitman, of New York State. The Governor recently met in conference the editors of the various technical journals in the State, desiring to get reliable evidence upon questions of mechanical production, transport, coal and timber conservation, the provision of machinists and toolmakers, and other vital factors essential to the successful prosecution of the war. As a result, the Governor has now a committee of five editors acting in an advisory capacity.

Perhaps no class in the community has its fingers more completely upon the pulse of British industries than the men who so worthily and efficiently edit our technical press, and we feel sure they might with advantage be called in to the State councils, where accurate information is above all things essential. At such a moment as this, when, to take only three important branches of public service, the Air, Agricultural and Marine Departments, there is urgent need for the wisest and sanest counsels as well as driving forces, we think nothing but good could come by the introduction of editorial assistance.—We are, &c.

BARIMAR LIMITED (Scientific Welding Engineers),
C. W. BRETT,
Managing Director and General Manager.

[We think there is much to be said in support of our correspondent's views.—ED. *E.*]

SHEFFIELD ELECTRICITY SUPPLY.

At the meeting of the Sheffield Corporation last week there was a long discussion on Councillor Graves' motion "that no further steps be taken with respect to the purchase of the plant for the Blackburn Meadows electricity generating station, and that all previous resolutions of the Council and Committee relating to the matter be rescinded."

Mr. GRAVES said that they might not know that it was possible to be a member of the Electric Supply Committee without being aware what was going on. They had a little sub-committee called the Emergency Committee, which did all the important work. He was not aware of what was going on, but at the July meeting he found out the terms of an offer from the Minister of Munitions, which had been accepted. The Council when they passed the proposal to go on with that huge scheme had no details before them. The only details were given on August 24, and those showed that out of £560,433 which was to be expended only £151,000 belonged to the Ministry of Munitions. Those were not final figures; they were asked to take an unjustifiable risk. They had not more than 16¾ per cent. allowed for depreciation, and no man of business who knew what he was talking about would get up and say 16¾ per cent. depreciation was enough. They had 7,550 consumers, and leaving out the tramway undertaking, two large customers took more than half of the energy produced. After dealing with the question of the allocation of profits to the relief of rates, he asked, if the scheme was a national matter, why did not the Government help them? How did they know what the conditions were going to be after the war? They were going to spend more than a quarter of a million for which in four or five years they would have absolutely nothing to show. How long could they guarantee that good trade would continue? How long would there be the present demand? It had been asserted that it was possible to produce energy at a farthing per unit. Their price was ¾d., plus 20 per cent. With a prospect of power so much cheaper, how were they going to hold their own? He wanted the permanent interests of the Council to be protected.

Councillor EVANS traversed the statements of Councillor Graves. The statement that the depreciation represented only 16¾ per cent. was not quite correct; the dopreciation equalled 37 per cent. of the total of the undertaking. In regard to the two very large consumers, he said that when one company first came to the Corporation they had to give a guarantee to take at least £1,000 worth of current per annum. Their total now amounted to £100,000. Because they got it at a reasonable price it paid them to get it from the Corporation, and the price was such that he ventured to think they could not generate it themselves at that figure. In addition, they got off scot free from breakdowns, which was a most important matter. Did it not rather strike one that the fact of a large company taking its power from the Sheffield Corporation was proof that it was one of the finest developments they ever had? It meant that it was cheaper than gas. Ever since electricity had been produced they had never been able to supply the legitimate demands of ordinary consumers. To-day the Government required large quantities of electricity and so did private consumers. A very large number of electric steel furnaces were to be put down and those all meant a demand for power. There were applications before the Electric Supply Committee for no less than 21,000 kw. for driving electric furnaces alone. It was the bounden duty of the Corporation to do everything they could to keep Sheffield works going. They had a very large and powerful company almost on their own doorstep simply waiting for Sheffield to make one false plunge and then, instead of the price of electricity going down, it would go up. As patriotic citizens, was it not their duty to lay everything aside and do all they could to help their large munition works with all the power they required in order that they might help to finish off this horrible war? Personally, he did not care a brass farthing if for the next three or four years they did not make a profit and did not make a loss—he did not admit that they had made a loss—so long as they were able to do a little bit to help in the war.

Councillor NEAL pressed the Council to give careful consideration to the financial position of the undertaking. In the first place, as holding a monopoly, they had duties and obligations put upon them. They were bound to supply electric power to all who demanded it, and they had to take the risks of the business together with its privileges. He hoped that the accounts would be carefully gone into before the next meeting of the Council, with a generous writing down for the depreciation of both the older and newer plant so that the cause of the criticisms of Councillor Graves would be removed. He was one who believed in a great future for electricity and was for going boldly forward with the policy of making the necessary provision for the supply of electricity for the manufacturers of Sheffield. As regards the purchase of the plant, they had to remember that it could only be obtained through the Ministry. He regarded it as a matter for congratulation that they had obtained the machinery. He agreed that it was unsatisfactory that more than half of their revenue should come from three customers. That was perhaps a helpful thing when they began, but such was not the case now. He hoped that contracts would be entered into with customers for long terms of years rather than for 12 months' notice of determination, which he considered detrimental to the undertaking.

Sir WILLIAM CLEGG desired some authoritative statement with regard to the financial position of the undertaking. They had a duty towards the ratepayers who were engaged in the undertaking to the extent of £2,000,000, and who were entitled to a return for their money. He thought the time was ripe for a slight increase in their charges to their customers. The works were making a tremendous amount of money, and the Corporation ought to be getting some of it instead of letting it all pass into the national Exchequer in the shape of excess profits. He did not think manufacturers would object to an increase if it were the case that they were now supplying electrical energy at a loss. The right attitude was to go forward, to adapt their plant as they went along until it had served its purpose. He believed in the undertaking and urged the Council to develop the electric steel industry of Sheffield, to encourage manufacturers to lay down furnaces and to become their customers. Neglect to do so might become serious for the city.

Ald. HOBSON said money had been set aside for the renewals fund, but the rate of depreciation was fixed by the Income-tax Commissioners, and therein lay the element of the whole problem. It might be that they were not depreciating scientifically. It might be that they ought to depreciate more rapidly, but they were not allowed to do so. As regards the accurate investigation of the financial position, in his opinion it would have to be done by an independent firm of valuers, jointly approved by the Government and the Council. He did not think they would get the figures accepted by the Government for the next Council meeting. He asked them to consider the possibility of a number of Sheffield manufacturers combining to supply their own power! Was that the sort of thing they wished to happen in Sheffield? If the Corporation refused to supply they would have others going to Parliament and applying for statutory powers to supply electricity on the ground that the Corporation had withdrawn from the field. They had an assertion from Mr. Fedden that the Government's sinking fund was not sufficient. He would remind the Council that the Government would not accept Mr. Fedden's opinion, expert though he was, because Mr. Fedden as their servant was to some extent an interested party. He did not think it would be impossible to get the Government to agree to the introduction of an independent authority. If this were done they might then get to know the right value of their undertaking. The war materially influenced the income-tax officials. Some time ago they had stated that for the purposes of valuation and depreciation, pre-war prices would be the standard. Then the Treasury became frightened at the rise in prices and post-war prices were introduced as the standard for valuation. The Government view now was that they saw no reason why prices should go down after the war. The Council would see, as he had seen in regard to two or three limited companies in which he was interested, how difficult it would be to make a trustworthy balance-sheet. The real question was, should the prices be raised or not? It was a question for careful consideration, but he wished to say that the question of electricity supply was one vital to the interests of Sheffield. He knew of a certain town which was ready to take the steel industry from Sheffield at any given opportunity. He was not going to say anything more definite than that at the moment, but if the electricity undertaking failed the manufacturers of Sheffield the other town would say: "Thank God, at last they have let them into our hands." He could not imagine anyone on that Council desiring such a contingency. They had got to go forward to supply electric power if Sheffield was to remain the centre of the high-class steel trade.

After further discussion, the resolution of Councillor Graves was lost and the minutes of the Electricity Committee were approved.

Digitized by Google

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

6,404 KETTERING. Electrical regulators. (26/7/15.) 101,014.
6,405 KETTERING & CHRYST. Systems of electrical generation. (27/10/15.) 101,960.
10,491 CROCHAT. Electrical driving, particularly for motor vehicles. (9/5/16.) 106,263. (Addition to 4,962/16.)
11,047 MARKS. (Kuntziger, Chauvin & Fontaine.) Cut-out for electric circuits. (4/8/16.) 108,511.
11,146 SELVATICO. Electrically-heated wearing apparel. (7/8/16.) 108,516.
11,326 SCHROEDER. Dynamo-electric machines. (10/8/16.) 108,529.
11,362 BERRY. Electric transformers. (11/8/16.) 108,532.
11,787 LONGFORD, LONGFORD & CLARK. Sparking plugs for use in internal-combustion engines. (19/8/16.) 108,546.
13,005 NABERS. Magnetos for telephonic and like calls. (18/9/15.) 101,542.
13,007 WESTERN ELECTRIC CO., NASH & GRACE. Telephone hand set. (13/9/16.) 108,565.
13,198 COX. Electrical fuses or cut-outs. (18/9/16.) (Addition to 2,491/16.) 108,567.
14,012 HEARN. Electric heating devices. (3/10/16.) 108,578.
14,518 B.T.-H. CO. (G.E. Co.) Methods of and apparatus for electric ship propulsion. (12/10/16.) 108,586.
14,821 B.T.-H. Co. (G.E. Co.) Means and apparatus for obtaining high vacua. (18/10/16.) 108,590.

The apparatus comprises a stream of condensable vapour which is caused to enter a condensing chamber in a downward direction, the condensing chamber being in communication by means of a conduit with a receptacle to be evacuated, and means for condensing the vapour and for preventing any of it from passing from the condensing chamber to the receptacle.

15,837 M. L. MAGNETO SYND. & WATSON. Interrupters for ignition magnetos. (6/11/16.) 108,603.
17,304 BARRETT. Manufacture of porous mineral product for use in chemical and electric operations as refractory material and for other purposes. (2/12/16..) 108,61.
17,451 GILL. (United States Light & Heat Corpn.) Dynamo-electric machines (5/12/16.) 108,620.

1917 SPECIFICATIONS.

2,872 TURNER. Regenerative braking systems. (31/3/16.) 105,225.
3,046 GUARDIOLA. Drawn filaments for electric incandescence lamps. (1/3/17.) 108,817.
3,881 TAYLOR, TUNNICLIFFE & Co. & COOPER. Applicances for the shaping of telegraph and like insulators. (16/3/17.) 108,821.
4,188 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electric circuit-breakers for polyphase alternating-current circuits. (22/3/17.) 108,651.
4,336 BRITISH WESTINGHOUSE ELECTRIC & MFG CO. (Westinghouse Electric & Mfg. Co.) Electric motor control systems. (26/4/17.) 108,824.
10,178 ARMELIN. Dry batteries. (13/7/17.) 108,846.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

August 10, 1917.

11,531 SMITH. Compasses and instruments for detecting changes of magnetic declination.
11,534 MASON. Magnetic compasses and electric lamps for use therewith.
11,544 SMILES & WARREN. Sparking control of aviation engines.

August 11, 1917.

11,570 LASSEN. Apparatus for softening and purification of water.
11,579 HANMAN. Sparking plug tester.
11,586 GREY & WILLIAMS. Self-acting mechanical brake for railway and tramway vehicles.

August 13, 1917.

11,607 NALDER BROS. & THOMPSON & GIFFORD. Electrical measuring instruments.
11,612 COWPER-COLES. Process for rendering aluminium and its alloys more durable.

August 14, 1917.

11,658 BENETTI & ROTA. Apparatus for Concentration of electric waves in a single direction or upon a fixed point.
11,659 HEARN. Electric heating devices.
11,660 LANGDON DAVIES & SOAMES. Electro-magnetic friction clutches.
11,667 B. T.-H. Co. (G. E. Co.) Automatic decelerating device.
11,669 LAMKIN. Device for indicating electric leakage in insulation of sparking plugs.
11,677 LAYTON. Starting apparatus for electric motors.

August 15, 1917.

11,707 BRIDGE. Searchlight projectors for sumbarines, &c.

August 16, 1917.

11,765 WESTERN ELECTRIC CO. Selective signalling systems, &c.
11,777 SUCHOSTAWER. Producing electricity and mechanical power by permanent magnets.
11,785 BAKER. Variable electric resistances.
11,791 GUINNESS. Sparking plugs.
11,806 STOTT. Electricity generating plant.

August 17, 1917.

11,820 AUTOMATIC TELEPHONE MFG. CO. & SMITH. Electric annunciators.
11,830 CUTTEE & HOLLINGSBEE. Trolley heads.
11,860 FOSTER. Ignition magnetos.

August 18, 1917.

11,862 LAKE. Electric furnaces.
11,864 MARR. Telephone receivers, &c.
11,867 NAAMLOOZE VENNOOTSCHAP DE NEDERLANDSCHE THERMO-TELEPHONE. Heating conductors of thermic telephones. (15/9/16. Holland.)
11,878 AUTOMATIC TELEPHONE MFG. CO. & HARRISON. Telegraph systems.

August 20, 1917.

11,899 STEVENSON. Protectors for trollies of elec. tramcars, &c.
11,909 AUTOMATIC TELEPHONE MFG. CO. & GREEN. Elec. signalling system for mines.
11,927 NAUL. Elec. switches. (10/5/16. U.S.)

August 21, 1917.

11,983 B.T.-H. Co. (G.E. Co.) Elec. transforming and converting apparatus.
11,990 AKT. GES. BROWN BOVERI ET CIE. Uniform distribution of current to d.c. units in parallel. (21/8/16. Germany.)
11,991 AKT. GES. BROWN BOVERI ET CIE. Starting apparatus for motor car engines. (6/11/16. Germany.)
11,993 MARKS. (Splitdorf Electrical Co.) Ignition dynamos.
11,996 HIBBS & IRELAND. Elec. ignition apparatus for internal combustion engines.
12,016 AUTOMATIC TELEPHONE MFG. CO. (Automatic Elec. Co.) Telephone systems.

August 22, 1917.

12,029 BAELLI. Illuminated switches.
12,035 BROOK. Switchgear for starting and controlling elec. motors.
12,041 MURRAY. Transposing machine for telegraph alphabets.
12,054 WESTERN ELEC. CO. Machine switching telephone systems.
12,074 IGRANIC ELECTRIC CO. (Cutler Hammer Mfg. Co.) Contact devices.
12,077 JOHNSON. (F.I.A.T. Fabbr. Italiana Automobili Torino). D.C. elec. motors.

August 23, 1917.

12,104 HUDD & WION. Electrical point detectors for railways.
12,105 THOMPSON. Supports for electric fans, &c.
12,125 WHITE. (Remy Electric Co.) Ignition apparatus for internal combustion engines.
12,127 SALLES. Incandescent electric lamp holders.
12,129 HOLLISTER. Magneto elec. generator.

August 24, 1917.

12,191 JENSEN. System for protection of three phase a.c. systems.
12,149 TAYLOR. (Burgess.) Elec. heating, &c., apparatus.
12,158 KAVANAGH & NEVILLE. Cord-grip for elec. lamp holders.
12,165 HOLDEN. Electrically operated mechanism for driving clockwork trains, &c.

August 25, 1917.

12,199 AUTOMATIC TELEPHONE MFG. CO. & REMINGTON. Elec. signalling systems for mines, &c.

August 27, 1917.

12,268 DENNETT. Electrical condensers.
12,276 B.T.-H. Co. (G.E. Co.) Power systems.
12,278 MARKS. (La French Power Spark Plug Co.) Spark plugs.
12,280 AKIMOFF. Testing for dynamo balance.
12,284 SCISM. Junction box coupling for electric conduits.
12,299 VRIES DE WAAL. Indicators for electric switches, &c.
12,303 STURGESS. Armatures of electric motors.

August 28, 1917.

12,308 KNIGHT. Electrically illuminated walking stick, &c.
12,320 HART. Combined electric light fitting and lamp-holder.
12,326 DENNY. Electro-deposition of tubes.
12,351 BROWN, BOVERI ET CIE. Time-limit electric circuit-breaker. (20/2/17, Germany.)
12,357 OLDHAM. Galvanic batteries.
12,362 ASHCROFT. Manufacture of oxides or salts of tungsten or of metallic tungsten.
12,365 ASHCROFT. Manufacture of aluminium or its oxides or salts from materials containing aluminium.

August 29, 1917.

12,373 BRANSON. Electric gramophone.
12,412 ALEXANDER. (Ollard Trolley Wheel Co.) Trolley wheels.
12,414 REYNOLDS. Fittings for electric lamp shades, &c.
12,421 MARCONI'S WIRELESS TELEGRAPH CO. & FRANKLIN. Receivers for wireless telegraphy.
12,423 WHITE. (American Conduit Mfg Co.) Surface electrical conduits, &c.
12,425 DEVEREUX. Electrolytic deposition of iron, &c.
12,427 MARKS. (Splitdorf Electrical Co.) Ignition devices.
12,441 MARCONI'S WIRELESS TELEGRAPH CO. (Marconi partly.) Reflectors.

August 30, 1917.

12,442 FRANKLIN. (Marconi partly.) Reflectors for wireless telegraphy and telephony
12,456 COX. Electrical switches.
12,460 ALEXANDER. (Kleinschmidt Electric Co.) Selection systems for telegraph typewriters.
12,462 DOWSING. Electric heating elements.
12,469 B.T.-H. Co. & SHUTTLEWORTH. Phase advancers.
12,473 GRAHAM. Electric bells.
12,478 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Control systems for electric motors.
12,479 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Phase converters for polyphase distributing systems.
12,480 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Phase balancers for polyphase distributing systems.

August 31, 1917.

12,520 PRITCHARD. Electromagnets.
12,539 SPLITDORF ELECTRICAL CO. Generating ignition currents for internal combustion engines.
12,577 MARCONI'S WIRELESS TELEGRAPH CO. Receivers for wireless signals.

September 1, 1917.

12,566 WORSNOP. Electrical accumulators.
12,572 PATE & WOOD. Electric heating and cooking apparatus.
12,577 FRANKLIN. Receivers for wireless signals.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Officer Commanding: Lt.-Col. C. B. CLAY, V.D.

Orders for the week:

Officer for the week.—Sec.-Lieut. C. E. Campbell.

Monday, Sept. 24.—Technical instruction (Searchlight) for No. 3 Company, Right Half Company at Regency-street. Drill, No. 3 Company, Left Half Company. Signalling class, 6.30. Recruits' drill, 6.30.

Tuesday, Sept. 25.—Physical drill and bayonet fighting.

Wednesday, Sept. 26.—Drill and elementary bridge construction for No. 1 Company, Right Half Company.

Thursday, Sept. 27.—Drill and elementary bridge construction for No. 2 Company, Right Half Company. Signalling class, 6.30. Ambulance class, 6.30.

Friday, Sept. 28.—Technical instruction (searchlight) for No. 3 Company, Left Half Company, at Regency-street. Drill, No. 3 Company, Right Half Company. Recruits' drill, 6.30.

Saturday, Sept. 29.—Commandant's Parade for Route march and drill. Parade at Headquarters 2.45 p.m. Uniform. "A" and "B" N.C.O.s and men are reminded that one route march a month is compulsory. Recruits' drill, 2.30.

Musketry.—All N.C.O.s and men who have signed the "A" and "B" agreements are required to attend during this month to re-classify in order to enable the Corps to obtain the Capitation Grant. Preference will be given to those men in firing. This does not apply to those who hold the proficiency badge.

Armlets.—The new issue armlets can now be obtained at Headquarters, and every enrolled man must obtain one without delay; at the same time all old red armlets (now obsolete) must be returned.

Unless otherwise indicated, all drills will take place at Headquarters (Balderton-street, Oxford-street).

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

Prohibited and Restricted Imports.

The following further decisions with regard to imports have been arrived at by the Department of Import Restrictions :—

Prohibited.—Nickelled bracket lamps or bulb holders (electric), cadmium, ceiling roses (earthenware), copper blanks for electric cranes, brush holder springs, tested fuse wire, ozone generators, spiralite advertising device (electric), spraying apparatus (electric), tramcar journal boxes, electric reading lamps, telegraph perforating keyboards, zinc strip, Okonite rubber insulating tape.

Not Prohibited.—Power-driven blowers, Coran copper alloys, magnetic compasses, earphones, ebonite containing less than 50 per cent. of rubber, "Elaterite," or elastic bitumen, crane controllers, fans (complete with motor), fire alarm apparatus, furnaces (electric), hair dryers (electric), portable hammers (electrically driven), interrupters (telephone switchboard), ozone generators, starters, syrens, complete with motor, transformer testing sets, transformers, refrigerating machines (electric), "Paxolin" insulating material, tungsten, tungsten target X-ray tubes vulcanite containing less than 5 per cent. of rubber, zirconia.

General Licence.—Bells and buzzers for fire alarm telephones, electrodes, telephone switchboards and parts.

* * * *

Government Co-operation with Manufacturers.

At a meeting of the Birmingham Brass Masters' Association on Monday, Mr. L. A. Paish, of the Commercial Intelligence Department of the Board of Trade, and Mr. C. Hamilton Wickes, Trade Commissioner (Canada), delivered addresses on the question of Government co-operation with manufacturers.

Mr. Paish said the German Government were making a strenuous attempt to get all manufacturers in Germany into syndicates. They realised the advantages of syndicates, and were assuring all manufacturers that the only way in which they could regain their place "in the sun" was to adopt that form of trading. The Board of Trade saw that tendency in Germany and America, and appointed a committee to consider the question, with the result that the Board had adopted that as their policy—that if British manufacturers were to increase their export trade after the war and to regain the trade they had lost, it was absolutely essential for them to get together into some sort of trading combination. They were prepared to face the question of trusts or combines, or whatever they were called. If we were to make a stand against combinations in other countries it would be necessary for us to adopt somewhat similar methods here. A combination of the whole of the Birmingham brass masters would be able to undertake a systematic investigation of any definite market that it wished to attack, whereas an individual firm would not be in a position to do so. If they had an association dealing with the whole of the products of the brass industry it would be possible to put a man in any market to study thoroughly the changes in the conditions that had taken place during the war. The Commercial Intelligence Department was prepared to co-operate in every possible way in such an endeavour, even to the extent of finding financial assistance in sending out a representative; it was out to give to manufacturers and traders every possible assistance that they could reasonably expect. He had been instructed to take such steps as might be found possible to get the formation of a trading association of brass masters actually going. If they were to live in the trade after the war, against the organised competition of Germany, America, and Japan, it was essential that they should combine. If they did not combine they would go under.

Mr. WICKES said that there was no question in his mind that what had been done in part by manufacturers in Germany in certain lines was going to be done by the whole nation—that was, to purchase, as one body the raw material that was required from outside countries for the vital industries of Germany. Was it not time that the manufacturers in this country got together?

A number of questions having been answered, a resolution was passed appointing a committee of the various sections of the brass trade, with a view to further developments on the lines indicated.

* * * *

The Commercial Intelligence Department.

Sir Arthur Steel Maitland has been appointed Parliamentary Secretary of the new Commercial Intelligence Department. As already announced, the reformed consular service will be one of the most important branches of the activities of the new department, which will eventually take over the records and some of the staff of the War Trade Intelligence and Statistical Departments. It will also form a connecting link between the Foreign Office and the Board of Trade. The new arrangement, though undoubtedly an improvement upon the existing practice, is open to the objection that it will be under the control of two Government Departments and unless there is the closest harmony and co-operation between them, the department may not prove a very efficient instrument for the purpose of developing our foreign trade and commerce. The Council of the Associated Chambers of Commerce and other representative organisations have approved the proposals for the reorganisation of the commerce intelligence department and of the consular service, as they look upon them as a compromise which, while open to objection, are a step in the right direction, and give a foundation on which other reforms might be based. Many think the proposals do not go far enough, but inasmuch as the scheme is a complete departure from the present administrative practice they are disposed to give it a trial before pressing further for the creation of a Ministry of Commerce.

* * * *

American Banking Facilities Abroad.

In a recent public address the manager of the Foreign Trade Department of the National City Bank of New York said that American banking was now rapidly extending its functions to foreign fields all over the world.

American business men were hesitating about deciding upon, or suggesting, large definite plans for the immediate future, owing to the uncertainty of the effect upon business of the participation of the United States in the war. The indications, however, all pointed in the direction of a minimum interruption of the ordinary course of business and, obviously, the best policy for American manufacturers was to go ahead in the expectation of handling normal business along with war business. The disposition was to keep up the organisation of foreign sales, to build it up even stronger, and to be in a position to do a great foreign business as soon as the war ends. American manufacturers and exporters would keep on organising, even if war temporarily checked the sale and delivery of goods, and they would be in a strong position to do a world wide business after the war. One of the prime essentials in the expansion of their commerce was adequate banking facilities, and the experience of the older commercial nations had demonstrated that foreign branches of a parent institution located in the home country were the best means of providing these facilities. In 1890 the value of American manufactured products was over nine billion dollars; in 1900 it had increased to over 11 billions, and in 1910 it had increased to upwards of 21 billions. From 1910 to 1915 the increase in the value of American manufactured products had been at the rate of 8 per cent. per annum. If that development was to continue, merchants and manufacturers must reach abroad to find purchasers who would take the surplus of American manufactured products after domestic needs had been satisfied. The approach of the new epoch in the commercial history of the United States had been foreseen, and in the beginning of 1914 the National City Bank had decided to establish branches abroad. The first branch bank was opened in Buenos Ayres in November, 1914. There are also branches at Rio de Janeiro, Santos, Sao Paulo, Bahia, Montevideo, Valparaiso, Havana, Santiago de Cuba, Genoa and Petrograd. In 1915, the International Banking Corporation was acquired by interests affiliated with the National City Bank. Offices were also maintained in London, Milan and Copenhagen.

* * * *

Trade with Canada.

The Imperial Trade correspondent at Winnipeg (Mr. W. J. Healy) reports that at a recent meeting of the Winnipeg Board of Trade a new standing committee was appointed with the object of promoting trade between the United Kingdom and Canada.

This Committee is prepared not only to answer all questions by British manufacturers bearing on the trade within the Empire, but to receive, and have properly displayed, samples from any British manufacturer. By this means, it is thought, importers in Western Canada will have an opportunity of handling British-made goods which are suitable for that territory. Samples submitted can usually be sold, and the proceeds, less a small commission to cover incidental expenses, remitted to the exporter. The Committee will also endeavour to establish connections between the importer and manufacturer, or the importer and agent. Communications should be addressed to the Secretary, Imperial Trade Committee of the Winnipeg Board of Trade, Winnipeg.

* * * *

Tramway Bye-Laws.

Among the new bye-laws made by the London United Tramways (Ltd.) is one which requires that "each passenger shall immediately upon demand, and in case no demand shall have been made before leaving the car, pay to the conductor the fare *legally demanded* for his journey and accept a ticket therefor. Any passenger leaving a car shall be deemed to have completed his journey." Under present circumstances many passengers travel without paying their fares and steps should be taken to compel them to pay what is legally due from them. However, it would not, in our opinion, be difficult to get over the above bye-law.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Bedford.—A special meeting of the Town Council was held last week to consider a report from the electrical engineer (Mr. R. W. I. Phillips) on the progress made with the contracts for extensions of the electricity station buildings, &c.

Mr. Phillips reported that the progress made with the buildings had been very much slower than was anticipated, entirely owing to the difficulty in obtaining labour, and unless the rate of progress could be increased the buildings would not be ready for the plant. Considering the number of men employed, the amount of work carried out was very good indeed; 20 out of the 24 foundation piers had been completed, and two large circulating water pipes had been laid from the temporary end of the building to the tow path, the cold well with its roof had been constructed and one large pier for the turbine was up to basement level. Two large reinforced concrete beams to carry the front wall were completed, and it was anticipated that several more of these beams would be completed during the week. It would be impossible to complete the tender for the whole of the buildings in the 22 weeks estimated. As the details for the plant to be installed had come to hand various necessary modifications had had to be made in the building and foundations, also certain improvements had suggested themselves. Details of the various alterations, &c., were set out in the report, and after discussion the Council adopted all the recommendations.

Burnley.—The Corporation have been authorised to borrow £1,000 for laying an additional cable feeder in the Calder Vale district.

Eccles.—The Council have acquired a site for a transformer and meter house required in connection with the scheme for taking electrical energy in bulk from the Lancashire Electric Power Co.

Wolverhampton.—The L.G. Board recently sanctioned loans of £56,452, £9,218, £8,387, £2,064 and £2,000 for the electric supply department.

GENERAL.

Bradford.—The Corporation has authorised the city electrical engineer (Mr. T. Roles) to render part-time service to the Coal Controller in waiting upon local authorities in the Yorkshire district, with the object of discussing possible fuel economies. The Government will pay travelling expenses on the Treasury scale.

Hendon.—The Rural Council has received further notices from the local electric supply company of its intention to lay distributing cables in this district.

Hove.—The accounts of the electricity department were approved by the Corporation last week.

The chairman of the lighting committee (Councillor Payne) said the result of the year's working was good, bearing in mind the present conditions. In addition to the profit made from year to year, a sum of about £12,000 had been paid off in instalments of principal and interest.

Councillor Varley criticised the committee for not making provision for depreciation, and contrasted the position with that of the company from whom the Corporation acquired the undertaking. The company set aside £4,500 a year for depreciation. The reserve did not appear to have any real existence, and from his analysis of the figures he contended that instead of a profit there was an apparent loss of £6,000 or £7,000.

Ald. Nye said that if times had been normal the expansion of business would have been very great. The undertaking was a successful one now, and there was every reason to believe that in the course of a few years the expansion of the business would be enormous. In the last three years they had paid off over £10,000 in capital. Of the £8,000 due to the treasurer, £4,000 was on capital expenditure, and as soon as the war was over they would be able to raise a loan and repay the treasurer. They had owing to them £7,900. He could see nothing but a very prosperous time for the undertaking in the future.

Increase of Prices.—The Launceston Electric Supply Co. has applied to the Board of Trade for permission to charge more for current than the present maximum price.

The local electric supply company has suggested to the Felixstowe Urban Council that consumers who were charged 6½d. per unit for the nine months ended June 30 last should be charged an additional 1d. in future, subject to ½d. per unit discount for payment within a month. The Council recently decided to consider the matter in committee.

The Kidderminster & District Electric Lighting & Traction Co. is increasing its charges for current for lighting by 12½ per cent. and for power by 10 per cent.

Launceston.—A meeting of the electric light consumers was held last week in order to discuss the recent application to the Board of Trade by the Launceston and District Electric Supply Co., for an Order to authorise an increase in the maximum prices which may be charged for lighting from 6d. to 8d. per unit, and for power and heating from 3d. to 4d.

Directors and officials of the Company attended and explained the reason for the application, which, they said, was rendered necessary by the effect of the war on the cost of materials, the restricted lighting, and the Daylight Saving Act.

After discussion, the consumers decided to take no action in the matter in view of the promises of the directors not to raise the price beyond 7d. per unit unless special circumstances warrant it, and they will consult the consumers before raising the price beyond 7d.

Redditch.—In moving the adoption of the minutes of the electric supply committee at the last meeting of the Council, the chairman (Mr. Dolphin) said everything was going satisfactorily at the generating station, and their output had been steadily increasing since April. The minutes were approved, and it was decided to ask Messrs. Ferranti (Ltd.) to quote for the supply of meters.

Ruthin.—The dispute with the Ruthin Electric Supply Co., as to the charge for street lighting, is likely to be compromised. The Council offer to pay £75 in full discharge of the disputed account, and to extend the period of ten years during which the Council had agreed to adopt electric lighting for the streets by the time during which the restrictions on lighting under the Defence of the Realm Regulations are in force.

St. Pancras (London).—The net profit on the electricity undertaking for the year ended March 31 was £26,828, of which £19,000 has been applied to the relief of rates.

Southend-on-Sea.—With reference to the recent decision of the Electricity Committee that consumers of electricity through slot meters should be required to pay a minimum of 18s. per annum, the Borough Accountant has been instructed to require payment of a deposit of 15s. from all persons using electricity slot meters who have not, during the last 12 months, consumed current to the value of 18s., and on and after Oct. 1 it will be a condition precedent to the hiring of slot meters that a deposit of 15s. per annum be paid.

With reference to the application of the Council for sanction to borrow £45,520 for the provision of additional generating plant at the electricity works, the L.G. Board has directed a local inquiry to be held on the subject by one of their inspectors.

South Shields.—The following increases of salary have been granted by the Town Council:—

Tramways manager (Mr. J. C. Whiteley) from £300 to £400; mains superintendent and station superintendent, each from £220 to £245 per annum; assistant tramways engineer (Mr. F. R. Batey) from £3. 5s. to £4 per week.

The Future of the Electrical Industry.—In the "Westminster Gazette" of the 14th inst. Mr. J. B. Braithwaite, in a letter criticising the opinions expressed in an article in our contemporary, dealing with electric power development, gives some reasons why electrical progress has been slower in this country than in the United States.

Mr. Braithwaite points out that Parliament itself is directly responsible for the present unsatisfactory condition of electrical supply. Firstly, it multiplied electric power stations of small size by limiting the area in which companies could give supply, and forbidding them to supply outside that particular area, or to combine together for joint generation or distribution.

Secondly, it has encouraged every small municipality up and down the country to put up its own little power-house at the expense of the ratepayers.

Thirdly, it has imposed upon the electric supply companies a purchase clause which is so vaguely drawn that the most divergent opinions prevail as to what its effect will be. To take the case of the London supply companies, Mr. Braithwaite says: "All these undertakings are purchasable by the London County Council in 1931, notice to purchase having to be given by 1927. It is clear, therefore, that, even if the other difficulties were removed, it would be impossible for these companies to raise the large sums of new capital that would be necessary to co-ordinate their systems of supply and concentrate their generating plant in one or two large power-houses, as suggested by your correspondent, with an unexpired tenure of only 10 years, which would be reduced probably to five or six years by the time the new works were in operation. The first thing to be done, therefore, if the electrical supply industry is to be put on a satisfactory basis, is to free it from the trammels which Parliament has imposed upon it. If Parliament will remove these, and give the industry scope for development, untrammelled by vexatious and harassing restrictions, we have financiers and engineers thoroughly competent to do for London and other large districts in England what has been done in Chicago and so many cities in the United States. I fear your correspondent's suggestions that water-power exists in Wales and Scotland which could do for London what has been done for Chicago is illusory, as water-power in these areas is not available in sufficient quantities, even if permission could be obtained for the erection of the necessary high-tension transmission lines. It must be remembered that Chicago, besides standing on Lake Michigan, affording an inexhaustible supply of condensing water, is also within easy reach, as your correspondent points out, of water-power of very high capacity.

Your correspondent also suggests that the burning of coal at the pit-mouth and the transmission of the energy thus produced to London or other great centres would be a desirable procedure. This I should doubt unless supplies of condensing water were available at the pit-mouth,

Digitized by Google

which I do not think is the case. It is interesting to know that three eminent consulting engineers, acting independently, have each selected the same site on the estuary of the Thames as the one that is best suited for the economical production of power for London. This conclusion was arrived at after fully considering the possibilities of placing the generating station nearer the collieries, and I assume that the absence of the necessary condensing water near the pit-mouth was the deciding factor.

No one would be better pleased than I should be to see electrical supply taken up in this country on really broad lines, but hitherto all our efforts in this direction have been crippled and thwarted under the restrictions and limitations imposed upon our actions by Parliament and the local authorities. The electrical industry has been very much awake for years past, but is at present like a giant struggling in vain to free himself from the cords with which he has been bound hand and foot."

Winsley Sanatorium.—The executive committee recently considered a report by Mr. H. T. Sully, consulting engineer, on the recent breakdown of the electric plant, and a contract for replacing the storage battery, at an approximate cost of £400, was accepted.

LIGHTING AND INDUSTRIAL POWER.

Blantyre.—The question of improving the public lighting was discussed at the recent meeting of the Parish Council.

It was pointed out that the only modification the military representative would agree to would be to allow a further lighting of the parish if they would guarantee that the lights, in the event of warning, would be all extinguished within fifteen minutes. That was hardly possible in Blantyre, which was mostly gas-lit, and was quite different from Cambuslang, which had electric lighting.

Mr. Richardson said their only hope was to get the Clyde Valley Electric Power Co. to extend their electric supply mains into Blantyre. Electric lighting would be about as cheap as gas.

Crickhowell.—Mr. H. O. Wenmann recently attended before the Rural Council in order to explain his proposal to establish electricity supply in the district, and he asked the Council to enter into a contract for street lighting.

The Councillors decided that they could not pledge themselves in any way as they had a contract with the gas company which ended March 31 next.

The Chairman intimated that the matter was one for the ratepayers.

Electric Furnace Progress.—At the National Steel Foundry, Leven, there are two electric furnaces (one a Heroult and the other a Snyder) in operation, and a third electric furnace is being erected. To supply electrical energy for the furnaces and the other requirements of the works, a 3,750 kw. generating set has been recently erected.

Electric Light Economy in America.—It is announced from Washington that the United States Government is about to curtail the use throughout the whole country of electric signs and lighting, in order to economise fuel.

Llandilo.—The Rural Council has been asked by the Llandilo Sawmills (Ltd.) for a supply of electricity for power.

New South Wales Electric Mining Rules.—We are informed that the revision of the Special Rules for the Installation and Use of Electricity in Coal Mines, which has been in progress for some time, is not yet complete, and will not, therefore, be approved this year. In this connection it may be of interest to know that, owing to existing war conditions, it has been decided to suspend work on the State Coal Mine for the time being.

Stair Lighting.—The question of stair lighting has been under consideration by the Dundee Electricity Committee.

Last winter an arrangement was made whereby, if the tenants satisfied the police that they would properly shade the stair windows, the police would recommend the lighting departments to turn on the light. The police cannot undertake the duty any longer, and Mr. Nairn, the convener, said it was impossible for the electricity department to undertake the work. Besides, he did not know what was meant by a subdued light. There was no electric light on common stairs more than 5 c.p.

The Town Clerk said the question was: Who was to be responsible for the proper shading of the light? Was it to be the tenant who paid for it, or the electricity department which turned it on? The police had to prosecute.

Ultimately, it was decided that the conveners of the Police, Electricity and Gas Committees and the officials should meet and make arrangements to deal with the matter.

Salford.—The Lighting Committee in conjunction with the Electricity and Tramways Committee, are making arrangements for putting up additional lamps on the main tramway routes.

The Greaves-Etchells Furnace.—Orders have recently been received by the manufacturers of the Greaves-Etchells electric furnace for the supply of five 6-ton furnaces to steel manufacturers in the United States.

ELECTRIC TRACTION.

Dover.—In consequence of the difficulty of obtaining drivers, the municipal electric tramway service is to be reduced.

Edinburgh.—The Admiralty has informed the Corporation that there is no objection to an application for a provisional order to authorise the construction of an electric tramway between Edinburgh and Queensferry, but no actual construction work can be carried out until after the war.

Electric Tramways in Australia.—On June 30, 1916, there were 406 miles of electric tramways in the Commonwealth. Of these 326 miles were of standard gauge, 75 miles of 3 ft. 6 in. gauge and 5 miles of 5 ft. 3 in. gauge. There were also 102 miles of steam tramways, 46 miles of line operated by cables and 60 miles worked by horses.

Hull.—The address of the Hull tramways department and of the tramway electrical engineer (Mr. J. Wilkinson) is now Tramway Power Station Buildings, Osborne-street, Hull.

Newcastle-on-Tyne.—The experience of the corporation tramways department with front exit tramcars has been very satisfactory.

For over 18 months seventeen of these cars have been in operation, and there has been an entire absence of accidents to persons boarding or leaving them, and the cars have also been enabled to make quicker journeys, an important matter in an industrial area. In a new design of double-deck car recently introduced by the manager (Mr. E. Hatton) the staircase, being entirely enclosed, is kept dry in wet weather and the platforms have a closed front above the dashboard, thus protecting the motorman from wind and rain.

Rawtenstall.—The tramway dispute has been settled by the Corporation deciding to pay a war bonus of 4s. per week to all employees (male and female) over 18 years of age, as from 1st inst.

Wallasey.—A partial strike of the employees of the municipal tramways department, which took place on the 12th inst., dislocated the service for a short time. The strike was due to the decision of the Council to train women as tramcar drivers, but after being out for a day those on strike accepted the committee's terms and resumed work.

Yarmouth.—Last week the tramways committee submitted a report on the work of the electric tramways, and recommended certain alterations in the service.

Mr. E. J. Middleton moved that the question of running the tramways be referred back to the general purposes committee. The time had arrived when they should try to cut some of their losses. He suggested the Yarmouth section should be closed down at Christmas till after the war, and the rolling stock kept for the benefit of the Gorleston section, which was making a profit.

The motion was carried.

MISCELLANEOUS.

A Woman Electrician.—It is announced that Miss Hilda Muriel Pickston, a lady clerk employed in the Chief Electrical Engineer's office at Stoke-on-Trent has been enrolled as the first lady member of the Stoke-on-Trent Engineers' and Engineering Students' Association. Miss Pickston qualified for admission under a recent rule, which required success in an engineering examination in the case of women applying for membership, by obtaining a pass in the City of Guilds of London Institute Examination in Electrical Engineering.

Bordeaux Samples Fair.—The second Bordeaux Samples Fair was opened on Sept. 1 and that, notwithstanding the adverse circumstances under which it is being held, the Fair will probably have a good measure of success. The chief exhibits include chemical goods, machinery, electrical goods, hardware, ironmongery, motor cars, &c.

Free Examinations in Electric Light Switching.—Messrs. A. P. Lundberg & Sons send us a copy of a new issue of their "exam. folder," containing new unsolicited testimonials from examinees.

The "Lektrik Lighting Connections" can be obtained at 7d. post free, or in French at 1s., or one franc, from Messrs. A. P. Lundberg & Sons, 477-489, Liverpool-road, London, N. 7.

Fuel and Lighting Economy in Germany.—"The Times" reports that notice has been given by the General in Command of the Münster Army Corps District that the consumption of gas and electric power in shops, restaurants, &c., must this winter not exceed one-half of the consumption in the winter of 1915-16. All the military and civil authorities, businesses, and other private undertakings are required to alter their office hours, from Oct. 1 onwards, to the time between 8 a.m. and 4 p.m. Schools will keep the same hours. The lighting of shop windows and the use of passenger lifts are forbidden, and all restaurants are to be closed at 9 p.m.

New Book.—A new book entitled "Continuous-Current Motors and Control Apparatus" by Mr. W. Perren Maycock M.I.E.E., has just been published by Messrs. Whittaker & Co. It has 330 pages, with some 150 illustrations and diagrams.

Digitized by Google

Olive Cake Fuel.—The "Colliery Guardian" reports that the Government of Tunis has been testing the efficacy of fuel briquettes made with the residue from the olive oil press, and the results have been successful enough to warrant an increased output of the new combustible. The greatest among the consumers of the new briquettes will be the tramway company, whose demand is 12 tons per day for its electricity station.

Retail Prices of House Coal.—Under the Retail Coal Prices Order, 1917, which has been made by the Board of Trade at the instance of the Controller of Coal Mines, maximum retail prices of house coal throughout the United Kingdom are now to be definitely fixed.

In view of the wide differences in the cost of coal in different localities, due mainly to transport charges, but partly also to differences in the maximum colliery prices and in local merchants' costs of distribution, the duty of fixing the maximum retail prices in each locality has, by arrangement with the L.G. Board, the Scottish Office and the Irish Office, been assigned to local authorities. In England and Wales these functions will be exercised by borough, urban and rural district councils, in Scotland by county and town councils, and in Ireland by borough and urban district councils, town commissioners and rural district councils. The basis on which the maximum prices are to be arranged is contained in the Order, article I. of which provides that the net profit from sales of coal delivered by road vehicle from a depot or wharf or railway siding in lots of 1 ton or over shall not exceed 1s. per ton. The Order further prescribes how the prices for sales of smaller lots than 1 ton are to be fixed by reference to the maximum prices of lots of 1 ton or over. The local authorities are to meet the local coal merchants, and after investigation of the figures submitted by them are to publish in the local press lists showing the prices chargeable for the various classes of coal.

The Brass Swarf Order.—A deputation from Birmingham interviewed officials of the Ministry of Munitions in regard to the recent Order of the Ministry in regard to brass swarf.

Mr. MADELEY (chairman of the Birmingham Brass Masters' Association) called attention to the fact that swarf was resold to brassfounders, at an enhanced rate, although the metal might not leave their premises.

The Government officials recognised that hardships would be inflicted upon certain manufacturers, and hoped that a modification of the Order might be made. A conference on the matter is to be held in Birmingham shortly, and the Ministry hope the firms will give the returns asked for.

Trades for Interned Men.—In connection with the scheme for finding employment for interned prisoners of war in Switzerland, it has been decided to conduct classes in certain subjects by trained teachers sent out from England.

The subjects will include joinery, acetylene welding, electric wiring, watch repairing, &c.

Three motor engineering classes, which have been established for some time, will be concentrated at Vevey; but two new training centres, to which men selected for the various trades will be sent from the camps, will be set up at the Polytechnic Chalets at Seeburg, near Lucerne, and at Meiringen. At the outset about 500 men will receive training

EDUCATIONAL.

King's College (University of London).—There are complete courses of study (extending over three or four years) in civil, mechanical and electrical engineering for the engineering degrees of the University of London and for the diploma and certificate of the College. The four years' course provides, in addition to the academic training, opportunity for practical training in "works." Considerable additions have been made to the engineering department, including a large drawing-office and lecture rooms for the mechanical and civil engineering departments, and lecture theatre and rooms for research, including wireless telegraphy, for the electrical engineering department. There are five well equipped laboratories for the purpose of teaching and research. The next term begins on Oct. 3. Full particulars may be obtained from the Dean, or the Secretary, King's College, Strand, W.C.

Manchester Municipal School of Technology, University of Manchester.—At this school there are courses leading to the Manchester University degrees (B.Sc.Tech. and M.Sc.Tech.) in the Faculty of Technology in the departments of mechanical, electrical and sanitary engineering, chemical industries, textile industries, printing and photographic technology and architecture. Prospectuses may be obtained from the Registrar.

Armstrong College, Newcastle-on-Tyne.—The session 1917-18 will commence on Sept. 24. Full courses leading to the degree of B.Sc. in engineering are provided in mechanical, marine, civil and electrical engineering, naval architecture, mining and metallurgy, &c. Particulars can be obtained from the secretary, Mr. F. H. Pruen, M.A.

The prospectus of the day classes in the 1917-18 session has been issued, and contains particulars of the courses of study, scholarships, fees, &c. The electrical engineering department is in charge of Prof. W. M. Thornton, D. Sc., D. Eng.; with Mr. Wm. W. Firth, M.Sc., A.R.C.Sc., as assistant. There are two courses of lectures throughout the session, one suitable for second year students who have attended the junior physics course, and the other advanced and required for the third year of the degree course in electrical engineeing. There are good facilities for practical work.

University of Bristol.—Merchant Venturers' Scholarships have been awarded to the following:—

Harold Hayes and Kenneth Allen Tayler (Merchant Venturers' Secondary School), John Hugh Coulson Wake (Bristol Grammar School) Edwin Hay Thatcher (Dean Close Memorial School, Cheltenham) and Edward Geo. Cove (Torquay Secondary School).

Northampton Polytechnic Institute.—The day and evening courses for apprentices and others in the electrical trades form a special feature of the work of the Northampton Polytechnic.

It is recognised that the technical instruction of apprentices in the electrical engineering trades is one of the urgent problems of the present time, and will become more urgent in the reconstruction period after the war. The pre-war methods of restricting the period of instruction to the evening hours after the day's work is done, even though early "time off" be sometimes given, is generally recognised as quite unsuitable for the average boy from 14 to 17 years of age, although good work has been done by boys of exceptional ability and grit. What is wanted in the future is that apprentices should receive a part at least of the training during the day time, not less than one whole afternoon a week being devoted to it. This time should preferably be occupied with technical instruction proper. In addition, it is necessary, at the present stage of educational development, that the general education of the boys leaving the elementary schools should be continued, and for the present this may be attained in London by attendance at the junior technical institutes for two nights a week for classes in English, in calculations, in general subjects and in gymnastics. In these classes the work of the elementary schools is continued, with a technical bias directed towards the industry in which the boys are engaged. The boys at present available may, it is suggested, be divided into three grades, roughly, but not necessarily, determined by the length of time they have been in the trade. As the scheme develops in future years the differences between the grades will tend to become more marked, and the syllabuses will be varied accordingly. The courses suggested are, therefore, to be regarded as for the session 1917-18 only, and will probably be modified in future sessions.

In Grade I. (for apprentices who have recently left school) there are afternoon classes at the institute in technical electricity and workshop drawing on Mondays from 2.30 p.m. to 5.30 p.m. On two evenings per week (7.30 to 9.30) the apprentices attend an affiliated junior technical institute, the subjects taken being English and a special tutorial engineering class, on Tuesday, and arithmetic and workshop calculations and gymnastics on Wednesday.

In Grade II. (for apprentices sufficiently advanced in such work as is covered by Grade I.) there are afternoon classes (on Wednesdays, 2.30 p.m. to 5.30 p.m.) at the Northampton Polytechnic in elementary electrical engineering, engineering drawing and elementary mechanics. Two evenings per week (Wednesdays and Fridays) are spent at the junior technical institute, the subjects being English, engineering (tutorial), elementary mathematics and gymnastics.

In Grade III. (for senior apprentices) there are specialised practical afternoon courses in elementary electrical engineering at the Northampton Polytechnic on Thursdays, 2.30 p.m. to 5.30 p.m.; also evening attendance at the Polytechnic for regular lecture course in electrical engineering and in mathematics, and also for the laboratory work of the lecture course.

The fee for the courses in Grades I. and II. is 12s. and in Grade III. 15s. 6d. per session.

Enrolments for the above courses commenced in the week beginning Sept. 17, 1917. The classes in the junior technical institutes will start on the 24th inst., and the day courses at the Northampton Polytechnic Institute on Oct. 1. The addresses of the L.C.C. Junior Technical Institutes affiliated to the Northampton Polytechnic Institute are Compton-street, Goswell-road, E.C. 1; St. John's-road, Hoxton, N. 1; and Medburn-street, St. Pancras, N.W. 1.

Further information and forms of application for admission can be obtained by application to the principal, Dr. R. Mullineux Walmsley.

With reference to the above classes, we are desired to announce that, the notice having been somewhat short, the date for enrolment has been extended to Friday, the 28th inst. We hope by that date the response from the trade will be sufficient to ensure the launching of this interesting educational experiment.

Training of Wireless Operators.—In view of the need for more wireless operators for ships, arrangements have been made for opening classes in the Royal Technical College, Glasgow, for the free training of youths in the principles of wireless telegraphy. The scheme, which is under the supervision of Prof. M. Maclean, provides that instruction will be given to students by the College in the theory of electricity and also in the use of wireless telegraphic instruments, while expert operators have been sent by the Marconi Company to train the students in the technical part of the work. The course is expected to be completed by average youths in a period of not more than five months, and at the end of that time they should be ready for appointments. Similar training centres are being established in association with the local educational institutions at Newcastle, Leeds, and Birmingham.

Bequest for Teaching Mechanical Science.—In the will of Mrs. Elizabeth Dack Denning, widow of the late Alderman Denning, of Croydon, there is a bequest of all her freehold property in trust for the advancement and propagation of education in mechanical science. The gross value of the estate is £169,719, with net personalty £78,581.

Digitized by Google

TENDERS INVITED AND ACCEPTED.

Converting Plant and Switchgear.

KIRKCALDY Corporation invites tenders for the supply and erection of converting plant and switchgear. Forms of tender from the borough electrical engineer, and tenders to the Town Clerk by Oct. 2.

Electrical Stores.

MERTHYR TYDFIL Guardians require tenders by noon Sept. 24 for six months' supply of electrical accessories, oils, paints, &c. Forms of tender, &c., from the Master of the Workhouse or the Superintendent of the Cottage Homes.

Tenders are invited for six months' supply of electric fittings to the Midlothian and Peebles District Asylum, ROSSLYNLEE. Forms of tender from the clerk and treasurer, 19, Heriot-row, Edinburgh, to whom tenders by Oct. 1.

TOXTETH PARK Guardians require tenders by noon Sept. 24 for three months' electrical and engineers' supplies, &c. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

ILFORD.—The Urban Council has accepted the following tenders:—General Electric Co., two rotary converters; W. T. Henley's Telegraph Works Co., cable; Albion Clay Co., stoneware conduits.

MANCHESTER.—The Corporation has placed an order with Hadfields (Ltd.) for the supply of special trackwork.

ST. PANCRAS.—The Borough Council has accepted an offer of the Brush Electrical Engineering Co. to provide a new air-pump for the converted 1,500-kw. Ljungström turbine at King's-road station for £300.

SOUTHEND.—The Council has accepted the tender of Callender's Cable & Construction Co. for 100 service boxes at 11s. 6d. each, and that of Belliss & Morcom for piston and piston rings at £20. 14s.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments:—

Postmaster-General's Department, South Australia.—Western Electric Co., 25 jacks, in strips of 10, at 8s. each; 100 ditto, in strips of 20, 9s. 6d. each; 20 calculagraphs, £19 each; 200 4-volt lamps, 6½d. each; 3 lbs. granulated carbon, 11s. 9d. per lb.; 250 carbon diaphragms, 1s. each; 1,000 number plates, 25s. per 100. Diamond Engineering and Trading Pty, 250 dry cells, 3s. 11d. each; 50 ditto, 2s. 6d. each; 100 ditto, 1s. 8d. each. J. Bartram & Son, 100 magneto bells, 17s. each; 25 telephones, 122s. each; 300 cords, 1s. 9½d. each; 200 carbon diaphragms, 9d. each. British General Electric Co., 500 cords, 1s. 3d. each; 300 carbons, 20s. per 100. Gray Bros., 8,000 steel gal. spindles, 2s. 1½d. each.

Cancelled.—The Postmaster-General's Department notifies that the acceptance of the tender of the India Rubber, Gutta Percha & Telegraph Works Co. for 8,000 copper binders, to specification No. 526, at 12s. 9d. per 100, and the tender of Grey Bros., for 8,000 spindles to specification No. 473, pattern No. 411, has been cancelled.

Postmaster-General's Department, New South Wales—F. & A. Nosworthy, approximately 370 c.i. covers and frames for manholes, £3 10s. each.

Postmaster-General's Department, Queensland—British Insulated & Helsby Cables, 100 foiled paper condensers, 2s. 4½d. each. J. Paton & Co., 150 etonite earpieces, 1s. 11d. each. Diamond Engineering & Trading Pty., 500 dry cells, 5s. 5d. each.

Victorian Railways Department.—Noyes Bros. (Melbourne) Pty., vulcanised rubber electric light wire—Item No. 1, 7/21½ standard wire gauge, 600 megohms (black), £17. 17s. 6d. per mile.

New Zealand Government Contracts.—The following tenders have been accepted by New Zealand Public Service Stores Tender Board:—

P. R. Baillie & Co., 100 miles rubber-insulated wire, £2,800; F. W. Markmann, 8,000 gal.-combiners, £216. 13s. 4d.

LIQUIDATIONS.

Winding up Petition.—A petition for the compulsory winding up of Bests' Safety Lamps (Ltd.) presented by Messrs. Wm. Barraclough (Ltd.), will be heard at the County Court, Leeds, on Oct. 8.

APPOINTMENTS VACANT AND FILLED.

London County Council invites applications for the position of charge shift engineer at their East Greenwich generating station. Commencing salary £250, rising by £10 a year to £300. Applications, on official form to be obtained from the Clerk of the Council, Council Hall, Spring Gardens, S.W.1, must be in by 1 p.m. of Sept. 24.

An advertiser requires a works electrician as working foreman for large controlled engineering firm in West London district. Must have knowledge of motors, telephones and lighting.

A head designer and an assistant designer are required for Admiralty establishment. *See advertisement.*

A science master is required in the Education Department of Ceylon. Candidates should possess good honours degrees in chemistry and be competent to teach physics. Salary £350, rising by annual increments of £25 to £450 per annum. Applications to the Assistant Private Secretary, Colonial Office, S.W. 1.

The Governors of the Borough Polytechnic Institute (Borough-road, S.E. 1) require an additional lecturer and demonstrator in the engineering department. Commencing salary £200. Particulars and forms of application from the Principal.

Chesterfield Corporation require a chief assistant electrical engineer. Commencing salary £230. Applications to the Engineer, Electricity Works, Chesterfield, by Oct. 1.

A chief assistant in mechanical engineering (salary £200) and an assistant lecturer in chemistry (salary £200) are required at Huddersfield Technical College. Particulars from the secretary.

The Deputy Controller for Auxiliary Shipbuilding, Admiralty, has appointed Lieut.-Col. J. Mitchell Moncrieff to be Director of Engineering Work, to deal generally with all civil engineering matters which may arise in connection with his department.

Mr. Thos. Copp, Peterborough, has been appointed permanent-way inspector of the Cape Town Electric Tramways.

BUSINESS ITEMS.

The Consolidated Electrical Co. has removed to Worcester House, Walbrook, E.C. 4.

With a view to centralising their business in London, the Stanton Ironworks Company are removing their office on the 1st prox. to Maxwell House, Arundel-street, Strand, W.C. 2. The new telegraphic address will be "Cobbles Eastrand London," and the telephone number "Central 6808." Mr. Arnold Longden, who has represented the company for some years on the London Coal Exchange, will continue to supervise the company's interests at Maxwell House.

CATALOGUES, &c.

AUTOMATIC COMPENSATORS.—We have received from the Electric Controller & Mfg. Co., of Cleveland, Ohio, Bulletin 1,042 (July, 1917), giving particulars of their automatic compensators for starting and stopping alternating-current squirrel-cage motors.

MOTOR CAR INSTRUCTIONS IN RUSSIA.—Messrs. C. A. Vandervell & Co., of Acton Vale, appear to be fully alive to the possibilities of extending their trade after the war, for they have just issued a Russian edition of their Running Instructions. This should certainly lead to increased trade with Russia when peace returns once more.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Birkenhead.—The capital expenditure on the tramways, as shown by the accounts for the twelve months to March 31, is £373,699 (no increase), of which £170,963 has been redeemed. Reserve and renewals funds amount to £42,530.

Revenue was £80,748 (against £72,821 in the previous year), and working expenses were £42,106 (£38,833), stamp duty and commission on loans absorbed £66 (£299), interest £14,778 (£12,973), sinking fund, &c. £10,145 (£10,146), the net balance being £13,652 (£10,570). £5,000 is placed to reserve, £5,832 to renewals, and £2,820 to relief of rates. Total revenue per car mile was 16·33d. (14·84d.) and working expenses, including power, were 8·51d. (7·91d.). Average fare charged per mile was 0·66d. ordinary and 0·45d. workmen's. Passengers carried were 17,950,433 (16,676,022), car miles run 1,186,186 (1,176,951), and units used 2,503,587 (2,406,755)=2·110 (2·044) per car mile.

The manager, Mr. C. Clarke, says in his report the difficulty of obtaining a sufficient supply of labour has made it impossible to keep the permanent way or rolling stock in the usual satisfactory state of repair, and as heavy commitments will be necessary for repairs and renewals after the war, Mr. Clarke advises the building up of the reserve fund as much as possible. The demands upon the staff for military service have continued, and the cars have for some time been operated with all female conductors, 84 female conductors and car cleaners now being employed.

Poplar (London).—The accounts of the electricity department for the year ended March 31, show gross capital expenditure £461,100 (increase £9,936), of which £300,005 is outstanding.

Income was £103,878 (compared with £88,490 in previous year), and working and general expenses were £67,069 (£52,178), leaving gross profit £36,808 (£36,311), to which are added £38 (£27) from property, revenue account, £158 (£217) from lamp sales account and £116 (£211) from interest on loans, discounts, &c., making a total of £37,122 (£36,767). Redemption of loans required £13,143 (£12,860), interest £11,382 (£11,530), and reserve contingency account £63 (£49). £500 (as in previous year) has been placed to superannuation fund, and the net surplus is £12,011 (£11,814). Coal, &c., cost 0·43d. (0·35d.) per unit, total cost of production was 0·69d. (0·58d.), and net revenue charges were 0·25d. (0·28d.). Units generated were 28,039,171 (26,244,494), and sold 23,476,842 (21,506,614). Total maximum supply demanded was 9,400 kw. (8,750 kw.).

Mr. J. H. Bowden, engineer and manager, says in his report coal cost 17s. 11½d. (against 20s. 5d.) per ton. Working costs rose from 0·58d. to 0·69d. per unit, which is probably still the record for the metropolitan area for the year. Average price obtained was 1·062d. per unit, and if the supply in bulk is deducted, the figure for energy sold in Poplar (1·194d.) is still, Mr. Bowden says, a record for the past year. Load factor was 30·11 (30·2) per cent., the increase being probably due to the restricted lighting.

Digitized by Google

COMPANIES' MEETINGS AND REPORTS.

COUNTY OF DORSET ELECTRIC SUPPLY CO. (LTD.)—Dr. J. A. Hosker, who presided over the recent meeting, said he regretted that the annual meeting was being held so late in the year, but it had been found impossible, owing to the difficulty in getting accounts prepared and audited, to hold it earlier. The accounts showed that there had been a set-back during the past year in the development of the undertaking. The gross revenue for 1916 was £2,270, compared with £2,461 in 1915, with a gross profit of £937, against £1,271, a decrease of £334. After allowing for interest on loan and hire purchase agreement there was a net deficit of £72. The company had been even more seriously handicapped during the past year than it had been in 1915, and it continued to be so. The cost of all material, and especially fuel, had gone up enormously, whereas the consumption of electric current was very largely curtailed owing to the lighting restrictions, the Daylight Saving Act and the economy practised by private consumers. It had been impossible to obtain the materials for extensions, so that what additional customers the company could obtain must be those on the route where the mains were already laid. During the year 30 new consumers had been added and the number of lamps connected had gone up from 15,448 to 20,426. The majority of those lamp-connections were made towards the close of 1916, so that they did not materially increase the output. The units sold amounted to 207,252, against 193,458 in the previous year. The Swanage and the Lyme Regis companies showed a profit on the year's working, and Blandford a small loss. Unfortunately, however, the Lyme Regis company had suffered very considerably both in regard to a material reduction in the sale of current and a very large increase in the costs of production, so that the net profit in that undertaking had been too small to allow any dividend being paid for 1916. While the results were unsatisfactory, it must be felt that they indicated progress in spite of serious obstacles. He was, therefore, inclined to believe that when times became normal the rate of progress would become considerably accelerated, and he saw no reason to modify his confidence in the ultimate success of the undertaking. It was with the most sincere regret that he had to make mention of the death of Lt.-Col. W. H. Baxter, of which he had just had news. Since the outbreak of the war he has been on active service in the East. The directors had lost a much-valued and highly respected colleague, and one whose loss was keenly felt. Three of our other directors were still engaged on their military duties, and upwards of a third of the staff were serving with the Colours.

DUMBARTON BURGH & COUNTY TRAMWAYS CO.—At the meeting last week the chairman (Mr. Geo. Balfour) stated that he viewed with the gravest apprehension the position in which this country would be placed as soon as the short burst of activity immediately following the war operations had passed away. The great mass of industrial workers in this country were being unfitted to stand the shock which must come, and the blame rested not so much with the workers as with those in authority, who, through lack of knowledge or lack of a sense of responsibility, either encouraged or acquiesced in conditions which were economically insupportable. They seemed to lose sight of the fact that at the present moment the greater portion of the wages distributed in this country was provided out of the capital funds of the country, and while this was inevitable to a certain extent in war time, it was a process which could not continue for many years without vitally sapping our national strength. The company's total receipts for the year amounted to £33,630, against £26,041 for the previous year, an increase of £7,589. The expenses, however, had increased by £3,247. The profit available, after payment of debenture interest, was £12,798, or about £5,500 more than the preceding year.

DUNDEE, BROUGHTY FERRY & DISTRICT TRAMWAYS CO. (LTD.)—Mr. Geo. Balfour, who presided over the annual meeting last week, stated that the receipts for the past year were £14,657, an increase of £2,822 over those of the previous year, and the expenses had increased by about £1,000. They had carried 2,151,529 passengers, compared with 1,655,843 in 1915-16. On the whole, he thought last year was perhaps a little less trying than the previous year owing to the improved receipts, relieving the management of considerable anxiety. They had now had time to ascertain the full effect of the sale of a portion of the line on the Craigie estate to the City of Dundee, and, in his opinion, the earning capacity of the line was substantially the same as it was before the sale. The directors were pleased to propose a distribution on the ordinary shares, which, owing to the effect of the war, had had to be discontinued for two years.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

CAMDEN ENGINEERING CO. (LTD.) (148,428).—Private company, reg. Sept. 8, capital £50,000 in £1 shares, mechanical, electrical and aeronautical engineers, boiler makers, motor car manufacturers, &c. First directors are :—G. H. Thomas (chairman), H. Burroughes and G. A. Peck.

CHAMBERS ENGINEERING CO. (S. AMERICA) (LTD.) (148,429.—Private company, reg. Sept. 8, capital £2,000 in 1,300 "A" shares of £1 each and 28,000 "B" shares of 6d. each, to take over from T. N. Chambers and J. Stephens all agencies acquired or to be acquired by them in America, to carry on the business of principals and (or) agents, factors and intermediaries in America for any persons, firms or corporations carrying on engineering business in any other countries, not being alien enemy countries, &c. First directors are :—T. N. Chambers, J. Stephens and A. Argles (man. director). Reg. office: 24, King-st., Cheapside, E.C.

ENGINEERING COMPONENTS (LTD.) (148,347).—Private company. Reg. Aug. 30, capital £7,500 in 5,000 ordinary and 2,500 7 per cent. preference shares of £1 each, to take over the business of manufacturing engineers carried on by W. H. Reynolds (Ltd.) at Reno Works, Rosslyn Crescent, Wealdstone, and to carry on the business of marine, electrical, mechanical and motor engineers, &c Reg. office : Reno Works, Rosslyn Crescent, Wealdstone.

RAPID ELECTRIC ARC WELDING & ENGINEERING (IRELAND) CO. (LTD.) (4,493).—Private company, reg. in Dublin on Sept. 4, capital £5,000 in £1 shares (1,000 preference), objects as title. Agreement with J. L. Gordon. First directors are :—J. L. Gordon and T. McKinty. Reg. office : 45, Rosemary-street, Belfast.

ROTASPHERE CO. (LTD.) (148,393).—Private company. Reg. Sept. 4, capital £5,000 in £1 shares. To take over business carried on as the "Rotasphere Co.," and to carry on the business of electrical, hydraulic, motor and general engineers, &c. First directors are :—Louis B. Cousans and Robert V. Holliday. Reg. office : 82, Belvedere-road, S.E. 1

STOKES CASTINGS (LTD.) (148,343).—Private company. Reg. Aug. 29, capital £6,000 in £1 shares, founders, mechanical, electrical, hydraulic and general engineers, &c. Agreement with F. W. Stokes, R. I. Ashley and S. M. Stokes. First directors are :—F. W. Stokes, A. M. Stokes, R. I. Ashley, S. Hersey, J. Richardson and W. A. Oubridge (all permanent). Reg. office : Union Foundry, Mansfield, Notts.

WHOLESALE BATTERY CO. (LTD.) (148,408).—Private company. Reg. Sept. 5, capital £100 in £1 shares. Electricians, engineers, &c. Reg. office : 14, Derby-road, Croydon.

MORTGAGES AND CHARGES.

BRITISH ELECTRIC TANNING SYNDICATE (LTD.)—Mortgage dated Aug. 28, 1917, to secure £1,500, charged on tanyard, house, land, &c., at Swimbridge, Devon. Holders : J. G. Smith and W. H. Smith.

LANCASHIRE ELECTRICAL ENGINEERING CO. (LTD.)—Debenture dated Aug. 22, 1917, to secure £200, charged on freehold works at Ashton-under-Lyne and company's general assets. Holder : A. Seymour, Ashton.

SEEAR, SCOTT & CO. (LTD.)—Particulars of £1,500 debentures created Aug. 28, 1917, have been filed, amount of present issue being £1,500. Property charged, company's undertaking and property, present and future. No trustees.

F. W. SMITH & CO. (1907) (LTD.)—Mortgage debenture dated Aug. 9, 1917, to secure £250, charged on company's undertaking and property, present and future, including uncalled capital. Holder: Mrs. E. Smith-Cleburne Peel.

WHITE, JACOBY & CO. (LTD.)—Issue on Aug. 30, 1917, of £450 debentures, part of series of which particulars have already been filed.

WRIGHT & WOOD (LTD.)—Mortgage dated Aug. 29, 1917, to secure £520. 16s., charged on land at Halifax. Holders : Halifax Permanent Benefit Building Society.

CITY NOTES.

BRITISH ALUMINIUM CO. (LTD.)—The directors have declared dividends at the rate of 8 per cent. per annum (less tax) on the ordinary share capital for the six months to June 30, and at the rate of 6 per cent. per annum (less tax) on the preference share capital for the six months to June 30, both payable on Oct. 1.

BRITISH INSULATED & HELSBY CABLES (LTD.)—The interim dividend of 7½ per cent. has been declared on the ordinary shares, compared with 5 per cent. last year.

BROTHERTON TUBES & CONDUITS CO. (LTD.).—A dividend for the half-year to June 30 at the rate of 8 per cent. per annum has been declared.

CONSOLIDATED GAS, ELECTRIC LIGHT & POWER CO. OF BALTIMORE. A quarterly dividend of $2 per share (at the rate of 8 per cent. per annum) on the capital stock will be payable on Oct. 1.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The directors have decided to pay an interim dividend at the rate of 4 per cent. per annum (tax free) on the Ordinary shares for the half-year ended June 30 last, payable on 1st proximo.

EASTERN TELEGRAPH CO. (LTD.)—The Company announce the payment on Oct. 15 next of dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock of the company for the quarter ending 30th inst., and the second quarterly interim dividend of 1½ per cent. on the ordinary stock (tax free) in respect of profits for the year ending Dec. 31, 1917. The transfer books of the ordinary stock will be closed from Oct. 6 to 13, inclusive.

EASTERN EXTENSION, AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The directors have declared a second quarterly interim dividend of 3s. per share (tax free) in respect of profits for the year ending Dec. 31 next, payable on Oct. 15. The share register will be closed from Oct. 6 to 13, inclusive.

MANILA ELECTRIC RAILROAD & LIGHTING CORPN. (LTD.)—A dividend of $1.50 per cent. has been declared for the quarter ending Sept. 30.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—An interim dividend has been declared on the ordinary shares for the half year to June 30 at the rate of 10 per cent per annum, tax free.

Digitized by Google

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—"Kukri" Grogan gets a 7-kw. electric fire into the Mayor's Parlour, Salford Town Hall. (What Lancashire does to-day, & c., &c.)

* * * *

The Army has developed its own mathematical terms, especially since war broke out. One of the most expressive is "umteen." I am told that it can be used to denote numbers of anything, coils of wire, four-point-fives, hairs in a sub-altern's "'taché" or bottles of er,—— varnish, and that it is always understood!

* * * *

Among the returns made recently in which the nationality of the person is disclosed, the following has been sent in to us:—Messrs. H. & J. West, Electrical and General Engineers, 62, King's-road, Gosport, Hants, Proprietor R. S. West (British), *formerly Scotch*, other business occupation, electric light station shift engineer.

The italics are mine and they recall the statement of the man who said he was Scotch by absorption!

* * * *

A correspondent who signs himself "Anti-Bos(e)h(e)" asks me if the E. Cecil Beman, whose peace-pifflette "The Sword or the Cross" which I remarked upon a fortnight ago, is managing director of the Electrical Supplies Co., Tottenham Court-road, London, W.C. I don't think there is any doubt about it, and as I remarked before I think it a pity any electrical engineer should publish anything which would tend to weaken the case for the Allies or encourage the idea of a premature peace. I have just had the pamphlet returned by an R.E. at the front and his marginal notes are too voluminous to reproduce in full. However, I cannot overlook his rejoinder upon the following:—Beman says, "in so far as the Entente Powers are induced to emulate in some respects the examples set by their opponents, may not the enemy legitimately claim to have won a signal victory by forcing us to fight with his discreditable weapons?" to which my R.E. friend replies: "Nonsense, I used to prefer a bout with my fists, but if the other chap picked up a club and I got near a pinch-bar, well—God help him!" And what else has the Hun done?

* * * *

The "Methodist Recorder" tells us that John Wesley wrote a volume on electricity:

"The title-page runs—*The Desideratum: or Electricity MadePlain and Useful*, by A Lover of Mankind and of Common Sense. The Reverend John Wesley, 1759." The first part of the book is an explanation of the subject. It describes electricity as "a fluid far more subtle than air," and declares that "all other matter seems to be only the Body, and this the Soul of the Universe." One suggestion that he makes is interesting not only in itself but for the way in which he defends it. Lightning conductors, he thinks, might prove "a very probable method of preserving houses, churches and ships." "Let it not be objected, that the using this probable means of preventing a threatening danger would imply a denial of, or distrust in, Divine Providence."

In matters of lightinng conductors I should be inclined to distrust the contractor rather than Divine Providence!

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, September 18, 1880.]

ELECTRICAL TARGETS.—A correspondent writes, with reference to the Wimbledon marking scandal, asking whether an electrical automatic recording target has never yet been devised. We have heard of some such device; and certainly the construction of an electrical system for this purpose would be by no means difficult. It does not appear, however, that anything of the kind has yet secured the patronage of the National Rifle Association.

BRIGHT'S ELECTRIC FIRE DETECTOR.—The North Shore Flour Mills, of Liverpool, are now fitted with this ingenious mode of detecting fires. The system is the one under experiment over a large area in the City of London and Southwark, the fire at the Daniel Lambert Tavern, on Saturday, the 28th ult., having been signalled by the apparatus. The Shore Milling Co. have also, it is stated, given an order for 30 electric lamps to be placed in different parts of their establishment.

DISTINGUISHING THE VOICE THROUGH THE TELEPHONE.—Mr. W. Dowling, writing to Messrs. Moseley & Sons, telegraph engineers, Manchester, says:—"I have a high opinion of your telephone, and have to thank you for permitting a test of its capabilities to take place at my house a short time since. Perhaps the most striking illustration of the faithfulness with which the voice is conveyed by your wonderful instrument was afforded by my wife's little terrier, who, on hearing its mistress's voice applied to the telephone in a distant room, connected with the room (in which was the dog) by your wire communication, instantly pricked up its ears, and made an attempt to jump into the mouthpiece in order to get to its mistress—an impartial, unerring testimony to the thoroughness of the apparatus.

Radiotelegraphy in Mexico.—The Mexican Department of Communications has caused two new wireless telegraph stations to be established in the oil district of the State of Vera Cruz (one at Tuxpam and the other at Puerto Lobos), in order to supplement the land telegraph system at times when it is disturbed by natural or other conditions.

Rubber Cables in India.—It is reported that the Bombay Fire Assurance Association has asked the Local Government and the Chamber of Commerce to assist it in making it compulsory for all cable manufacturers to adopt the practice of British makers, viz., to attach to all imported rubber insulated wire and cables labels giving the maker's name, the grade and the insulation resistance.

German Research Work.—According to "The Times," investigations into the properties of pit coal carried on by the "Kaiser Wilhelm Institut fur Kohlenforschung," have yielded important industrial results.

The treatment of coal with liquid sulphurous acid at ordinary temperatures has produced viscous, golden-yellow mineral oils, the amount produced being 5 kilogs per metric ton. A process has also been elaborated by which through heating naphthalene under pressure, in the presence of aluminium chloride, an oil is produced which can be used for illuminating purposes in the same manner as petroleum. The utilisation of lignite has been greatly extended. In the first place it is being used extensively as a fuel in the industrial establishments which have recently sprung up in the Central German lignite fields, especially in the neighbourhood of Bitterfeld and Halle a/S, where the German air-nitrate factories are situated. A process has been discovered by which nearly twice the usual amount of ozokerite can be obtained from lignite, and the gas is being more extensively used for heating and smelting purposes.

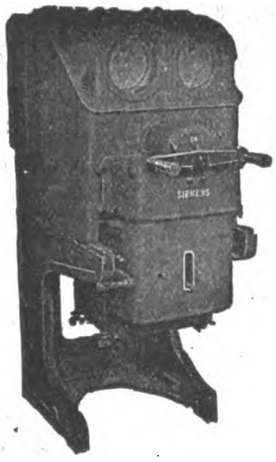
For obtaining nitrates from air a new process has been discovered, which works with quadruple air velocity through the reaction space, and produces a result about 80 per cent. higher than heretofore. Further progress has been made with the production of substitutes for copper, brass and bronze, especial mention being made of zinc and lead alloys, and the increasing importance of aluminium. There have been new developments in ore smelting. With copper schists the metallurgical possibility of going as low as 0·7 per cent. has been shown, whereas formerly the average lower limit was 2·5 per cent. Successful experiments have been made in obtaining aluminium from clay, which will, it is claimed, make Germany independent of foreign bauxite. With nickel ores the workable limit has been reduced from 2·5 to 1·5 per cent. A process has also been discovered for obtaining nickel and cobalt from pit waters containing these substances. In the German rubber industry the situation is said to have been eased by the progress made in rubber regeneration, and by the substitution of mechanical spring wheels for pneumatic tyres. The idea of exploiting German caoutchouc plants has been given up.

L.P.S. INSULATING MATERIALS.
INSULATING VARNISHED
Silk, Cloth, Linen, Paper and Tapes (Straight and Bias Cut).
COTTON and SILK TAPES and RIBBONS of every description.
LEATHEROID AND PRESSPAHN.
THE L.P.S. ELECTRICAL COMPANY,
14, Howick Place, Westminster, London, S.W.1.
Telephone: Victoria 7346. Telegrams: "Engineyor, Sowest, London."

SILVER SOLDER for BRASS,
Specially suitable for ELECTRICAL INSTRUMENTS.
Free Sample on application.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 100, WARDOUR STREET, W.
"Gosilplat, Ox., London." 4746 Gerrard.

Digitized by Google

SIEMENS



IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars

Distribution Boards

Main Switchboards

Write for particulars to —

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350 Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood Bldgs.
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

THEIR lasting qualities, and the fact that they retain to the end their initial brilliance, make them equally suitable for Street Lighting, Factory Lighting, Train Lighting, the Hotel or the Home.

For Street Lighting
POPE
ELASTA
(British Made)
WIRE LAMPS
Strong Brilliant Economical.

Advt. of Pope's Electric Lamp Co., Ltd., Hythe Road, Willesden, N.W. 10.

NEW ZEALAND IMPORTS.

The report of Mr. R. W. Dalton, H.M. Trade Commissioner in New Zealand, on the trade of New Zealand in 1916, contains the following information :—

The total imports were valued at £26,339,283 compared with £21,728,834 in the previous year, an increase of £4,610,449, or about 21 per cent.

Competitive and Non-Competitive Imports.—The statistics have been analysed in order to arrive at an idea of the amount of trade for which United Kingdom manufacturers can compete, and to eliminate those goods for which they cannot compete owing to natural causes. Goods have been included as competitive when, although the trade done in them by the United Kingdom does not compare in size with that done by other countries, the goods are such as could be manufactured in the United Kingdom, even although manufacturing conditions would have to be considerably altered to admit of such manufacture.

The following table shows in £'s the value of certain classes of goods imported into New Zealand in 1916 and 1915, distinguishing between (*a*) competitive and (*b*) non-competitive merchandise, the 1915 figures being given in parentheses :—Oils, fats and waxes, (*a*) 231,375 (143,086), (*b*) 857,281 (708,368); paints and varnishes (*a*) 230,700 (165,249), metals manufactured and partly manufactured, and ores (*a*) 339,375 (265,362), (*b*) 26,723 (26,075); metal manufactures, other than machinery (*a*) 2,589,784 (2,403,042); machinery (*a*) 1,186,899 (1,050,109); india-rubber and manufactures of, not including tyres (*a*) 47,551 (49,591); leather and manufactures thereof, including substitutes, (*a*) 329.757 (225,544), (*b*) 6,704 (19,545); timber, (*b*) 166,817 (305,685); optical, surgical and scientific instruments, (*a*) 276,192 (170,333); drugs, chemicals and druggists' wares, (*a*) 740,652 (520,022), (*b*) 151,245 (160,460).

Competitive imports showed an increase of about 30 per cent., and non-competitive imports declined by about 4 per cent. Increases in competitive imports were fairly general. The increase of motor cars and tyres accounted for £500,000.

The following were the value in £'s of imports from the United Kingdom, Australia, Canada, the United States and Japan, divided according to whether they were of (*a*) competitive or (*b*) non-competitive character :—

United Kingdom, (*a*) 12,985,568 (10,347,248), (*b*) 328,020 (276,178); Australia, (*a*) 1,184,333 (986,231), (*b*) 1,894,846 1,799,943); Canada, (*a*) 733,086 (592,310), (*b*) 28,019 (203,307); United States, (*a*) 3,456,852 (2,064,938), (*b*) 901,954 (797,599); Japan, (*a*) 554,170 (288,298), (*b*) 62,616 (60,373); other countries, (*a*) 1,569,578 (1,359,213, including Germany 48,469), (*b*) 2,640,241 (2,953,196), including Germany 39,815).

Metal Manufactures, Other than Machinery.—British manufacturers have lost ground in this class. A good deal of this loss is due to dealers having to purchase the products of other countries against their will, but there are a few lines in which the goods which have been supplied are capable of holding their own on their merits, even in normal times. It will, therefore, require a display of energy and adaptability if British manufacturers are not to lose, permanently, trade in this market which they formerly held.

In bolts and nuts, the imports from the United Kingdom decreased from 27,391 cwt. to 24,282 cwt., while the imports from the United States increased from 1,761 cwt. to 3,831 cwt. Imports of brass plate and sheet from the United Kingdom showed a large increase, while imports from the United States declined. In hardware, hollowware and ironmongery, not otherwise enumerated, there were considerable increases in the imports from Canada, Australia, Sweden, Japan, and the United States. The greater part of the growth in imports from the United States is probably due to increased trade in files, screws, &c. The United States has been supplying good selling lines in pliers, such as formerly came from Germany. Mr. Dalton considers that the United Kingdom trade in general hardware lines is not what it ought to be. The manufacturers are too much inclined to satisfy themselves with making a good article and leaving the article to sell itself. Imports of galvanised and corrugated sheets, for which the demand is very great, showed a large decrease. Imports from the United States increased from 8,072 cwt. to 10,579 cwt., but it would seem almost certain that when supplies are again available the trade will revert to the United Kingdom. Owing to the war, Canada has done a very large business in wrought iron tube 6 in. and under in internal diameter. In 1915 very large quantities of this tube were placed on the market at low prices. In tinsmith's furniture and fittings there has been a large increase in imports from Australia—the majority of these imports probably consisting of fittings for articles used in daity factories.

Machinery.—In those trades in this class in which the position of British firms is unsatisfactory, the reasons are chiefly that British manufacturers have not examined the development of the Dominion; that if they know of the development they have either not realised its importance or have not attempted to cater for it, but have persisted in offering unsuitable lines; and that their selling campaigns are not adequate. Firms may not find it profitable to manufacture certain lines exclusively for the New Zealand market, if those lines are different from their standard designs, but if this is so, it would be better for themselves and for the reputation of British trade to refrain from offering lines which are unsuitable, or from offering suitable goods in such a manner as would seem to indicate that it was immaterial to them whether they got the trade or not. American manufacturers supply machinery which is similar to that made for their own home conditions, and it is, therefore, not particularly enterprising of them thus to supply New Zealand's needs.

Digitized by Google

Our Manufactures include:

Cables for Lighting, Power, Telegraphy and Telephony.
H.C. Copper Wires and Strands.
Aluminium Wires and Sheets.
Phosphor Bronze Wires.
Brass Rod.
Brass Forgings.
Enamelled Wires.
Cotton Covered Wires.
Aerial Cables.
Joint Boxes and Pillars.
Jointing Compounds.
Primary Batteries.
Exploders.
Shot Firing Cables.
Window Lead.
Cable Racks.
Static Condensers.
Pole Line Steelwork.
Paper Pinions.
Fuses and Fuse Wire.
Electric Welders.
Telephone Cords.
Annealing Furnaces.
Tramway Insulation.
Overhead Equipment.
Electricity Meters.
Knife Switches.

WE WANT YOUR MONEY

That is why we try our level best to give you the highest and most enduring value in exchange.

Our aim is extraction without exaction.

We endeavour, by faithful service, to render the process so beneficial that you will come back for more—and then some.

Please examine the list of inducements on the left.

WE CAN GIVE SPECIALLY QUICK DELIVERIES of COTTON COVERED WIRES AT PRESENT.

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

QUARANTEED SECOND HAND

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Victimaster, Sowest London.

PEEBLES Bruce Peebles & Co., Ltd.
ELECTRICAL MACHINERY
Engineers, Edinburgh.
See our Illustrated Advt. next week.

Digitized by Google

"FORMITE"

The New PHENOL-FORMALIN Products, Manufactured in Up-to-date Plant under Scientific Control and freed from moisture by special process.

For Moulded & Built-up Insulation

It surpasses any Natural Products, being UNAFFECTED by Heat, Moisture, Chemical Fumes and Solvents.

Sole Selling Agents for the DAMARD LACQUER CO., Ltd.,
Messrs. PINCHIN JOHNSON & CO., Ltd.,
MINERVA HOUSE, BEVIS MARKS, LONDON, E.C.

LEWIS'S SCIENTIFIC CIRCULATING LIBRARY.

ELECTRICAL, MECHANICAL & GENERAL ENGINEERING TEXT BOOKS & TECHNICAL WORKS.

New Works and New Editions can be had from the Library immediately on publication. Telephone: MUSEUM 1072.

SUBSCRIPTION, Town or Country, from ONE GUINEA.
READING ROOM open Daily to SUBSCRIBERS.

H. K. LEWIS & Co. Ltd.,
136, GOWER STREET, and 24, GOWER PLACE,
LONDON, W.C.

FOR

High and Low Tension SWITCHGEAR

THE

NEW SWITCHGEAR CONSTRUCTION CO., Ltd.
SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE

TRADE MARK.

Brass & Copper Tubes and Sheets.

BRASS CONDENSER TUBES FOR STANDARD SHIPS, &c.

CHARLES CLIFFORD & SON, LTD.,
BIRMINGHAM.

ARORA ELECTRIC FIRES.

The accompanying illustration shows an Arora electric fire specially built for the Mayor's Parlour at Salford Town Hall. This is reported to be giving great satisfaction. It is built up on a special framework to match the existing fireplace, which is of antique brass surrounded

by tiles. The heating elements consist of 10 of the Arora Co.'s standard 750-watt bars ranged in two columns of 5 bars. Two separate circuits are taken to the fire so as to balance the two sides across the three-wire system. Each side is worked at a pressure of 220 volts and controlled by two switches external to the fire.

WOMEN IN THE ELECTRICAL INDUSTRY.

The "Bulletin" of the National Electric Light Association contains an interesting article on women's place in the electrical industry in the U.S.A.

It is pointed out that in preparing women to take men's places in industry the operation of electrically-driven machinery is obviously one of the first places where feminine effort will make itself felt. Already a number of large corporations have established training classes for women, so that when their men are called away the wheels of industry will not suffer the slightest interruption. At Bush Terminal, in New York Harbour, between 25,000 and 30,000 persons are employed. Owing to the modern character of the undertaking it is attractive to the best class of labour, and the proportion of men subject to conscription is unusually large. The electrical equipment of the Bush Terminal is probably the most complete of any large transportation and industrial enterprise in the world. All of the 250 or more industries located in the Bush Terminal Loft Buildings are operated by electricity, while there are many unusual applications of electricity in the handling of merchandise for transportation. Energy for operating the terminal and its allied industries is furnished by the local electric company through two substations, from which it is distributed throughout the property. The consumption amounts to about 15,000,000 kw.-hours per year. Not only does the terminal company do most of its switching by electric locomotives, but it has a fleet of 50 five-ton electric trucks for metropolitan deliveries, and a complete system of interplant transportation by electric tractors and tractor cranes. It is not expected that women will be used in switching for some time to come, but the demands of women students for lessons in switching cars were so strong that they were included in the training. The handling of trucks and tractors, however, will probably be done by women among the first work which they take over. This is due to the fact that chauffeurs are generally of the age which subjects them to the first draft, and, since local transportation must go on if the terminal is to do any business at all, substitutes must be found for the men who will go.

While the organisation of young women at Bush Terminal wa a

Digitized by Google

FERRY **FERROZOID**

CONSTANTAN **CHRONIC**

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:

HENRY WIGGIN & CO., Ltd.
George Street, Birmingham.

TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."

AGENT:

LIONEL ROBINSON,
3, Staple Inn, London, W.C.

TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

Important Announcement.

ELECTRICITY METERS:

THEIR

CONSTRUCTION AND MANAGEMENT.

A PRACTICAL MANUAL FOR CENTRAL STATION ENGINEERS, DISTRIBUTION ENGINEERS AND STUDENTS.

BY

C. H. W. GERHARDI, A.M.I.E.E.

CHIEF OF THE TESTING DEPARTMENT OF THE METROPOLITAN ELECTRIC SUPPLY COMPANY, LONDON.

New and Completely Revised Edition.

450 PAGES. 350 ILLUSTRATIONS.

Ready in October, price **15/-** *net.*

"THE ELECTRICIAN" OFFICES, 8, BOUVERIE STREET, E.C. 4.

Send for particulars
TO
EDWIN A. MANSFIELD
& CO.,
Electrical
Engineers,
NEW
BRIGHTON

Digitized by Google

Co-efficients of Friction.

Hard Oak on Oak .19 to .48. Metal to Metal .14 to .30
Leather on Metal .15 to .46. Hemp on Oak .35 to .53
FERODO FIBRE .4 to 8.
FERODO BONDED ASBESTOS .3

Ferodo Fabric and Ferodo Bonded Asbestos not only possess a higher co-efficient of friction than hard oak, leather, cast iron, hemp, or *any* other practical friction surface, but they are infinitely more durable. They save power by giving maximum acceleration and deceleration, and absorbing more pounds of energy per square inch than any other friction surface.

FERODO FRICTION SURFACES—give equally good results when brand new and when worn to the thickness of a sheet of paper.

—cannot spark—cannot char—cannot throw off metal dust—cannot seize.

—are always reliable. Each weaving is thoroughly tested by experts before leaving our works.

Write for Lists to—

The Herbert Frood Co. Ltd.

Works: Chapel-en-le-Frith.

Contractors to the War Office and Admiralty, London General Omnibus Company, and Underground Electric Railways of London and Paris.

Depots at London, Birmingham, Belfast, Bristol, Cardiff, Edinburgh, Glasgow, Liverpool, Manchester, and Newcastle.

FERODO

Friction Surfaces.

GENUINE
M & M VULCANISED FIBRE.
MOSSES & MITCHELL, 122 & 124, GOLDEN LANE, LONDON, E.C.

INSULATION BEADS

HOLDER-HARRIDEN, LTD.

purely voluntary one, established on the initiative of the girls themselves, the company naturally takes a lively interest in the training, and the advice of officials is freely sought and given. A unique feature of the equipment of Bush Terminal is the outfit of portable electric winches. These consist of a motor-driven drum, mounted on a heavy truck, which makes it possible to place the winch at any desired point on short notice. For example, each warehouse group is equipped with stationary winches of two or four drums, these stationary winches serving eight to 12 openings. In case it is necessary to work more openings than can be handled by the regular equipment, portable winches are called for, and perform the extra service. Outlets are provided throughout the property so that portable electric machinery can be connected instantaneously. The portable winches are also used to a great extent along the bulkheads in handling the cargoes of lighters.

The more stalwart among the Bush Terminal feminists have set themselves to learn the operation of these winches. It requires a firm foot, as well as a steady hand, to operate a winch, as foot power is depended upon to operate the brake release. In the warehouse department, women are practising on the huge electric freight elevators.

The most ubiquitous bits of equipment at Bush Terminal are the tractor cranes. These are equipped with storage batteries, and after hauling half a dozen trailers from one part of the plant to another the tractor unhooks from its train and proceeds to unload the trailers. Small storage battery trucks are also used in handling heavy commodities from bulkhead direct to warehouse, and in the cotton-disinfecting plant through which all imported cotton must go before it is passed by the United States Department of Agriculture.

ELECTRIC TRUCK RESULTS IN SAN FRANCISCO.

Among the numerous fields of work now employing automotive transportation, the electric vehicle is daily proving itself, from many points of view, to be the wisest choice for practically every urban use.

That the electric truck is achieving splendid results in the field of delivery work is plainly shown by the following table, which gives the operating and maintenance costs of three electric trucks (with nickel-iron batteries) in shipping and delivery work under the abnormally hilly conditions of San Francisco :—

One-ton electric delivery wagon, in service 46 months, ran 26,528 miles, or an average of 22·2 miles per day. Two-ton electric delivery wagon, in service 39 months, ran 18,910 miles, or an average of 18·7 miles. Three and-half-ton electric delivery wagon, in service 46 months, ran 17,140 miles, or an average of 14·3 miles.

The total expenses up to Jan. 1, 1916, were as follows :—

	46 months.	39 months.	46 months.
Original cost of trucks	$3,250·00	$4,040·00	$5,240·00
Wages	3,183·00	3,184·91	4,658·12
Garaging	990·00	1,072·50	1,610·00
Current	804·32	764·15	1,076·86
Repairs and Renewals	907·14	912·40	1,099·46
Tyres	492·91	451·86	552·16
Liability Insurance	191·91	162·24	191·91
Fire Insurance	103·80	131·43	207·60
Interest	274·58	288·22	244·59
Total Expenditure	$10,128·24	$11,007·71	$14,880·70
Total Earnings	11,318·33	11,088·47	18,511·92
Surplus	$1,190·09	$80·76	$3,631·22

The average total cost per month for the three wagons was $182.03, $219.06 and $261.98 respectively; and the average total cost per mile was $0.382, $0.582 and $0.868.

Trade after the War.

If you contemplate erecting a

NEW WORKS *or* FACTORY

in an ideal position with the advantage of

CHEAP POWER
GOOD WATER SUPPLY
HEALTHY SURROUNDINGS

SIDING ACCOMMODATION
EFFICIENT TRANSPORT FACILITIES

Write Great Central Railway Publicity Office, 216, Marylebone Road, London, N.W. 1, stating your requirements.

SAM FAY, *General Manager.*

Digitized by Google

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,054. [Vol. LXXIX. No. 26] FRIDAY, SEPTEMBER 28, 1917. PRICE SIXPENCE. By post, 7d. Abroad, 9d.

CONTENTS.

NOTES	995
The High-Tension Magneto with Special Reference to the Ignition of Aeroplane Engines. By A. P. Young. Illus.—*Continued*	998
British Westinghouse Turbo-Alternators. Illustrated	1001
On the Calculation of the Coupling Coefficient of Two Coaxial Flat Spiral Coils. By P. Baillie, L.Sc. Illustrated.—*Concluded*	1004
Experience With Induction-Generator Plant. By J. H. Siegfried	1005
Mines and Quarries Report	1006
The Limitation of Short-Circuit Currents in the Power Station at Golpa. By G. Klingenberg. Illustrated	1007
RESULTS ON THE NORFOLK & WESTERN RAILWAY	1008
REVIEWS	1008
Effect of Barometric Pressure on Temperature Rise of Self-Cooled Transformers. By V. M. Montsinger. Illustrated	1011
CORRESPONDENCE	1014
Industrial Reconstruction	1014
Australian Minimum Wages Award	1015
Patent Record	1016
Volunteer Notices	1016
COMMERCIAL AND INDUSTRIAL SECTION	1019
Electricity Supply	1020
Tenders Invited and Accepted	1022
Financial Matters	1023

NOTES.

Industrial Reconstruction.

IN some respects it is a good thing for this country that the war has not been brought to a speedy conclusion. There is no man that would not wish for the present devastation and misery to be brought to an end, but we very much doubt whether we, as a nation, would have realised our position in so true a light if the war had come to an end as rapidly as some of us anticipated. As a nation we are slow; we do not organise except under the pressure of necessity, and it frequently takes us a considerable time to realise what we are up against, with the result that we "muddle through" in a way that has often been painfully evident. The protracted nature of the war, however, is bringing us to our senses, and we are learning to make provision in advance without waiting for action to be forced upon us. This becomes evident from time to time. From the speech made at Huddersfield by Dr. ADDISON, the Minister of Reconstruction, we are glad to note that real progress is being made in the arrangements for demobilisation. Men in certain industries, such as the railways and shipbuilding, will be badly wanted when peace comes, and the question is being considered with a view to ascertaining the men for whom places are ready and the occupations in which men will be needed most urgently. Apart from the question of demobilisation, Dr. ADDISON sounded a note of warning in regard to the inevitable shortage of certain materials due to the destruction of tonnage, calling attention to the fact that ships had been taken off their ordinary trade routes, and that a considerable interval must elapse before these routes could be re-established. For this reason it becomes essential that the various trades should proceed to work together in order to solve their own difficulties, and that the Government should work with the trades in order to ensure that the best course is followed in each case.

A New Outlook.

DR. ADDISON pointed out that the war has shown us very clearly not only that the elements of labour, management, technical experience, research, science and marketing could not be worked successfully in watertight compartments, but also that this country has never made sufficient use of the brains that have been available, and that the salaries paid to many highly trained scientific men were a disgrace to the community. There is no doubt that the Ministry of Munitions, whatever its defects, has taught us how to carry on work on a large scale, and has shown many works they were working in an inefficient and antiquated way. If we are to succeed in the future, we must learn to work on larger lines. Methods and plant must be overhauled, and in all probability a great deal of plant will have to be scrapped. As Dr. ADDISON points out, we require the same enthusiasm in industrial production that has been shown recently in the cultivation of waste ground for the production of food. There must be a general improvement in our methods and means of production. With peace there will come an opportunity as great as any in our history, but if we neglect it we shall be handicapped, not merely for a generation, as Dr. ADDISON suggests, but probably for many generations.

Minimum Wages.

THE fixing of a minimum wage is one of those difficult problems which is rendered all the more difficult in that it defies the law of supply and demand. Some distinction should be drawn between a living wage and the minimum wage that is desirable. A minimum desirable wage is obviously higher than a living wage, and should depend to some extent upon personal effort. It should enable those who receive it to live in reasonable comfort. But if the minimum desirable wage is to be so high as to suit all needs there will be created a tendency to reduce all workers to the same level, and to eliminate the less fit from any occupation. On the other hand, if the living wage is really what it implies, then it permits the employment of the less fit, and it provides an incentive to obtain a higher wage. The tacit assumption is frequently made that the cost of living is independent of wages. Unfortunately, this is not the case. The difficulties connected with the subject have recently been pointed out in Australia by Mr. Justice POWERS in giving an award in regard to the living wage. In Australia, during the past year, there has been a consistent fall in the cost of living owing to the fact that the Commonwealth, which is a self-contained country, has been faced with a diminution of shipping available for the purposes of export. On the other hand, for a similar reason, the cost of clothing has increased as much as the cost of food has decreased. It is, therefore, not easy to reach a sound conclusion as to the cost of living, and there is always the complication that a minimum wage over a certain district may be satisfactory in some parts and too low in other parts, depending upon the conditions. In his statement the Judge points out that, although the request for an increase in wages is easily made, this, if granted, would mean an enormous extra charge on all industries. It is the ultimate effect of this

Digitized by Google

extra charge, which should be considered along with the present position of those in receipt of the current wage before it can be definitely decided whether the granting of an increase is a real advantage to those by whom the demand is made, and does not entail a serious sacrifice on the part of other sections of the community.

Women's Work in Munitions.—Last Wednesday an exhibition arranged by the Ministry of Munitions was opened at Sheffield by the Lord Mayor. Numerous exhibits are on view illustrating the work of women in the production of Munitions. The exhibition will close on Oct. 9.

Training of Disabled Soldiers and Sailors.—The 12th course at the Northampton Polytechnic Institute for giving a preliminary training to disabled sailors and soldiers as substation attendants has just been completed and a number of the men are awaiting vacancies. Engineers of supply undertakings having vacancies are invited to communicate immediately with Dr. R. M. Walmsley, Principal of the Northampton Polytechnic Institute, Clerkenwell, London, E.C. 1.

Association of Municipal Electrical Engineers of South Africa.—We have received a copy of the programme of the second annual convention of the Association of Municipal Electrical Engineers of South Africa, which was held at Durban from Aug. 27 to Sept. 1, 1917. The programme included a presidential address by Prof. J. H. Dobson, a discussion on "Tariffs" opened by Mr. John Roberts, a Paper on "Standardisation," by Mr. John Roberts, and a Paper on the "Design and Management of Small Power Installations," by Mr. J. Hamlin. The Paper on "Standardisation" is in connection with the movement which is supported by the South African Institute of Electrical Engineers, the South African Institute of Engineers, the Association of Municipal Electrical Engineers (S.A.), the Engineering Section Natal Society for the Advancement of Science and Art, the British Electrical and Allied Manufacturers' Association, the Institution of Electrical Engineers (England), and the Government Departments of the Union of South Africa.

Municipal Tramways Association.—At the sixteenth annual conference, which was held at Blackpool last week, the president (Mr. Hy. Mozley) delivered his presidential address, which, together with the other Papers read at the gathering, were abstracted in our last issue.

Among those who took part in the discussion upon the Paper, "Notes on Tramway Finance," were Ald. C. F. Spencer, Messrs. Arthur Ellis, R. J. Bishop and W. G. T. Goodman (Adelaide), and Ald. Fletcher, Bailie Montgomery and Councillor Irving.

Mr. Arthur Ellis, of Cardiff, in his Paper, said in view of the developments of food cultivation, tramways would play an important part in the conveyance of produce from allotments in the rural areas to the local market or the railway station and the canal loading stations. That would suit the farmer and be of the greatest possible service to him, and so they would find that by means of the tramways they would have solved one of the serious problems facing the farmers and produce merchants. He referred to the great possibilities in the carrying of goods traffic by cars and trailer goods wagons. By the traffic railways being relieved of short-distance traffic they would be able to devote more attention to the conveyance of stores, coal, iron, &c., thus making up in some way for the shortage of engines, rolling stock, &c., due to the war. Short spur lines and connections could run into railway yards, and goods brought down by railway could be transferred to light tramway cars and trailer goods wagons for delivery to short distances in the urban and rural districts served by the new tramways.

The Utilisation of Pyrites in Coal.—In the "University of Illinois Bulletin," Mr. E. A. Holbrook remarks that the mineral pyrites, which forms a constituent of nearly all Illinois coals, may prove now to have an industrial value. The pyrites occurs as brassy yellow streaks, nodules or plates, sometimes as much as 10-12 in. in thickness. In the ordinary course the pyrites, which contains a considerable amount of sulphur, is rejected as a deleterious impurity. Its heating value is small and the sulphur dioxide to which it gives rise when burned has a decided corrosive influence, attacking boiler flues and stacks. It must therefore be removed as far as possible from the coal. It seems possible, however, that in the altered circumstances brought about by the war the rejected pyrites may have a distinct commercial value. In normal times pyrites, which contains nearly 50 per cent. of sulphur, has been imported from Spain in considerable quantities for the manufacture of sulphuric acid. Since the war the supply of Spanish pyrites to the States has been largely cut off, and at the same time the demand for sulphuric acid for the making of explosives has increased. There is, therefore, reason to seek a use for the indigenous pyrites of Illinois. In the Bulletin above mentioned the conditions of occurrence of this substance are fully discussed, and detailed particulars are given of plant for its extraction and treatment to obtain the sulphur.

Phosphorescent Zinc Sulphide.—Much interest has recently been taken in the conditions affecting the brightness of zinc sulphide and other phosphorescent materials, and it has been remarked that the chemical side of the subject requires fuller investigation. It is, therefore, of interest to observe, in the "Transactions" of the Chemical Society, an account of some researches by Miss E. MacDougall and Messrs. A. W. Stewart and R. Wright, on the preparation of phosphorescent zinc sulphide, in which the effect of various impurities is discussed. It is remarked that the sulphide is only phosphorescent when prepared by the action of heat, the best temperature being between 650–900°C; the product is then semi-crystalline. The temperature appears to determine the colour of the phosphorescence; if treated at 650°C, the material phosphoresces blue, at higher temperatures green or yellow. Certain impurities, such as iron, are prejudicial to the phosphorescence; while others, such as common salt, improve it. The latter action appears to be associated with the formation of a thin film of zinc chloride over the surface of the material. The addition of manganese produces gives a golden yellow phosphorescence, and manganiferous zinc sulphide exhibits marked tribo-luminescence.

The Flow-Meter in the Boiler Room.—In the "General Electric Review" Mr. J. H. Hough lays stress on the value of flow-meters in the boiler-house, which is probably the most inefficient portion of a generating station. As a general rule, batteries of boilers are operated in parallel without any effective means being provided for indicating how they are dividing the load. The installation of a draught-gauge and a steam flow meter for each unit would enable the performance of each boiler to be judged. The author points out the great contrast between the full equipment for control on the switchboard in the electrical section, and the crude devices generally prevailing in the boiler-room. The fireman struggling to hold the load has no guides to assist him but a pressure-gauge and a water-column. The man who analyses coal bills has usually no conception of the load efficiency curve of the boiler, perhaps is not aware that at one particular rating the best thermal efficiency is obtained, and that the efficiency falls rapidly on either side of this point. Yet the cost of coal represents more than 70 per cent. of the total cost of producing electrical energy. Where steam flow-meters have been installed boilers have been much more efficiently utilised and overloads prevented. Instruments are now available giving a graphic record of steam flow over a given period, and such apparatus is being applied largely to the measurement of steam used for manufacturing purposes, for example in oil, sugar and copper refineries.

Glass Research by the Institute of Chemistry.—The "Proceedings" of the Institute of Chemistry for August contain an account of some of the researches being conducted on optical glass, to which reference was made by the Minister of Munitions in the House of Commons on June 28. As is well known, the work of Prof. Jackson and his colleagues has been of great value for war purposes, seeing that only about 10 per cent. of the optical glass required by the country could be produced by British sources at the outbreak of war. A whole group of industries connected with the glass trade, it is stated, have now been placed on a secure foundation. Another interesting statement relates to the supply of potash. Through

Digitized by Google

the ingenuity of Mr. Kenneth Chance a process has been discovered whereby great quantities of potash may be obtained, and we should now be able to provide every ounce of potash that the glass trade requires, as well as very largely to meet the needs of agriculture. A list of six additional glasses has recently been worked out, including a variety designed to hold tungsten wire sealed into it, for use in electric glow lamps. The Glass Research Committee have considered an invitation from the Department of Scientific and Industrial Research to undertake (1) the preparation of a reference list of vitreous compounds, their compositions, densities, refractive indices and dispersive powers, and (2) an investigation of cements for prisms and lenses. The Institution of Electrical Engineers has been in communication with the Institute with regard to acid tests applied to porcelain, and the views of members of the Glass Research Committee have been communicated to the Porcelain Panel of the Research Committee of the Institution.

Works Lighting.—A series of articles on the above subject by Mr. D. H. Ogley has been appearing in the "Automobile Engineer," in which the principles of industrial lighting are fully considered, frequent reference being made to matters which have been discussed at various meetings of the Illuminating Engineering Society. Among other matters, special reference is made to the maintenance and cleaning of lamps and reflectors. The progressive deterioration in illumination that may occur in lighting units that are left untended for 40 weeks is graphically represented, and amounts to 15 to 35 per cent., according to type. The curves presented bear out the impression that enamelled iron reflectors have the advantage in this respect. Although it is impossible to control the distribution of light from such units to the same degree as in the case of polished or aluminium-coated metal reflectors, they appear to be very suitable for use in factories where much dust collects. By shaping the contours of such reflectors correctly, satisfactory results as regards diffusion of light and elimination of glare may be attained. They are also not liable to breakage, and presumably their reflecting power can always be restored by re-enamelling. It is shown that the money value of the light lost through dust deposits in general far exceeds the actual cost of the cleaning and maintenance necessary to avoid deterioration in illumination.

Industry and Education.—We have received particulars of a scheme for the better co-ordination of engineering training, it being proposed to form a central organisation of engineers and educationists for this purpose. The object in view is outlined in the following announcement :—

A meeting will be held in the theatre of the Institution of Civil Engineers, by kind permission of the Council, on Oct. 25, at 3.30 p.m., for the purpose of considering the establishment of a central organisation for improvement in and better co-ordination of engineering training and the appointment of a representative committee of engineering and educational interests to initiate action. Sir Maurice Fitzmaurice, C.M.G., President of the Institution of Civil Engineers, will preside, and representative engineers and educationists from all branches of these professions have signified their intention to be present. Those interested are requested to obtain invitations from Mr. A. P. M. Fleming, British Westinghouse Co., Trafford Park, Manchester, or Mr. A. E. Berriman, Chief Engineer, Daimler Co., Coventry, who are acting as honorary organisers for the committee responsible for arranging this meeting.

Although engineering training has made great strides in the last 20 years, largely owing to the growth of provincial universities and technical schools, and to the good influence of some of the more important engineering institutions, it is a fact that the link between the industry and education is not forged as closely as it should be in the interests of the State, and a strong nucleus of opinion has grown in favour of forming a central organisation with co-ordination activities as the best means to secure the improvement that is desired.

Engineering is one of England's most important staple industries, and it is of the greatest national consequence that all who are engaged therein from bottom to top should be representative of their highest respective types, and this can only be secured when the proper purpose and value of education is not only recognised but achieved in the widest sense of the term.

In their respective spheres, the engineering institutions, the universities and the technical schools have exerted a most valuable influence, and the time is now ripe for providing some central organisation through which their activities may be co-ordinated in such a manner as to give them a much wider effect. In fine, it should now be possible to forge a permanent link between the professions and industry of engineering, the universities and schools, and parents and boys who have chosen this fine career for their life's work.

Iron and Steel Institute.—The autumn meeting of the Institute was held at Westminster last week, the president (Sir Wm. Beardmore) being in the chair.

It was announced that M. C. P. E. Schneider, of the Creusot works, had been nominated by the Council as the new President of the Institute, and M. Schneider had accepted the nomination.

At a special session the reports were considered of the special committees appointed to investigate the cause of the much smaller output of steel obtained from British furnaces as compared with foreign practice.

Mr. E. H. Sainter presented the preliminary report of the Metallurgical Section of the committee, which stated that there was general agreement that in foreign practice the proportion of scrap used up to 80 per cent. helped output very materially in cold-charged basic open-hearth practice, if used in conjunction with suitable pig iron. When furnaces of the same size were compared, our output was greatly inferior as compared with that abroad. At the same time, in comparing two so-called 50-ton furnaces, it would generally be found that the foreign furnace was the larger. There was a general opinion that the gas producers were a source of loss of output in this country, and that more care was devoted to them abroad. There was also general agreement that our labour conditions were detrimental to output, but it was not suggested that this was due to inferiority of the men individually. In this country there was a shorter working week; there was an objection by the men as a body to promotion by merit; there was a lack of close attention and obedience which should be given by such highly paid men. The committee added that to increase output it was necessary to reduce the effort required from the workman by every possible means, and this could only be done by a well-laid-out and well-organised plant.

Mr. A. J. Capron, who presented the report of the mechanical section of the committee, stated that if the British steel trade was to hold its own in open competition with the other steel producing countries of the world, it would be necessary, amongst other changes, to have a Central Board, to which all orders would go, and whence the work would be allocated to the different works according to their ability to do it. This would save the enormous amount of capital at present locked up in stocks of rolls.

OBITUARY.

DEATHS ON ACTIVE SERVICE.—The following members of the staff of the County of London Electric Supply Co. have recently been killed in action :—

Privates F. H. Bent (3rd S. Wales Borderers), A. Goldsworth (23rd County of London Regt.), L. W. King (4 2 County of London Royal Fusiliers) and G. White (R.A.M.C.), Lance-Corporal E. A. Price (1st Batt. Essex Regt.), Driver James E. W. Purcey (R.F.A.) and Gunner W. Whapshott (R.G.A.).

The following deaths are also reported :—

Capt. A. T. Rickards (R.G.A., attached R.F.C.), aged 24, who was killed on Sept. 13, was educated at the Marlborough College and the Central Technical College, South Kensington, and finished his engineering training at the McGill University, Montreal.

Sec.-Lieut. Wm. S. H. Palmer (R.F.C.), who was killed in an aeroplane accident last week, was educated at the Finsbury Technical College, where he obtained his certificate as an electrical engineer. He was in his 21st year.

PERSONAL.

Mr. G. M. Clark has been elected president of the South African Institution of Engineers for 1917-18.

WAR HONOURS.—The Military Cross has been awarded to Lieut. N. F. Hawes (Machine Gun Corps) for bravery in action on the French front on June 21 last. Lieut. Hawes was employed in the mains department of the County of London Electric Supply Co. before the war.

The following honours have also been conferred :—

Corpl. E. T. Moore, a Cardiff tramcar conductor, has been awarded the Military Medal. The Cardiff Tramwaymen's Association recently presented to Corpl. Moore a gold watch and chain, and to his wife a gold locket and chain.

Pte. Tom Whitham, Coldstream Guards, who was formerly employed in the Burnley tramways department, has been awarded the Victoria Cross.

WAR CASUALTY.—Sec.-Lieut. P. A. Fennell (Royal Warwickshire Regt., attached Heavy Trench Mortar Battery) has been wounded in action.

He was educated at King Edward's School and articled to Messrs. Belliss & Morcom, and when his articles expired he joined the firm's agents at Bulawayo. On the outbreak of war he enlisted in the 1st Rhodesian Regiment. Subsequently he returned to England and was given a commission in the Royal Warwickshire Regiment. He had been at the front 12 months.

Digitized by Google

THE HIGH-TENSION MAGNETO WITH SPECIAL REFERENCE TO THE IGNITION OF AEROPLANE ENGINES.*

BY A. P. YOUNG.

(*Continued from p.* 966.)

Summary.—The author explains the principles underlying high tension magnetos for aeroplane work and discusses various points in the design, as affecting the efficiency of performance and the nature of the spark. Curves are presented showing the variations in the flux and the importance of remanence and coercive force in the magnets are emphasised. The relation of the flux to the energy of the spark is considered, and some details are presented to illustrate the need for careful mechanical design and accurate workmanship. Finally the author gives some instructions as to the care of magnetos and their upkeep in practice.

PART III.

THE INSTALLATION AND CARE OF A MAGNETO.

1. *Installation.*—Satisfactory operation of a magneto can only result if the alignment between the driving shaft and the magneto shaft be perfect. It is necessary to drive the magneto through some form of flexible coupling. The drive often is transmitted through a steel leaf spring. This design of coupling is not ideal, because whilst being sufficiently flexible in a plane at right angles to the axis of rotation, to take care of rapid and cyclic variations in the driving torque, it does not allow for the alignment of the two shafts being slightly in error. Obviously, any error of this nature will bring into play large stresses which may eventually cause the magneto to function imperfectly. I believe that a large percentage of the troubles that have arisen in practice with aeroplane magnetos have been due to imperfect alignment.

The magneto manufacturer is very careful in machining the base to ensure that the distance between the bottom of the base and the axis of the spindle conforms with extremely fine limits of accuracy. For example, this distance in the type A.8.S. magneto is nominally 50 mm., the limits being plus 0 mm. and minus 0·05 mm., giving a tolerance of 0.05 mm. It is very difficult for engine builders to work to such fine limits as these in milling the platform to which the magneto is secured. Some method of fixing that will simplify the machinery problem is, therefore, desirable. The use of a curved base plate on the magneto is a possible solution, because this enables the engine builder to machine the surfaces requiring alignment at a single boring operation, instead of having to perform two distinct boring and milling operations. The curved form of base is used by the S.E.V. Co., of Paris.

Even when fixing screws are used in the base, it is customary to employ a strap which completely embraces the magnets. These straps are usually made of steel, and tests carried out on a type A.8.S. magneto have shown that the shunting of the magnet flux resulting therefrom amounts to about 6 per cent. This means approximately a 12 per cent. loss in the energy output of the magneto—an amount not to be overlooked. It is therefore recommended that the straps be made of phosphor bronze.

2. *Timing.*—It is essential that when installing a magneto the adjustment of the coupling should be carefully made to give the correct "timing." When the contacts are just on the point of separating—as determined by the indication of a battery and bell connected in parallel with them—the relation of the driving shaft to the magneto shaft must be such that the piston in the cylinder to be fired is some definite distance from the top of its stroke. When the magneto is provided with variable ignition, this adjustment is made with the timing lever fully advanced. Usually, an aeroplane magneto is timed so that each cylinder is fired when the crank shaft is about 30 deg. behind the dead-centre position.

3. *Setting of Distributor Brush.*—When the contacts are on the point of separating and the high-tension discharge is about to begin, the carbon brush (or metal brush in the type A.8.S. magneto) should overlap the distributor segment to the extent of about two-thirds of its contact surface. In the rotating armature type magneto the desired relation between brush and segment can be easily achieved by altering the meshing of the distributor brush gear wheel with the full-speed wheel on the armature shaft. Generally speaking, the correct meshing is indicated by the magneto manufacturer, who spot-marks two teeth on the brush gear wheel and one tooth on the other wheel. When the armature is in some definite position the latter tooth should mesh between the two former teeth.

In the type A.8.S. magneto the relation of brush to segment can only be altered by displacing the brush holder moulding with respect to the gear wheel to which it is secured. A change in the meshing of the two gear wheels is not permissible.

4. *Care of Distributor and Brush.*—The distributor and brush are vital parts of any magneto, and in overhauling they should be subjected to very careful treatment. The brush track of the distributor should be kept clean and polished. Any appreciable carbon deposit can be removed by cleaning the track with a cloth soaked in petrol, but if the segments protrude even by the smallest amount, it is necessary to have the track machined. If the dustributor is made of an entirely satisfactory insulating material, trouble of this nature will not be experienced, because there will be no tendency for the insulation to shrink away from the metal during the life of the distributor.

For the best results to be secured, it is necessary to use a very hard grade of carbon brush, which should be properly bedded and polished. The spring tension should not be excessive, and both brush and spring should be perfectly free to move in a radial direction. There should be no signs of binding in the brush holder. I am informed that in certain quarters a carbon brush having a highly-polished contact face is looked upon with suspicion, and in consequence it is the practice to remove the polished surface by the careful application of a file! This is a most pernicious habit, and cannot be condemned too strongly. Experience has shown that to secure freedom from what is called "tracking" of the distributor it is very necessary to use a carbon brush that will readily take a high polish.

5. *Contact Breaker.*—The satisfactory operation of any magneto is to a large extent dependent upon the platinum contact-breaker points being correctly adjusted. In the type A.8.S. magneto the maximum gap between the contact points, which are made slightly convex, should be 0·012 in. In rotating armature type magnetos the gap usually worked to is 0·015 in., and, generally speaking, a magneto has to operate at very high speeds—that is, one which has to give a large number of sparks per minute, as in the case of a 12-cylinder magneto—should work with a smaller gap than one that has not to perform such strenuous duties. Great care should be exercised to prevent oil getting on to the contacts, because this will set up sparking, in consequence of the large resistance interposed between the contact faces and carbonisation of the oil will result, which will greatly interfere with the satisfactory running of the machine. The contacts should be kept perfectly clean by using a fine emery cloth. A file should not be employed under any circumstances whatever.

6. *Lubrication.*—As it is standard practice to use ball bearings in every type of high-tension magneto, very little lubrication is necessary, and special attention should be given to this point by all those who are entrusted with the care of magnetos fitted to aeroplanes or used for other purposes. Over-lubrication is, in fact, more likely to produce injurious results than too little lubrication, because the oil wells are likely to become flooded, and oil will possibly find its way into the distributor and contact breaker housing. Taking the type A.8.S. magneto, for example, six drops of oil in each well every 12 hours of running will be quite sufficient.

THE PROBLEM OF ENGINE STARTING.

The starting characteristics of the petrol motor are inherently bad. With other prime movers, such as the steam engine or turbine, motion results as soon as steam is allowed to enter the machine, whilst the ordinary electric motor can be started by the simple closing of a switch.

There are fundamentally only three methods of starting a petrol motor, neither of which is ideal:—

(*a*) To rotate the crank shaft slowly by applying a driving torque until the cylinders are filled with an explosive mixture, and the magneto is running at a sufficiently high speed to ensure satisfactory ignition. The driving torque may be produced either by hand rotation or by driving the crank shaft through gearing with an electric motor fed from a battery.

(*b*) To introduce compressed air into the cylinders so that the necessary driving torque is transmitted to the crank shaft through the medium of the pistons and cylinders. Starting is then effected as under (*a*).

(*c*) To fill one particular cylinder with an explosive mixture by hand rotation, or in some other way, and, whilst the crank shaft is

* Abstract of a Paper read before the Aeronautical Society.

Digitized by Google

stationary, cause an igniting spark to occur in this cylinder, using for this specific purpose a hand operated auxiliary magneto co-operating with the main magneto. The main magneto may itself be adapted for producing this spark, while stationary, if suitable auxiliary apparatus be provided.

Method (*a*), using an electric motor, is widely adopted in America and in this country at the present time for motor-cars, and the method is far from perfect, chiefly for the reason that the torque required to start the engine is enormous for the size of motor that is generally installed. At the instant when the switch is closed, the momentary rush of current reaches a very high value—about 200 amperes for a 12-volt battery—when considered in relation to the capacity of the battery that has to supply it. Such treatment means that the battery very rapidly deteriorates.

This method has, it is stated, been tried on aeroplanes, but does not seem to be particularly suited to the requirements of the case; unless by very special attention to the design of the electric motor it is possible to reduce the weight to an extremely small figure.

Method (*b*) has also been tried on aeroplanes, but here again the increased weight of the compressed air bottles is a drawback.

Method (*c*) appears to have met with the greatest success, and is generally used at the present time on aeroplanes; it is necessary to slightly modify the distributor brush holder, by adding what is termed a "trailing point." This is merely a nickel point which is moulded in the insulator so that the angle between it and the axis of the distributor brush is something of the order of 30 deg. This point is connected to a brass ring on the front of the brush holder moulding, and an extra terminal on the distributor is connected to an additional carbon brush which is in contact with the ring.

The hand-starting magneto—which is a small rotating armature type machine driven through gearing by hand—is connected to the extra distributor terminal, so that when it is operated the trailing point is maintained at a high potential. This means that when the trailing point comes in close proximity to the trailing edge of the distributor segment current will flow from the point to the segment through the air, and thence to the electrodes of the spark plug in the cylinder that is filled with an explosive mixture.

Owing to the angular displacement between the trailing point and the main brush, the piston in the cylinder under consideration will always be near the dead-centre position when the conditions as previously described obtain. The piston should, therefore, receive a forward impulse when the spark occurs, and this should be followed by other impulses in proper sequence, until a speed is reached at which the ordinary magneto is capable of performing its proper functions.

The hand-starting magnetos that have been developed in this country differ from the standard Bosch machine in that no high-tension switch is provided for the purpose of breaking the connections to the main magneto so long as the starting magneto is being operated. It is true that the introduction of such a device complicates the wiring, because it means that the high-tension lead from the armature of the main magneto has to be brought to a distributor terminal on the starting magneto, and another lead run between some other terminal on this distributor to the rotating brush on the main magneto.

Against all this we have to consider that the use of a high-tension switch absolutely prevents the main magneto coming into action until the starting magneto is stopped. Without the high-tension switch the main magneto will come into action at extremely low speeds, so that to prevent backfires it is necessary to retard the ignition during the starting period. The other scheme eliminates this necessity, because with fixed ignition on the main magneto it should be possible to take the engine up to a sufficiently high speed with the hand starter to ensure that when the main magneto comes into operation the timing of the spark will not be too far advanced.

It is perhaps not out of place to refer to the method of starting adopted on the 200 H.P. Maybach engine fitted to German airships brought down in this country, as described in the "Autocar" for December 16, 1916. This type of engine has six cylinders, two-point ignition being provided. Two Bosch Z.H.6 magnetos—a new type of rotating armature magneto evidently developed since the outbreak of war—one of which is fitted with a trailing point, are provided. The hand starter is coupled up to the magneto with trailing point in the ordinary way.

A special method is adopted for filling the cylinder with an explosive mixture. By means of a lever and cam shaft all the valve tappets, inlet and exhaust, are lifted off their cams. At the same time the lever actuates other levers which close the exhaust passage to the silencer, by partially rotating the water-cooled barrel valve in the exhaust manifold. The exhaust ports and the outlet in the exhaust manifold are thus put in communication with a secondary outlet pipe that leads to a large suction hand pump, by means of which gas is sucked into the cylinders from the two carburetters through all the inlet valves. When this has been done the lever arm previously referred to is returned to its normal position. This operation opens the exhaust outlet to the silencer in the normal running position and closes the pipe leading to the suction pump. The hand starter is finally turned and the engine begins to rotate.

It is interesting to note that the angle between the trailing point and the centre of the distributor brush on the Bosch Z.H.6 magneto is 42 deg. On the type A.8.S. magneto fitted with trailing point this angle is, as already stated, 30 deg.

Special Problems in Connection with the Design of Aeroplane Magnetos.

1. *Reliability.*—Reliability is a desirable feature of every piece of apparatus, no matter for what purpose it be used. In the case of an aeroplane magneto, this is a consideration of primary importance, because failure of the magneto may mean sudden destruction of the machine and pilot.

Fundamentally, a reliable piece of apparatus will result if:—

1. The design is reliable.
2. The materials are correctly chosen.
3. The workmanship is perfectly sound.

These three points can be checked by *testing* the apparatus most carefully with the object of bringing to light any incipient defect.

An aeroplane type of magneto should, therefore, be most carefully and rigorously tested before it leaves the manufacturer. During this test the strain put upon the machine, both mechanical and electrical, should be greatly in excess of the maximum strain likely to obtain under abnormal working conditions. If the machine passes this test, both the manufacturer and user will know that the factor of safety is sufficient to ensure that no breakdown will occur during the subsequent life of the machine.

An elaborate system is in force for testing both "A" magnetos, and samples from each batch of material received.

In the case of the armature, which forms such a vital part of the whole construction—being virtually the "heart" of the magneto—extraordinary precautions are taken. First, by carefully inspecting all the insulating material and each reel of enamelled wire, and, secondly, by subjecting the finished armature to a prolonged electrical test with the secondary discharging at 9,500 volts between electrodes. In addition to this, the armature is inspected several times at various stages of the winding and finishing process.

Finally, every magneto is subjected to running tests as follows:—

1. Run for 20 hours at 2,500 revs. per min. at air temperature, with each distributor terminal connected to a spark gap adjusted to discharge at 7,500 volts.

2. Completely dismantled and various metal parts cleaned in petrol. Magneto then reassembled and adjustments made where necessary.

3. After re-magnetising, magneto run for four hours at 2,500 revs. per min., with spark gaps as under (1), in a hot box with air at 100°F.

4. At the end of this final run the magneto is tested at low speeds to ensure that the sparking characteristics are satisfactory.

5. Before shipment, the magneto is inspected in every detail, all adjustments carefully checked, and screws tightened and locked where necessary.

2. *Reduction of Weight.*—It is obviously desirable to keep the total weight of an aeroplane type magneto as low as possible. To do this it is first necessary to develop a design that requires a minimum volume of material, and, secondly, to use, if possible, aluminium castings. Special steels should also be used wherever possible, so that the required strength can be achieved with a minimum weight of material.

Die castings made of an aluminium-copper alloy containing no zinc are to be preferred to sand castings, because the general appearance of the magneto is enhanced thereby, and the amount of machining that has to be performed on the parts is very considerably reduced. Furthermore, the metal is much tougher, and the threads in tapped holes are not so likely to become stripped when the screws are securely tightened.

At the present moment the few manufacturers in the country capable of producing satisfactory die castings for this class of work are so inundated with urgent Government orders that it is doubtful whether they are in a position to meet the whole of the requirements of the magneto industry. I refer to the matter, however, in the hope that the many firms now producing satisfactory aluminium sand castings, but not die castings, may have their interest stimulated in this direction.

Most excellent die castings are at the present time used by all the leading magneto manufacturers in France.

3. *Elimination of Fire Risk.*—This is of vital importance, because any sparking within the magneto may, under operating conditions, be the means of initiating a fire by igniting a mixture of air and petrol

Digitized by Google

in the surrounding medium. I am at liberty to refer to certain tests * that were carried out by the N.P.L. in the early days of the war to determine the extent of this danger. A number of different types of pre-war Bosch magnetos were taken, including the types Z.U.4, Z.F.4, D.U.6, and D.A.L., and run in a chamber that could be filled with an explosive mixture of air and petrol. Generally speaking, it was found that explosions were likely to occur as a result of :—

1. A succession of sparks at the safety gap.

2. Sparks between distributor segments or other high-tension parts, and the frame of the magneto.

3. Sparks at the contact-breaker points.

Trouble is most likely to arise from cause (1), although this was eliminated by enclosing the safety spark gap in a fine mesh gauze casing on the principle of the Davy safety lamp, so as to prevent any explosion in the immediate vicinity of the safety gap electrodes being propagated in the surrounding medium.

Trouble due to causes (2) and (3) can be eliminated by careful attention to the design of the magneto to prevent any wasteful sparking of this nature. In the type "A" magneto this is done, whilst the safety spark gap is contained in a separate gas-tight chamber fixed underneath the distributor and provided with a ventilation hole covered with a piece of very fine mesh gauze. It is necessary to ventilate the chamber so that the products of ionisation have free access to the surrounding air. The gauze opening ensures that any explosion occurring inside the chamber as a result of a discharge at the safety gap is not communicated to the outside medium.

As a "spark-gap" type of distributor is used, it is necessary to provide some form of ventilation so that the products of ionisation can escape. Here again the ventilation hole in the front of the distributor is covered with a piece of fine mesh gauze, and the whole combination is thus perfectly safe. I would add that very severe tests carried out on this particular machine, by introducing an explosive mixture of coal gas and air into the contact-breaker housing, safety spark gap chamber and distributor, have quite confirmed this view that the risk of fire under operating conditions has been entirely eliminated.

In the 12-cylinder polar inductor magneto previously described, the safety spark-gap rotates with the distributor brush. This is, in my opinion, a distinct improvement upon the stationary form of spark-gap generally adopted, because the products of ionisation are churned up and quickly expelled through the ventilation window provided in the front of the distributor. This window is covered with gauze, as in the type "A" machine, which makes the magneto fireproof.

4. *The Problem of Variable Timing.*—Opinions differ as to whether it is absolutely essential that an aeroplane magneto should be provided with means for adjusting the timing. Several thousand type "A" eight-cylinder aeroplane magnetos with fixed ignition have been supplied, so presumably on certain types of engines variable ignition is not required.

When starting a petrol engine it is generally necessary to retard the ignition so as to prevent the explosive wave in the cylinder being sufficiently propagated before the piston reaches the top of its stroke to produce a backfire.

In the case of an aeroplane engine, the necessity for making such an adjustment should not arise if a hand starting magneto provided with high-tension switch be used. In view of the fact that the hand starters now being used in this country are not fitted with this special cut-out switch, some provision should be made either inside the magneto or in the outside drive for an adjustment of this nature.

The primary current curves shown in Figs. 12 and 13 clearly prove that at low speeds—when the necessity for retarding the ignition is greatest—any retarding of the spark will greatly weaken its intensity. At high speeds, on the other hand, the reverse is true.

This inherent defect of a high-tension magneto, as ordinarily constructed, can be overcome by providing special sliding poles, which are mechanically connected to the timing lever, so that their position is changed at each adjustment of the timing. A design of this kind is used on one of the Bosch Company's latest magnetos, developed since the outbreak of war.

Having overcome one inherent difficulty, the other one associated with the distributor still remains. If we assume that when the timing lever is fully advanced the contact-breaker points close just before the carbon brush leaves the distributor segment—and at very high speeds the high-tension spark will persist until the contacts close—it is clear that with the lever fully retarded the carbon brush will be some distance off the segment when the spark ends. In other words, sparking between carbon and segment will result, which must tend to burn the brush track.

* *See* Report and Memoranda No. 186 of Advisory Committee for Aeronautics.

This second inherent difficulty can only be overcome by designing the contact-breaker cams to give a very short period of open circuit (θ_1), but from other considerations, it is undesirable to make θ_1 too small. The difficulties likely to arise in this connection are more pronounced on a 12-cylinder magneto, where the problem of distribution is very complex.

Taking everything into consideration, therefore, I firmly hold the view that in the case of an aeroplane magneto adjustment of the timing should be made outside the magneto and incorporated in the drive by the engine designer. This enables the magneto designer to work out his design on the basis of fixed ignition, and he is thus enabled to simplify the mechanical construction of the machine and arrange matters so that the magneto will give the very best electrical performance over a wide range of speed.

The problem of devising some mechanical method of adjusting the timing that can be incorporated in the magneto is not difficult of solution. For example, some form of sleeve working on a coarse thread and capable of movement in an axial direction can be provided for this purpose. On these lines it is possible to develop a scheme whereby both magnetos (in cases where two-point ignition is adopted) can be adjusted in phase by the movement of a single-lever arm. It is also possible to provide for adjustment through a worm spindle operated by a flexible drive terminating in a hand wheel placed in close proximity to the pilot. This latter method would allow of a remarkably fine adjustment being obtained.

The Problem of Securing a Truly British Magneto.

Now that a British magneto industry has been established on a sound foundation, it is vitally important that when the war is over this industry should be supplied with the necessary materials used in the construction of high-tension magnetos from within the British Empire.

I give below the various materials now being used in the construction of high-tension magnetos, classifying, where possible, under the component parts of the machine, in the construction of which they are used.

1. *Armature.*—(*a*) Enamelled high conductivity copper wire; (*b*) Varnished paper, silk and cambric; (*c*) silk tubes of very fine bore; (*d*) best Egyptian cotton tape; (*e*) insulating baking varnish; (*f*) high resistance sheet-iron giving maximum permeability.

2. *Condenser.*— *a*) Best ruby mica; (*b*) tin foil, preferably having a matt surface on both sides.

3. *Contact-breaker.*—(*a*) Best grey fibre: (*b*) platinum-iridium contacts; (*c*) very high-grade steel strip springs.

4. *Magnets.*

5. *Moulded Insulating Material comparable with Stabalite.*

6. *Ebonite Rod and Sheet.*

7. *Carbon Brushes.*

8. *Aluminium Copper Die Castings.*

9. *Brass Stampings and Die Castings.*

10. *Special Steels.*—(*a*) Accurately finished stampings; (*b*) rough forgings; (*c*) bar material.

11. *Ball Bearings.*—Practically all the essential materials itemised above are produced in this country at the present time, but the following materials are of special interest to English manufacturers.

Varnished Paper, Silk and Cambric.—These insulating materials are essential to the manufacture of a satisfactory magneto armature. Although they can be purchased in England at the present moment the greater portion of this material is imported from America. The varnished silk in particular is of somewhat peculiar origin. The very fine mesh silk itself is woven in Japan, being sent from there to America, where it is treated with a special high-grade insulating varnish. The finished article is then sent to England. There does not seem to be any reason why English silk manufacturers should not supply silk of the necessary degree of fineness, and I understand that there is no difficulty in subjecting the silk to a varnish treatment that will produce a finished article comparable with what is now being imported from America.

The insulating varnish generally used for this purpose has a linseed oil base, and the varnish manufacturer is at the moment depending on supplies obtained from foreign countries. As is well known, linseed oil is produced by crushing the seeds of the flax, and it is evident, therefore, that adequate supplies could be obtained within the boundaries of the British Empire.

Moulded Insulating Material Comparable with Stabalite.—At the present moment there are several manufacturers in England who are making moulded insulating material similar to the German stabalite, and although very good results have been achieved, it does not appear that these manufacturers are yet in a position to meet all the demands of the magneto industry for moulded distributors and

Digitized by Google

other parts, such as slip rings and brush holders. Furthermore, an improvement in the quality of the material now being produced is to be looked for, although I would add that the recent progress made in certain directions has been most gratifying.

There seems no reason to suppose that the English manufacturers will not eventually be in a position to adequately meet all the demands for this class of moulded material, but co-operation between them and the magneto manufacturers is necessary, so that the former may be fully alive to the importance of details, and to ensure that immediate action is taken to overcome any objectionable characteristic of the material, which may only make itself evident under operating conditions on a magneto.

Carbon Brushes.—The most satisfactory distributor carbon brushes are apparently being manufactured in France, although one English manufacturer in particular has made commendable progress during the past 12 months in this durection. This is another case where hearty co-operation between the brush and the magneto manufacturer is necessary.

Die Castings.—(*a*) *Aluminium.*—For magneto work, die castings made from an alloy of aluminium and copper, containing no zinc whatever, are eminently desirable. Such castings are being produced in this country, although unfortunately the amount of war work to be done in other directions does not allow of the few manufacturers concerned meeting all the demands of the magneto manufacturers. It is hoped, however, that the manufacturers of die castings will give special attention to this question after the war.

(*b*) *Brass.*—The present position as regards the manufacture of brass die castings is even less satisfactory than that outlined above. The magneto industry would receive considerable assistance if it were possible to purchase brass die castings in large quantities.

Bibliography.—"Magneto Ignition," by J. F. Henderson, B.Sc., "Proc." Inst. Automobile Engineers, January, 1915, with discussion; "The H.T. Magneto," by A. P. Young, A.M.I.E.E., "Automobile Engineer," March, 1915; "Magneto for Electric Ignition," by H. Armagnat, "La Revue Electrique," translation in THE ELECTRICIAN, March 24 and 31, 1916; "The Magneto: Its Function,' Design and Construction," by Mr. E. A. Watson, M.Sc., Paper read before the Coventry Engineering Society on February 23, 1917, and published in the "Automobile Engineer," May, 1917.

(*To be concluded.*)

BRITISH WESTINGHOUSE TURBO-ALTERNATORS.

On a recent visit to the works of the British Westinghouse Co. at Manchester we were interested to see passing through the shops a 10,000 kw. and a 15,000 kw. turbo-alternator for the Manchester Corporation, this rating being on the basis of a power factor of 0·85 and an overload of 25 per cent. for two hours. A third machine for 20,000 kw. was also on order for Manchester. In addition to these generators we were informed that two generators were on order for Glasgow, rated at 18,750 kw. on the basis of a power factor of 0·8, and one generator of 16,500 kw., on a power factor of 0·7, for the Clyde Valley Electrical Power Co. The Glasgow machines are wound for 6,000 volts and that for the Clyde Valley for 11,000 volts.

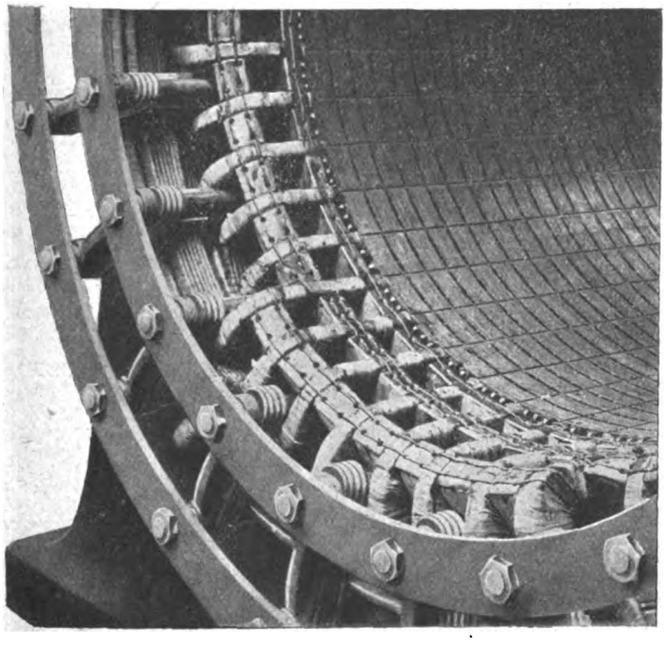


FIG. 1.—STATOR WINDING OF 5,000 kw. 11,000 VOLTS 1,000 R.P.M. TURBO ALTERNATOR.

From the above it is evident that the power stations in this country are now rapidly reaching the stage at which the size of unit will not be less than 15,000 kw., and before so very long we hope to see this raised to, say, 25,000 kw. When this is accomplished we shall feel that electricity supply is beginning to make the rapid progress which it merits.

Having regard to the many interesting points that arise in the design of these large generators we give below some details of manufacture, mainly from one of the recent publications of the British Westinghouse Co.

THE STATOR.

The stator consists of a circular box girder type yoke which carries the punchings. These are dovetailed into the yoke, being rigidly held between heavy end plates; in the larger machines the whole structure of end plates and punchings is bolted together by means of axial bolts. The main object is to obtain a solidly compressed core and prevent troubles from loose and vibrating laminations.

The yoke is generally provided with an air outlet chimney at the top and at the bottom, sufficient section of ventilating passage being provided in the yoke for the full air volume to be discharged either way, depending on whether the air is discharged into the engine room or led away to the outside of the building.

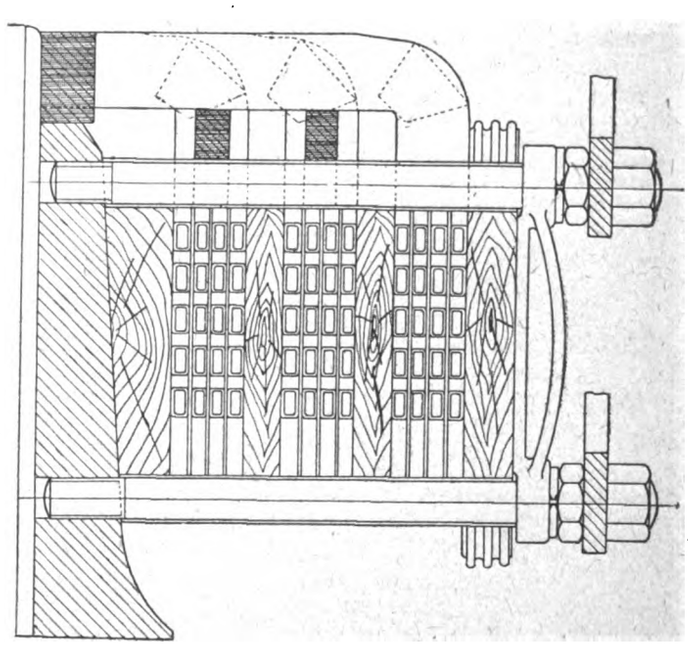


FIG. 2.—METHOD OF CLAMPING AND BRACNG END WINDINGS.

The stator winding is usually of the concentric type, consisting of separate bars and end connectors. The bars are impregnated and insulated with mica before they are placed in the semi-enclosed slots. They are held in position by the overhanging tips of the core teeth and by wedges made of hard insulating material.

The main advantages of this winding are the following:—Each conductor and end connector is quickly removable for repairs. The end connections allow of a solid bracing without interfering with the ventilation, the distance between supports being a minimum.

For large machines in which only one or two conductors per slot

Digitized by Google

are generally used, each conductor, where possible, is insulated for the full voltage between terminals, thus practically eliminating the possibility of a breakdown between turns. Insulation is by means of mica which is wrapped on hot in a wrapping machine. The conductors are split up into several parallel straps to avoid eddy-current losses which would cause excessive heating.

In order to obtain a mechanically stiff conductor the individual straps are made as heavy as possible, and the splitting up in parallel strands is not carried any further than required for a reasonable eddy-current loss; no flexible, stranded, or pressed cable is used. For smaller machines the former wound coil type of winding is used. The coils are formed at one end, the other end remaining open, and pushed into the slots axially; the projecting ends are then connected together to complete the coil.

ample ventilation for the windings, should be mechanically strong enough to obviate any liability to unbalancing due to any movement of the conductors. This difficulty applies in particular to the end windings (or those parts of the coils lying outside the core), which are often of considerable weight.

It was only after experiments of the most exhaustive kind that the British Westinghouse Co. adopted the smooth, cylindrical, radial slot type of rotor, the slots being milled out of the solid forging. The advantages of this type are, in short, the following:—

1. Easy anchoring of the slot winding and end connections;
2. Large output from comparatively small dimensions;
3. A good wave form;
4. Little noise in operation.

The field core in general use is forged solid with the shafts, although

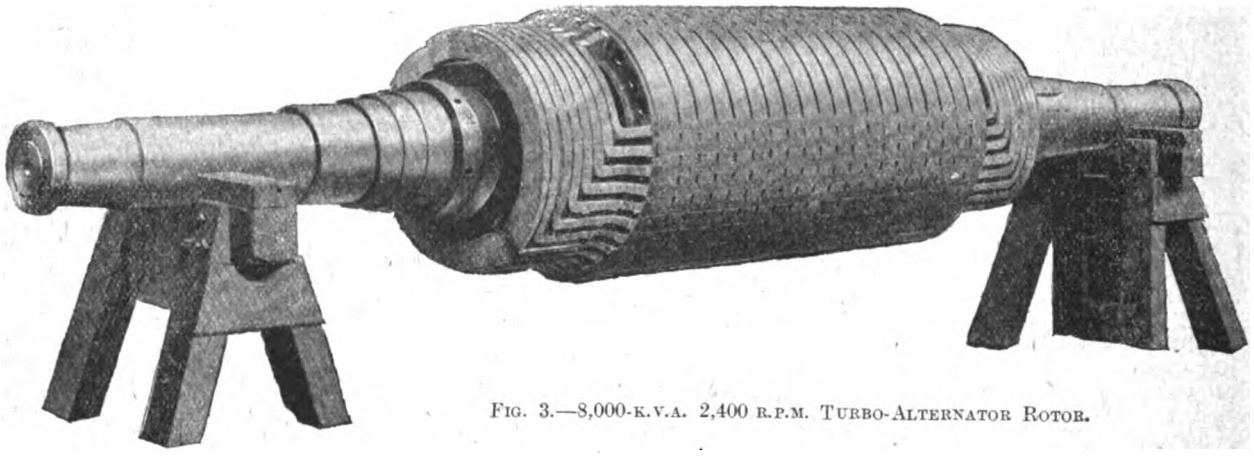


FIG. 3.—8,000-K.V.A. 2,400 R.P.M. TURBO-ALTERNATOR ROTOR.

Particular care is taken to brace the end connections and the projecting straight parts of the coils. The method of clamping is shown in Figs. 1 and 2. The end connections are solidly braced together and against the end-plate by means of wood blocks and metal bolts, which are screwed into the end-plate. Bronze bolts and clamps are used where the magnetic stray fields would cause eddy-currents and heating in steel. Heavy metal rings connect the ends of the bolts and prevent any bending. To prevent movement of the straight parts of the coils just outside the iron, they are blocked together into a solid ring by means of hornbeam blocks,

in some cases punchings or boiler plates are used where special conditions may make this desirable. The forgings used are of a high class, homogeneous material, forged down from ingots of several times the size of the finished rotor. Test pieces are taken in radial, tangential and longitudinal directions, and subjected to tension and bending tests. All forgings which do not meet the specified figures for ultimate strength, elastic limit, and ductility are rejected.

The field coils are held in radial slots by means of metal wedges, and the end connections are held by means of steel or bronze end shrink rings. The winding is laid in turn by turn and is insulated

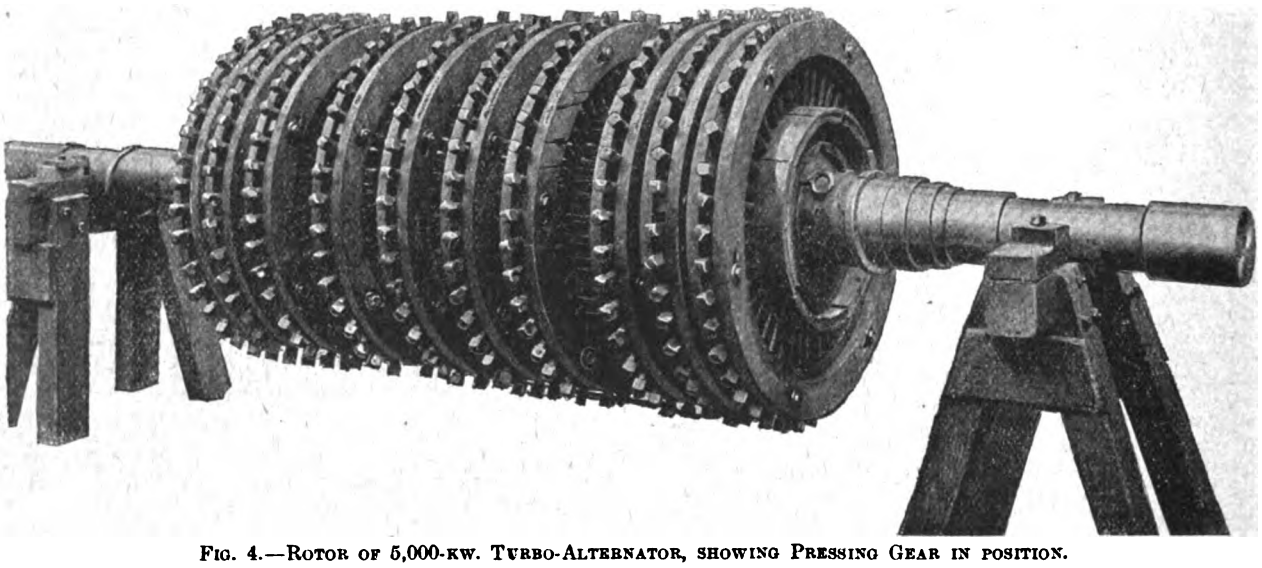


FIG. 4.—ROTOR OF 5,000-KW. TURBO-ALTERNATOR, SHOWING PRESSING GEAR IN POSITION.

which are roped to the coils, and by segmental pieces of heavy fibre. In this way any lateral or radial movement is prevented.

In order to test the bracing, short circuit tests at full voltage have been made on many different sizes of machines, which have demonstrated fully the ability of the winding to withstand the severest short circuits.

On very large units additional measures are taken in the electrical design of the stator to obtain an increased internal reactance to reduce the short circuit current to a minimum.

THE ROTOR.

The chief difficulty met with in turbo-alternator manufacture is the construction of a successful rotor. Such a rotor, while providing

with mica strips. The guaranteed temperature rise is 60°C., but there is no physical reason why this part of the machine should not be run at a much higher temperature.

A comparatively small number of wide slots is used in the rotor, which results in a substantial wide strap for the end connections. The strap used on the large machines varies from 1½ in. to 2 in. in width at the end connections. Tests have demonstrated that this strap will not become deformed even if the machine is short circuited and the rotor brought to a sudden standstill. The blocking of the ends can therefore be reduced to a minimum and the space between coils used for ventilation.

A cause of trouble sometimes found in turbo-rotors is the shrinkage

Digitized by Google

of the insulation due to the combined action of temperature and centrifugal forces. The shrinkage due to the temperature is overcome by the use of pure mica strips between the turns. It has been demonstrated that this insulation will withstand temperatures far above any value reached even with the highest overloads obtainable on the machine.

In order to overcome the action of the centrifugal forces, the field coils after being insulated and wound are baked at a high temperature and a pressure is applied approximately equivalent to the centrifugal force at full speed. This varies from 50 to 100 tons for each slot on the larger rotors. To obtain this high pressure a clamping arrangement is used, as illustrated in Fig. 4. This consists of a number of heavy steel rings and radial press screws, the number and size of the rings depending on the length and diameter of the rotor. As the pressing rings are removed the coils are keyed in position.

The effect of the high pressure, combined with the high baking temperature, is to take all compressibility out of the insulation and to press the copper conductors absolutely flat; all breathing of the coils under the action of the centrifugal forces is thus eliminated.

The current carrying capacity of rotors insulated and treated this way is practically limited only by the joints between coils. These joints are made partly by electric welding, partly by silver soldering, the latter process being employed at the air inlet side, which is of course the coolest part of the winding. Each coil is made in one length of copper; there are no joints between the turns of the individual coil.

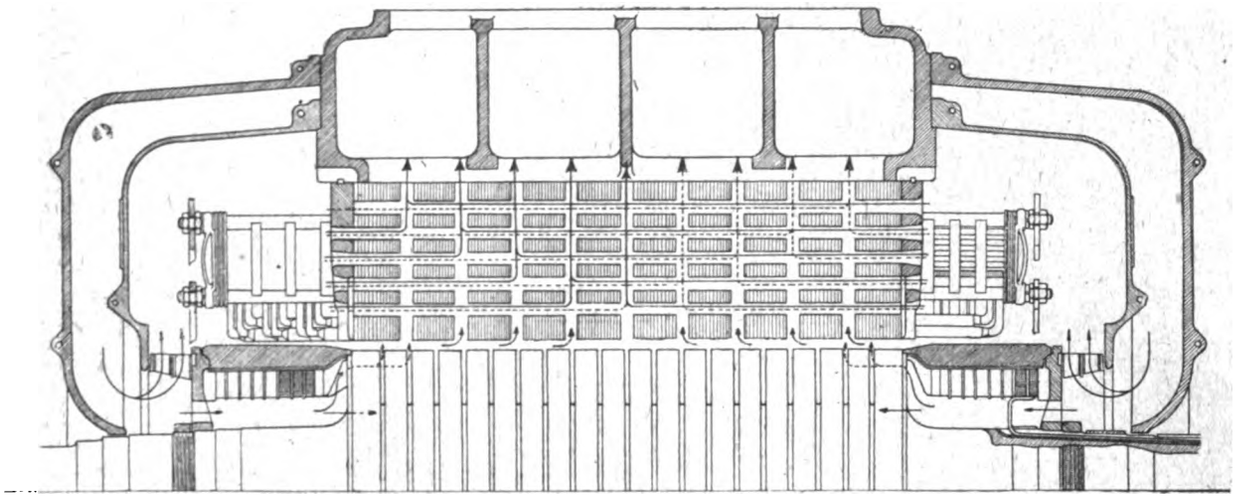


FIG. 5.—RADIAL AXIAL SYSTEM OF VENTILATION.

VENTILATION.

Stator.—The ventilation system used on small and comparatively short machines is of the radial type. In this system the cold air is drawn into the machine by means of centrifugal fans mounted on the ends of the rotor, which maintain a steady pressure of several inches water gauge in the endbell which surrounds the armature end connections. From here the air traverses the air gap and is discharged into the radial ventilating ducts which are provided at frequent intervals in the stator core.

In the larger machines the radial system of ventilation would require an excessive air pressure to pass the required air volume through the air gap and therefore additional air passages are necessary. These additional air passages are provided in the Westinghouse patented radial axial system.

In this system both radial and axial ducts are provided. The axial ducts are furnished with cold air from the endbell spaces at both ends of the machine. This discharges into the radial ducts, and from there passes radially outward into the yoke. The arrangement is such that part of the axial air streams traverse the whole length of the core in both directions and a counterflow action is thus obtained. The air is discharged from the axial ducts over the whole length of the core, and not in the centre of the core, or at one of the ends as in the usual axial systems, and the high local temperature due to localised discharge of the air is therefore eliminated.

The radial-axial system is the result of a prolonged experience with purely radially ventilated machines and with purely axially ventilated machines; it combines the advantages of both systems: viz., the uniform temperature of the radial system and the large air volume obtainable with the axial system.

Rotor.—The air enters the revolving field by way of axial holes extending the whole length of the field core; these holes feed ventilation ducts provided in the core every few inches. From these ventilation ducts the air moves across the air gap and escapes through the radial ventilation ducts in the armature core.

Particular care is taken to cool the rotor end connections which, as is well known, tend to attain high temperatures. The blocking which is used between the rotor end connections is reduced to a minimum, liberal vent spaces are provided instead, and fresh air admitted into these vent spaces at both ends of the rotor.

Generally all machines are made self-ventilating by means of blowers mounted on the shaft ends and separate fans are not necessary, even for units of from 15,000 kw. to 20,000 kw. The amount of power lost in the high-speed fans is reduced to a minimum by carefully proportioning the blades and overall dimensions of the fan (for the high peripheral speed which is used), and the overall efficiency is very high, even including friction and windage losses.

THE EXCITER.

The difficulties in the way of collecting current from a high speed commutator are due to the rapid cross-axial vibrations inseparable from a high speed shaft, and to the combined heating effects of the contact losses and brush friction. The first difficulty, which, with a high-speed cylindrical commutator and carbon brushes, would inevitably cause more or less chattering with its ill effects, is avoided on the Westinghouse exciter by the use of the radial commutator. On this type of commutator the brush contact is maintained independently of any cross-axial vibration of the armature, and is not disturbed by the end play, which latter can only be slight and of low frequency. The end movements are so slow—10 to 15 per minute—that the springs pressing the brushes can easily follow the play of the shaft when only a minimum brush pressure is employed. Further, the heating effect of the commutator is always kept at a minimum by means of a large contact-surface, the large radiating capacity, the light brush pressure, and the fan-like action peculiar to the radial design.

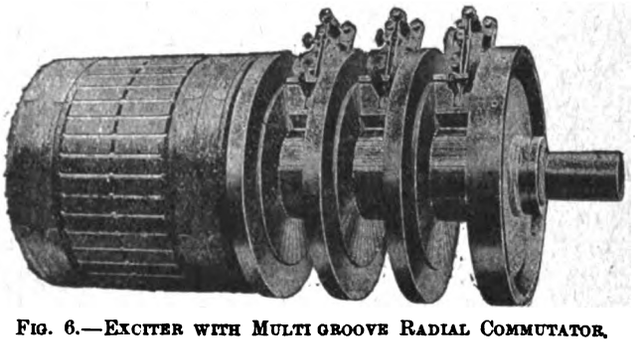


FIG. 6.—EXCITER WITH MULTI GROOVE RADIAL COMMUTATOR.

The exciter is usually overhung on an extension of the rotor shaft and no coupling or outside exciter bearing is used. In this case the radial commutator is usually of the single face type, which has the advantage of giving easy accessibility to the brush gear. In some cases the commutator is of the multi-groove type (see Fig. 6), and on machines running at comparatively lower speeds the cylindrical commutator is sometimes used.

The slip-rings are either of the radial type with renewable copper faces and carbon brushes or of the cylindrical type with steel rings and carbon brushes depending upon speed and exciting current.

Digitized by Google

ON THE CALCULATION OF THE COUPLING COEFFICIENT OF TWO COAXIAL FLAT SPIRAL COILS.

BY P. BAILLIE, L.SC.

(*Concluded from p.* 976.)

Consider, now, two flat coaxial coils wound to the centre. Fig. 5 is a section by a plane containing the axis. The first coil has been divided into p sections having the same width and consequently the same number of turns. Similarly the second coil has been divided into q sections having the same number of turns.

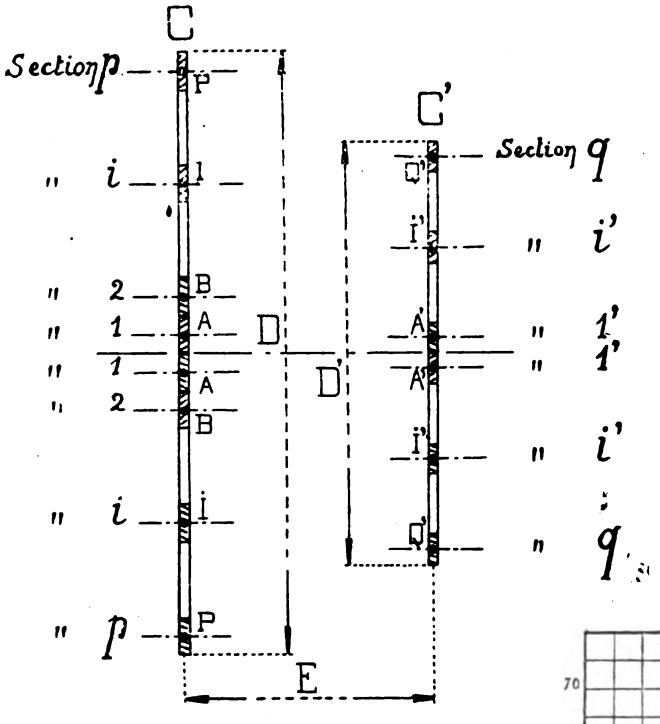


FIG. 5.—CROSS SECTION OF COILS.

When unit current is flowing through coil C a flux M is linked by the second coil C'. That flux M is the sum of the flux produced by the p sections of coil C through the q sections of coil C':

$$M=\sum_{i=1}^{i=p}\sum_{i'=1}^{i'=q} (\text{flux through section } i' \text{ due to section } i).$$

Calculation of each term of this sum has been carried out by replacing the n different turns of section i by n equal turns equal to the mean turn II, and in the same manner by replacing the n' different turns of section i' by n' equal turns equal to the mean turn $I'I'$.

A similar method may be applied to the calculation of the coupling coefficient of two cylindrical co-axial coils. The mutual inductance of the various sections may be taken from the curves in Fig. 4.

Mutual inductance calculated in such a way is only an approximate value. The greater the number of sections p and q (for two given coils) the closer the approximation. Practically, dividing each coil into 8 or 10 sections gives an approximation quite sufficient for technical purposes. A discussion of the resulting error shows that this error is a minus one and that limits can be assigned to it.

Results of the preceding method have been used to plot curves giving K for different values of D/E and D'/E. These curves are shown in Fig. 6. Numbers written above the curves are values of D/E.

In order to make the calculation of R, S, T and U quicker an abac has been constructed as follows:—

Let AA', BB', CC' be three parallel equidistant straight lines (Fig. 7). Take a point A' on AA' such that $AA'=3\log D$. and a point B' on BB' such that $BB'=3\log D'$.

Draw $A'B'$; this meets CC' at C' and we have:

$$CC'=\tfrac{1}{3}(AA'+BB')=\tfrac{3}{2}(\log D+\log D')=\log\sqrt{D^3D'^3}.$$

Now let EE' and FF' be parallel to CC'. Take a point E' on EE' such that $EE'=\log(0{\cdot}8493)+\log K(\lambda\lambda')$. Join E' to C' by a straight line; this meets FF' at F', and we have

$$FF'=\tfrac{1}{2}[\log(0{\cdot}8493)+\log K(\lambda\lambda')+\log\sqrt{D^3D'^3}],$$
$$FF'=\tfrac{1}{2}\log R.$$

This abac* (Fig. 8) may equally be used to calculate S, T and U.

It should be noted that the scales of D and D' may be simultaneously multiplied by 10, 100, &c., provided the scale of R be multiplied by 10^3, 100^3, &c.

* The abac has been graduated so as to give values of R, S, T and U, which should be used with L and L' expressed in microhenries; it then gives $\dfrac{0{\cdot}8493.K(\lambda\lambda').\sqrt{D^3D'^3}}{1{,}000}$ instead of $0{\cdot}8493.K(\lambda\lambda')\sqrt{D^3D'^3}$.

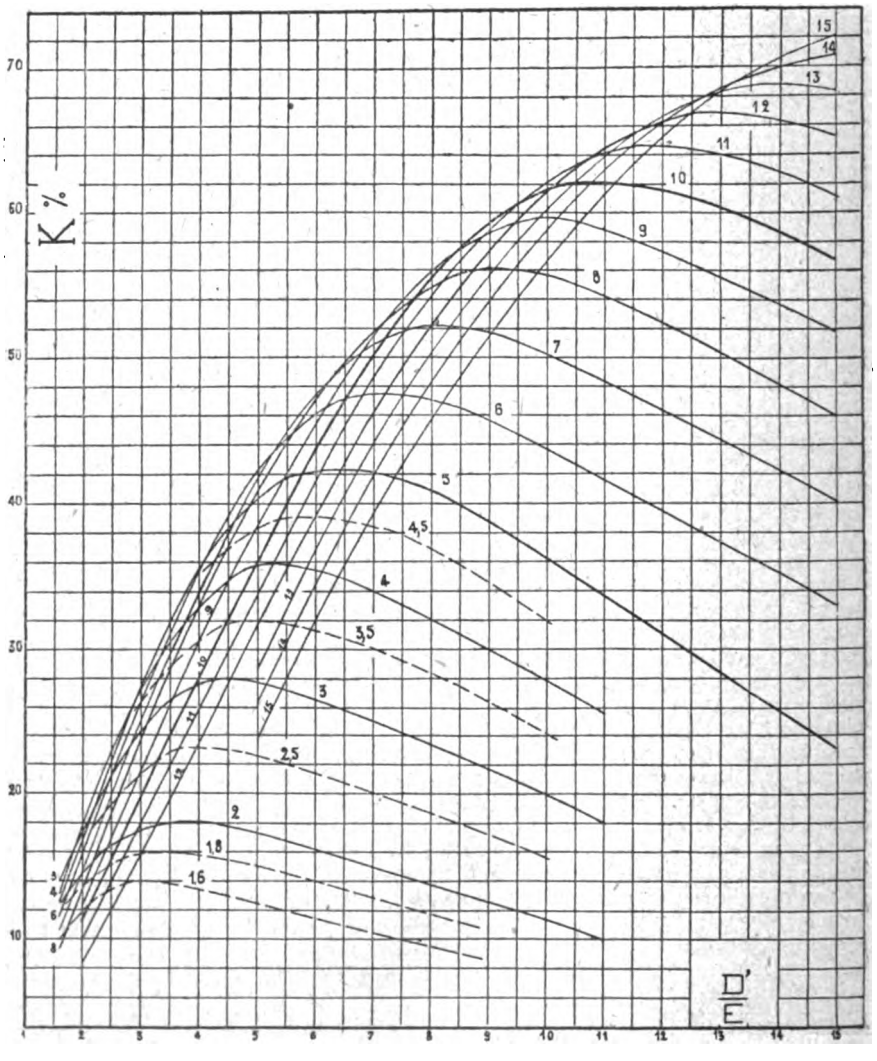


FIG. 6.—CURVES GIVING COUPLING COEFFICIENT OF TWO WOUND-TO-THE-CENTRE COILS IN TERMS OF D/E AND D'/E.

Digitized by Google

As an example, let us assume that

$K(\lambda\lambda')=28$ per cent. $D=17$ cm. $D'=11$ cm.

Join by a straight line (Fig. 9) point 17 of scale D to point 11 of scale D'; this line meets scale C at C.

Then join C to point 28 of scale K; the reading at F where it meets scale R is the required value

$$\frac{0{\cdot}8493.\sqrt{D^3D'^3}.K(\lambda\lambda')}{1{,}000}=60{,}810.$$

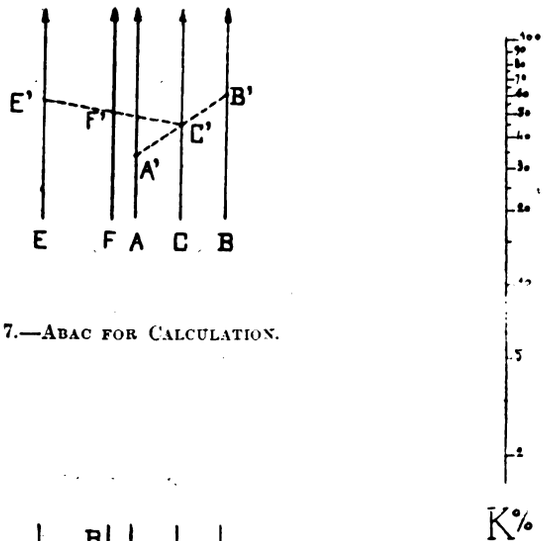


FIG. 7.—ABAC FOR CALCULATION.

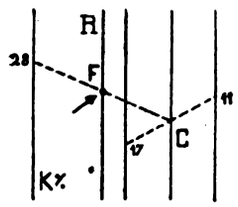


FIG. 9.—ABAC FOR CALCULATION.

Conclusions hitherto arrived at may be summarised as follows:—

SUMMARY OF RESULTS.

I. *Coils Wound to the Centre.*—(Internal diameters=0; external diameters D and D'; space between coils E). Calculate D/E and D'/E and read off K (in per cent.) from curves in Fig. 6.

II. *Coils with any Internal Diameters d and d'.*—Calculate D/E, D'/E, d/E and d'/E, and take from the curves in Fig. 6 the coupling coefficient of the various wound-to-the-centre coils; then find R, S, T, U from the abac, Fig. 8, according to the table below:—

Coils.	Parameters for curves, Fig. 6.		Parameters for abac.			Results.
λ and λ'	$D/E=$	$D'/E=$	$K(\lambda\lambda')$	D	D'	$R=$
l and l'	$d/E=$	$d'/E=$	$K(ll')$	d	d'	$S=$
λ and l'	$D/E=$	$d'/E=$	$K(\lambda l')$	D	d'	$T=$
l and λ'	$d/E=$	$D'/E=$	$K(l\lambda')$	d	D'	$U=$

Then $$K=[R+S-T-U]\frac{n_1n_1'}{\sqrt{LL'}} \text{ per cent.}$$

L and L' being in microhenries.

III. *Particular Cases.*—(*a*) When coils have the same dimensions (they may have different windings)

$$K=[R+S-2T]\frac{n_1n_1'}{\sqrt{LL'}} \text{ per cent.}$$

(*b*) When one of the coils is wound to the centre

$$K=\frac{n_1n_1'}{\sqrt{LL'}}[R-U],$$

L and L' being in microhenries.

As an example of the approximation that may be obtained we shall consider two identical coils placed 2·5 cm. apart. These coils were wound to the centre and had 56 turns and 10·6 cm. external diameter. Each coil had an inductance of 112 microhenries, and the coefficient of mutual induction was measured 40 microhenries. Hence

$$K=\frac{40}{112}=35{\cdot}7 \text{ per cent.}$$

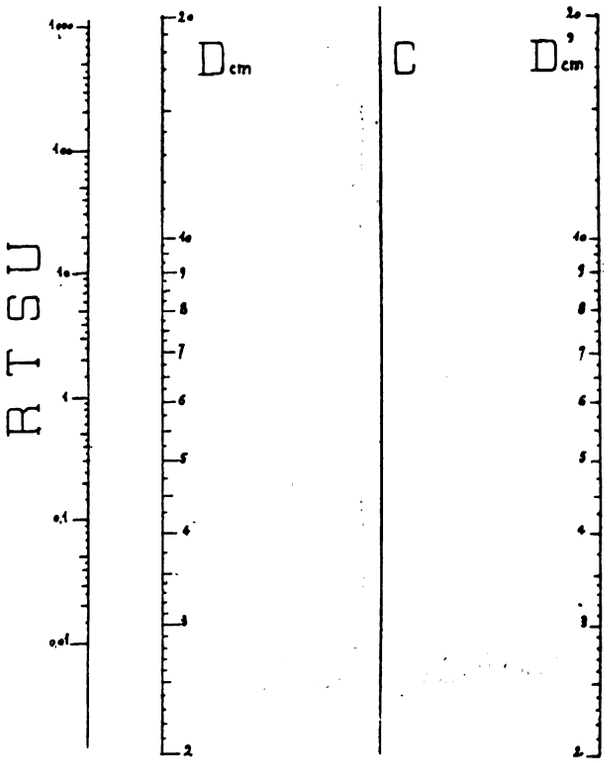


FIG. 8.—ABAC FOR GRAPHICAL DETERMINATION.

On the other hand, $D/E=D'/E=10{\cdot}6/2{\cdot}5=4{\cdot}24$, and the curves in Fig. 3 give $K=35{\cdot}2$ per cent.

$$\text{Relative error}=-\frac{0{\cdot}5}{35{\cdot}7}=-\frac{1{\cdot}4}{100}.$$

EXPERIENCE WITH INDUCTION-GENERATOR PLANT.*

BY J. H. SIEGFRIED.

(Superintendent of Power, Pacific Power & Light Company.)

The construction and operation of the Pacific Power & Light Company's induction-generator plant, in the Naches Valley, 15 miles (24·1 km.) north-west of North Yakima, Wash., present several interesting features. The Wapatox ditch, which supplies the plant with water, was originally built for irrigation purposes. The canal is 9·4 miles (15·1 km.) long and supplies the Naches power plant with water under a head of 147 ft. (44·8 metres). In 1913 it was enlarged and lined with concrete its full length, and all falls were concentrated at one point near the middle of the canal; here a new plant was installed in 1915.

Since the plant stood in the middle of the canal it was necessary to provide some means for carrying the water around it during the periods of light load or when the plant was shut down. This was done by providing a wasteway between the upper and lower levels of the canal, and arranging a spillway at the forebay of such a length that the entire capacity of the canal could be spilled with a 12 in. (0·3 metre) rise of water. Since the lower and upper levels of the canal are only 500 ft. (152 metres) apart, the wasteway had to be given a steep slope. The end of the canal below the plant was, therefore, enlarged to form a "stilling" pool 20 ft. (6·1 metres) deep, 50 ft. (15·2 metres) wide and 102 ft. (31·1 metres) long. The sides and bottom and the apron at the end of the wasteway were made of reinforced concrete. When not used through the waterwheel the water rushes down the wasteway into the stilling pool, where its kinetic energy is lost, after which it flows quietly out of the pool and into the lower section of the canal.

* Abstract of an article in the "Electrical World."

Digitized by Google

The forebay is triangular in form, and is connected with the canal at its apex. Two head gates, each made of a steel frame filled with concrete to give it weight, are provided, and are operated by a chain hoist. After passing through the gates the water enters a cone-shaped chamber which connects with a steel pipe that leads to an 8 ft. (2·4 metres) wooden penstock, where there is a butterfly valve placed inside the power-plant building.

The power house consists of a steel framework covered with metal lathing, plastered inside and having a stucco finish outside. The building is 29 ft. by 30 ft. 6 in. (8·8 metres by 9·3 metres), is well lighted and is equipped with a hatch in the roof through which the machinery can be handled by means of a 70-ton (63·5 metric ton) stiff-leg derrick permanently erected near the building. The derrick also serves the outdoor high-tension transformers and lightning arresters.

THE INTERIOR EQUIPMENT.

Inside the building are a waterwheel-driven generator and a switchboard. The water heel is a vertical Pelton-Francis unit which develops 1,900 H.P. at 200 revs. per min., and the generator is a 1,400 kw. 2,300-volt three-phase General Electric induction-type unit. The waterwheel is controlled by means of a large hand-wheel geared to the waterwheel gates.

A 400-gallon (1,514l.) oil storage tank is installed near the roof of the building, and the oil is carried through sight feeders to the Kingsbury thrust bearing supporting the revolving element and to the guide bearing. Overflow from the bearings flows by gravity to a sump tank, inside of which are filters.

Three 500 k.v.a. 2,300/38,000-volt transformers connected delta on the low-tension side and star on the high-tension side are provided to feed the 66,000-volt high-tension system. The line connecting them with the system is 2·9 miles (4·6 km.) long, and consists of three No. 4 stranded BB steel conductors arranged in an equilateral triangle 6 ft. 6 in. (1·97 metres) on a side.

As is well known, an induction motor driven above synchronous speed will act as a generator when connected to a system fed by synchronous generators and will deliver power to the system in proportion to the force driving it.

The generator at the Drop plant is of this type and is practically fool-proof. It cannot be over-excited or under-excited by any action of an attendant, and cannot be overloaded because the waterwheel capacity is less than the capacity of the generator. It cannot be burned out by means of short-circuits outside the generator, for the reason that a short-circuit will interrupt the magnetising current, and thus prevent the production of any E.M.F. Furthermore the voltage or frequency of the system will not change as long as synchronous generators equipped with governors are operating on the system.

On account of these characteristics this plant is operated without an attendant. The canal patrolman stops at the plant in the morning, pumps the oil into the storage tank, takes the wattmeter readings and reports them to the load dispatcher at Kennewick. The load dispatcher then instructs him to open the waterwheel gates until the load desired is obtained, after which the machine is allowed to run without attention until the patrolman passes the plant again. At night the patrolman is instructed to close the gates and reduce the load to a point determined by the load dispatcher, after which the generator is left to run all night without attention. This machine has been operating in this way without trouble for almost two years, and in that time has generated 11,700,000 kw.-hours.

To put this unit in service after a shut-down, the waterwheel gates are slowly opened until the machine has reached approximately normal speed. In order to tell when synchronous speed is reached a stroboscopic indicator is provided. This consists of an arc lamp fed from the circuit to which the generator is to be connected and a series of black and white stripes on the generator shaft, the number of stripes corresponding to the number of poles of the generator. The arc lamp is placed inside the frame between the generator and the waterwheel. When the lamp is energised and the light shines on the striped shaft the stripes appear to move slowly ahead or back, depending on whether the generator is running above or below synchronous speed. When the stripes appear stationary—that is, when synchronous speed is attained—the attendant closes the generator switch. It has been found in actual practice, however, that less disturbance occurs on the system if the switch is closed when the generator is running slightly below synchronous speed.

The transmission system with which this plant connects has 300 miles (482·8 km.) of 66 kv. and 112 miles (180 km.) of 25 kv. lines. The load is light and the power factor leading except during the heaviest demand for power in the irrigation season. In the winter, when ice prevents the operation of this unit by water, the generator is allowed to run as an induction motor for the purpose of using the charging current. The addition of the Drop plant generator is of considerable benefit, for it requires 825 k.v.a. for its magnetisation. This is supplied from the lines of the high-tension system and relieves the synchronous generators to this extent.

If at any time the synchronous apparatus should be tripped off the system the induction generator will still maintain voltage on the system and carry load.

Under certain conditions this generator will trip off the line, and it is necessary to get into communication with the canal patrolman and send him to the plant to put the generator in service. This may appear to be a great disadvantage, but the patrolman's beat covers only four miles—one mile above and three miles below the Drop plant—and telephones are installed every mile along the canal. From the time the generator is tripped off the line to the arrival of the patrolman at the station the generator speeds up, but as the machine is designed to withstand 100 per cent. overspeed no damage can result.

MINES AND QUARRIES REPORT.

Part I. of the annual general report on Mines and Quarries for the year ending Dec. 31, 1916, which gives divisional statistics of the persons employed, output, &c., and reports of the Divisional Inspectors has been issued. The total output of coal for the year was 256,348,351 tons, compared with 253,179,446 tons in the preceding year.

In Mr. H. Walker's report for the Scotland Division it is stated that the number of coal cutting machines has increased by 111 compared with 1913. There were 184 accidents causing 194 deaths, increases of 39 and 45 respectively over 1915. One man was killed by touching a flexible metallic tube connecting the electric leads between a switchbox and a pump motor. The hole in the switchbox through which the incoming leads passed was not provided with a bush, although its edges were sharp and the box itself was not properly connected to earth. By machinery five persons were killed, four of them being coal cutting machine attendants. The practice of forcing disc coal cutting machines to cut their way into the face prior to making a cut along the face cannot (says the Report) be too strongly condemned; it is a fruitful source of most horrible accidents. In all cases places from which such machines could start to cut should be made by hand. The number of persons killed by accidents on the surface was 13 more than in 1915, the number being 32, but one only was due to electricity. "The most fruitful source of accidents is due to the practice of oiling when the machinery is in motion. This is a matter which, by the provision of proper lubrication, can easily be avoided." The fatal accident due to electricity was due to a linesman beginning work on a high tension transmission line before his assistant whom he had sent to cut off the current, had done so.

Mr. J. R. Wilson's report on the Northern Division states that at Burnmoor Colliery, Durham, a cleaner-out at a coal-cutting machine was killed by an electric shock which he received by coming into contact with the framework of the machine which was rendered "live" through defects in connection with the cable plug box at the machine and the earth wire in the trailing cable. Owing to a loose or bad contact between a plug and a socket a terminal was overheated, the solder with which the lead at the other end of the terminal was sweated in was melted and ran out, making electrical contact with a brass casing enclosing the plugs, &c. The continuity of the earth wire was found to be broken at two places, one at either end of a joint three inches long, which had been made rigid by the use of soldering to finish it off. Such rigid joints in flexible cable should never be made. A dry joint properly spliced answers the purpose equally well.

Mr. Thos. H. Mottram, in his report on the York and North Midland Division, states that the proportion of coal produced by coal-cutting machines was 7,700,586 tons, or about 11·3 per cent. of the whole output of the Division. There were two cases of failure to comply with the Special Regulations for the use of Electricity in Mines, and convictions were obtained in both cases.

Mr. A. D. Nicholson, reporting on the Lancashire, North Wales and Ireland Division, states that though there was an increase of 5 per cent. in the number of persons employed, there was a decrease of 46,605 tons of mineral obtained.

In South Wales there was an increase of 11,445 persons employed (5·6 per cent.) and the output increased 1,628,109 tons (or 3·2 per cent.). There were two convictions for breaches of the Regulations relating to the use of Electricity in Mines. Dr. Atkinson states that "although the accidents due to electricity were not high comparatively, considering that more electricity is used in the South Wales Division than in any other, there is, nevertheless, room for improvement at some of the smaller collieries; and a means of promoting this would be the appointment of more competent electricians at such collieries. Considering the importance to safety of the skilful supervision of electrical plant at mines, it would not be unreasonable to require some standard of qualification for colliery electricians."

In his report on the Midland and Southern Division, Mr. W. Walker reports that a fatal accident due to electricity should not have occurred. "A works foreman who knew little or nothing about electricity was killed by handling a double-strand g.i. wire pole stay which had broken and fallen across a live overhead conductor of a three-phase system carrying electric current at 500 volts. The stay was attached to the pole at a point just above the arms which carried the conductors, and weakened by corrosion it broke close to the anchor. If the stay had been properly fixed and maintained the accident would not have occurred."

Digitized by Google

THE LIMITATION OF SHORT-CIRCUIT CURRENTS IN THE POWER STATION AT GOLPA.*

BY G. KLINGENBERG.

In the case of a short-circuit very large currents pass, with corresponding mechanical stresses. These come so suddenly that damage is done before the best possible cut-out has time to act. The oscillographic records of Biermann confirm this, and in a big power station the remedies he recommends are a serious matter. It may, therefore, be of interest to explain how the question is dealt with in the largest steam station in the world.

The author's first plans for the power station at Golpa date from about two years ago. The problem was to transmit 60,000 kw. over a distance of 25 km. at a pressure of 80,000 volts; a second project to deliver a further 30,000 kw. at 6,000 volts was undertaken later. Auxiliary purposes required also an extra 6,000 kw. The machine room contains eight turbo-generators, each giving 22,500 k.v.a. at 6,000 volts. The transmission of the first portion of the output takes place through two different transmission lines suspended on different lines of poles. Each line carries two circuits, and thus in all there are 12 transmitting conductors on the three-phase system. One line of poles carries, however, sufficient conductors to convey the whole output in case of need. The first four machines are used for this output, which amounts to a total of 60,000 kw. The construction of the generators is such that the short-circuit current is limited to about 15 times the working current. Let us suppose the four generators to have been coupled up in the usual way to a 6,000-volt bus-bar. Then the point K, shown in Fig. 1, might have to carry a maximum short-circuit current of 135,000 amperes. The mechanical stresses would then reach very high values.

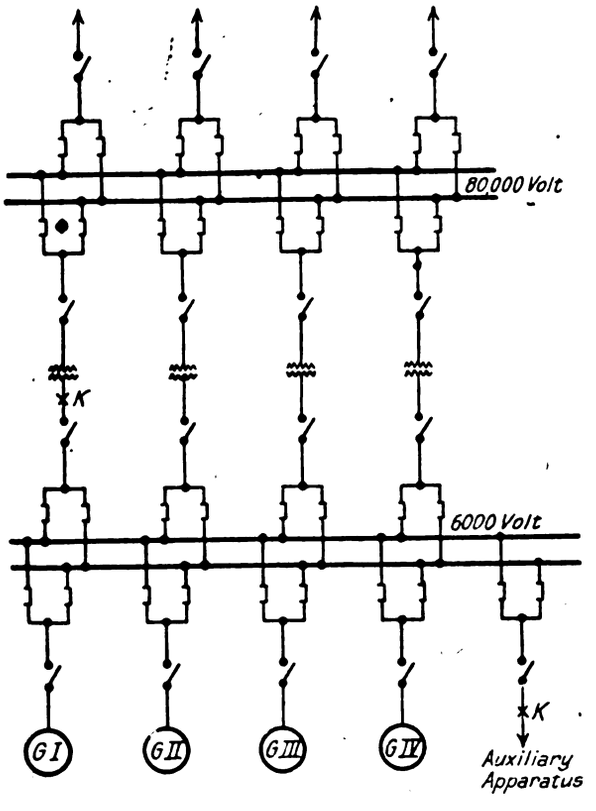


FIG. 1.

The auxiliary purposes of the power station require, however, a comparatively small part of the output. The system of coupling the generators in parallel, as shown in Fig. 1, was therefore abandoned, and the parallel coupling was thus confined, as shown in Fig. 2, to the 80,000-volt side. The transformers therefore constitute, as it were, portions of the generators, and are always switched in with them. The requisite current for auxiliary purposes is obtained by separate connections. Thus one generator furnishes this current, and any generator can be chosen for the purpose. This arrangement has an advantage, which has been pointed out by Binder, inasmuch as the reactance of the transformers tends to limit the current passing through the short-circuit. The number of the transmitting circuits is purposely made the same as that of the transformers and generators, so that there is no need for any parallel working in the power station itself. By subdivision of the 80,000-volt bus bars the generators can be separately connected to the corresponding transmitting circuit. The parallel connection is then made on the bus bars of the distant station. Thus we have the further advantage that in case of a short-circuit there is also the reactance of the overhead conductors to be dealt with. In spite of this subdivision, which admittedly can only be carried out in special cases and in very large works, we must also take into account the parallel connections which are made in the power station in case of a breakdown on the transmission line. The auxiliary purposes of the power station require a pressure of 500 volts, while the coal pits take 6 000 volts. This double transformation should be avoided. Current for those purposes is therefore not taken from the 80,000-volt bus-bars, but directly from the terminals of the generators. Each generator is therefore, provided with a reactance coil, A, beyond which the cables for auxiliary purposes are connected up. Here also

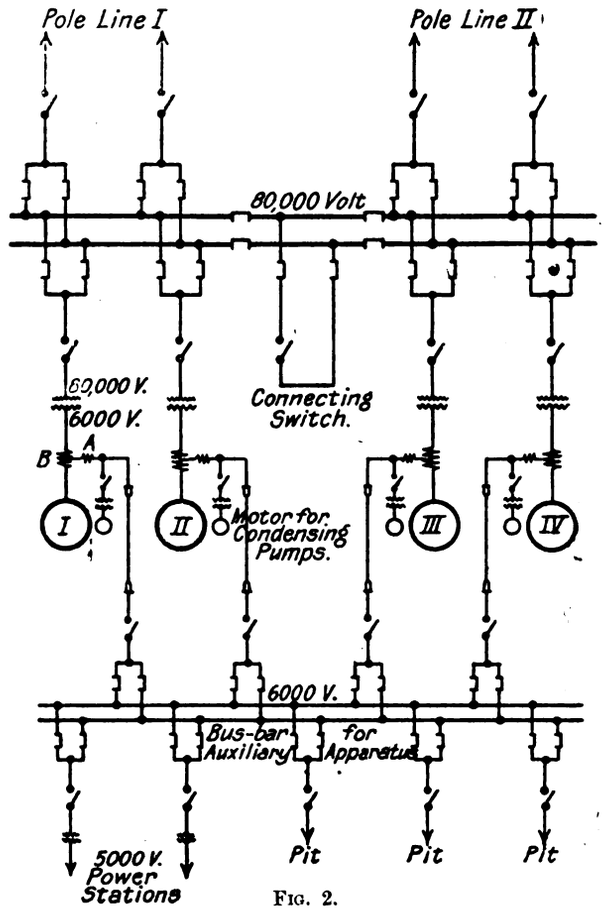


FIG. 2.

are made the connections to the transformers which feed the motors working half the condenser pumps, the other half of the pumps being driven by the steam turbines.

In order to increase the damping effect in case of short-circuits, the total reactance of each generator and transformer is increased by an additional reactance coil, B; this is housed along with the reactance coil, A. Binder limited his investigation to the heating effects at different points in the system; but equally important are the mechanical stresses. The author thinks that the limitation of the short-circuit current is far more important than protection against surges. The best protection against the latter is to be found in a factor of safety, which must be sufficiently high, always remembering that the factor of safety in the internal parts of a machine differs from that in the external projecting connections. Thus the breakdown pressure of the winding (of a transformer) to the case should be notably higher than the flash-over voltage from an insulated terminal to the core. These three principles have been carefully applied to the design of the Golpa power station, and, in spite of its great size, no protective device against surges is used. There have been numerous heavy thunderstorms, but as yet no breakdown has taken place.

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 50, 1916.

Digitized by Google

The Electrician.
FRIDAY, SEPTEMBER 28th, 1917.
Editorial and Publishing Offices:—
8, BOUVERIE STREET, LONDON, E.C. 4.
Telephone: City 9853 (4 lines). Telegrams: "Benbrotric Fleet London."

SPECIAL NOTICE.

The present number of "THE ELECTRICIAN" completes Vol. LXXIX. The Index to the Volume will be issued (Gratis) on October 12th.

RESULTS ON THE NORFOLK & WESTERN RAILWAY.

From time to time attention has been called to the results obtained on the Norfolk and Western Railway in the United States, and recently some interesting data were mentioned in this connection at a meeting of the New York Railroad Club. We gave a description of the electrical equipment of this railway in THE ELECTRICIAN of July 2, 1915, but we may remind our readers that it presents some unusual features. The length of the electrically equipped part of the line is equivalent to about 97 miles of single track, and in this respect it is no unusual achievement, but it includes some long and heavy gradients, sometimes exceeding 2 per cent. It is a line which serves a coal field, so that the traffic is mainly of a mineral character and is particularly heavy. As an example of the type of traffic which is handled it may be mentioned that in the days when steam locomotives were employed a train of about 3,000 tons weight required two 240-ton locomotives at the head and one at the rear on one of the up-gradients near the Elk Horn Tunnel. Owing to the length of the trains comprising, say, 45 cars, it was not unusual for the rear locomotive to receive the signal to go ahead one full minute or even more before the head locomotive came into action. Similarly, in coming to a stop on an up-grade, the head locomotive would shut off power and would apply brakes, while the rear engine would keep pushing the train until its tractive effort was exceeded by the bunching of the front cars. Consequently the conditions of working, as far as the locomotives were concerned, were very severe. One of the difficulties of working the line was the Elk Horn Tunnel, which is equipped only with single track, 3,000 ft. in length. In order to avoid excessive smoke and gases in this tunnel the trains were run through it at reduced speed and at intervals sufficient to ventilate the tunnel to some extent.

During the last few years the increase in the volume of traffic has been very considerable. For example, in 1906 the number of ton-miles against the gradient was 279,933,339, in 1914 the figure was 457,163,921 and in 1916 it was 592,597,018 ton-miles. With this rapid growth of traffic it became necessary to increase the capacity of the railway. A new route was considered, but it was found that the better plan was to electrify the present railway. The system adopted includes one unusual feature, in that transmission is by single-phase current which is converted on the locomotive into three-phase current by means of a split-phase converter, so that three-phase motors are used on the locomotive. Thus electric braking is utilised which is such a prominent feature of this type of motor on heavy gradients.

The results of the electrification have proved to be exceedingly satisfactory. Whereas in the old days the speed on the heavy gradients was only 7 miles per hour, it is now 14 miles per hour; and although the number of steam locomotives required was 43, the service is now handled by means of only 9 electric locomotives. The traffic has increased by 25 per cent., but the number of engine hours has fallen from 93,625 to 14,112. Further, it is stated that there is a considerable reduction in the operating costs, and that the financial results show a return on the cost of the installation. Owing to the special conditions it is doubtful whether the present traffic could have been handled in any other way but by the electrification of the line. It may be said that the results obtained on this railway show once more the flexibility of electric traction and the extremely important part it may play on mineral railways—a fact which is not always appreciated.

REVIEWS.

The Electrical Contractor. By LOUIS W. MOXEY, Jr. (London: Hill Publishing Co.) Pp. vii.+86. 6s. 3d. net.

Every electrical contractor might usefully provide himself with a copy of this little book. Although many of its tables and most of its prices deal with American conditions only, its methods are suggestive and might be adapted by British firms engaged in this and kindred trades. Much would be found directly useful on both sides of the Atlantic. The author knows how to make things plain to the plain man, so that he may use more intelligently the very simple mathematical formulæ required for the daily business of an electrician.

The first four chapters deal with costing and accounting. The author shows how it is pure gambling, not business, when cost records are not kept systematically and in detail. He would have no sympathy with the man who glances at a wiring job or set of plans and forthwith bases his estimate on a shrewd guess at what would probably get him the job. His own experience has led him to allow for oncost, or general business expenses, 20 per cent. on net workshop cost, the latter including foreman's time. He then adds 10 per cent. as profit and so gets his price. As this rate of oncost obviously does not apply to the larger items, such as engines, generators, batteries, &c., merely bought and resold, the electrician, when ascertaining his actual oncosts to get his guiding figure for future tendering, must found his percentage mainly on time and material for work done, chiefly by his own men. Many business men contend that oncost should be calculated only on wages paid and made large accordingly. A common figure for electricians' oncost in Britain is 10 per cent. on the Day Book Annual turnover, but this (11·11 per cent. on cost) cannot be applied to everything before profit is added, or firms quoting thus would lose many profitable sales and lose money on other work. Perhaps the best method is to have two rates for oncost, say 5 per cent. on larger items bought and sold and perhaps 25 per cent. on time and material of work done by own men. Some trades ask 100 per cent. for oncost—on war work. Each business must, by exact records, ascertain its own true ratio. The chief criticism to be made on the author's accounting methods is that they would add too much to the clerical charges. Simpler methods, even more inevitable in their accuracy, and applicable to any size of business, could easily be devised.

The later chapters of the book deal with wire-sizes and relative matters and with illumination calculations and general data. Some of the author's methods might be criticised by the purist, but errors are few and unessential for the purpose in hand. J. M. M. M.

The Yearbook of Wireless Telegraphy and Telephony, 1917. (London: Wireless Press, Ltd.) Pp. cxv.+928. 3s. 6d. net.

The edition for 1917 of this well-known yearbook is again extended in size, and contains the usual amount of standard information and data on wireless telegraphy. In the preface the Editor refers to "the incurable habit of progress which has characterised wireless telegraphy during recent years," and it is unfortunate that in the present circumstances so little can be said regarding the great progress which is generally

Digitized by Google

believed to have taken place since the outbreak of war. In the field of wireless telephony, in particular, on which very little is said, there will doubtless be many interesting developments to record in the future.

The record of development, starting from the year 1831, is therefore naturally somewhat restricted for the period 1914-1916. There are, however, several incidents of importance recorded during 1916, notably the discussion on the control of wireless telegraphy at the Pan-American Conference at Buenos Ayres in April, which is regarded as a big step forward on the part of the South American Republics. A noteworthy incident was the initiation of the newly established Trans-Pacific Wireless service between the U.S.A. and Japan, while the determination of the difference in longitude between Paris and Washington by the aid of wireless telegraphy was also an interesting scientific achievement. Reference is also made to the important decision on Sept. 20, 1916, of Judge Mayer in the U.S.A. District Court in the action between the American Company and the De Forest Radio Telegraph & Telephone Co., regarding the patents involved in the Fleming-Vale controversy. This is reported in full elsewhere in the volume.

The reference section naturally differs little in material presented, from the previous edition. The reprinted summary of the world's wireless laws and regulations have been revised so as to include amendments made by various British dependencies and foreign countries, and the complete list of land and sea stations is again presented, and likewise the conclusions of the International Radio-Telegraphic Convention of 1912.

A considerable amount of new matter is to be found in the section of the work devoted to technical matters, which includes the following contributions :—

"The Electric Arc as a Generator of Persistent Electric Oscillations," by Prof. J. A. Fleming; "The Wireless Drama," by Alfred Noyes; "Ionic Valves," by Dr. W. H. Eccles; "Inductance, Capacity and Natural Frequency of Aerials," by Prof. G. W. O. Howe; "The Heavyside Layer," by Dr. E. W. Marchant; and "Some Features of Long Distance Stations of the American Marconi Company," by C. H. Taylor.

The contribution by H. J. B. Ward on "Wireless to the Rescue," including a list of timely rescues, is supplemented by an account of various incidents illustrating the heroism of wireless operators during the war. The "Definition of Terms used in Wireless" and the list of "Useful Formulæ and Equations" have been revised by Dr. Erskine Murray and the "Dictionary of Technical Terms in Five Languages," for which Dr. Erskine Murray is also responsible, is a valuable feature.

The book concludes with various useful data and tables, and the usual series of biographical notices. In view of the inevitable restrictions and difficulties arising from the war, the 1917 edition of the yearbook is a distinctly creditable production.

EFFECT OF BAROMETRIC PRESSURE ON TEMPERATURE RISE OF SELF-COOLED TRANSFORMERS.*

BY V. M. MONTSINGER.

Summary—A standard rating applies only when an electrical machine is installed in a temperate location and at a moderate altitude. For service in a tropical climate or at a great altitude, an electrical machine must be re-rated, as otherwise the temperatures attained may exceed approved values. The author discusses the effect of altitude upon the temperature rise of oil-immersed transformers without water cooling. Formulæ are developed to enable the effect of altitude to be accurately taken into account.

General.—Although it is generally recognised that an increase in altitude has the effect of increasing the temperature of electrical apparatus, the extent to which such apparatus is affected by changes in atmospheric pressure has never been accurately determined.

The 1915 A.I.E.E. rule (Section 308), which specifies that the same correction be made for all types of air-cooled apparatus may be correct for certain types. But the correction is too large for others, principally self-cooled stationary apparatus where the cooling is not as dependent on the volume of air passing through or over the cooling surfaces as is the case with forced ventilating systems. All self-cooled transformers, of course, fall within the self-cooled class, and air-blast transformers (and rotating machinery to a greater or less extent) fall within the forced ventilating class. The purpose of this article is to present a short discussion on the dissipation of heat from self-cooled transformers in order to show how barometric pressure affects the heating and to give the results of experimental observations conducted on transformers at different altitudes.

Modes of Heat Dissipation.

The loss of heat from the surface of a tank takes place by radiation and by convection, the relative amounts depending to some extent on the colour and the height of plane, but principally on the shape of the contour.

Radiation is dependent upon the envelope surface or outer perimeter of a tank, while convection is dependent upon the total developed surface, providing free circulation of air is allowed.

For the present discussion the writer has used for radiation the empirical constant that is given by the best authorities. For convection, the constant was determined by subtracting from the total, or supplied losses, the calculated loss by radiation.

The loss of heat from a self-cooled transformer may be expressed as follows :—

$$W = W_r + W_c, \quad \ldots\ldots\ldots \quad (1)$$

where W = total losses supplied to transformer,
W_r = loss by radiation,
W_c = loss by convection.

Radiation.—The Stefan-Boltzman law that radiation is proportional to the difference of the fourth powers of the absolute temperatures is generally expressed in the form—

$$W_r = KE(T_2^4 - T_1^4), \quad \ldots\ldots\ldots \quad (2)$$

where W_r = watts dissipated by radiation per square inch of surface.
K = constant = $3{\cdot}68 \times 10$,
E = relative emissivity which depends upon the nature and colour of the surface
T_2 = absolute temperature of the radiating surface,
T_1 = absolute temperature of the room.

Convection.—Practically all physicists have found that loss by convection varies very nearly as the 1·25 power of the temperature rise. The following equation is therefore no doubt fairly accurate, and for practical purposes may be used for the loss of heat by convection from vertical surfaces of tanks :—

$$W_c = K\theta^{1{\cdot}25}, \quad \ldots\ldots\ldots \quad (3)$$

where W_c = watts dissipated per square inch of developed surface.
and K = constant for any one tank
θ = temperature rise of surface above room temperature.

Maximum Oil Rise v. Total Loss Supplied to Tanks.

Referring to Fig. 1 in which the maximum oil rise (θ) is plotted on logarithmic scale against total watts (W) supplied to the three different tanks as shown in Fig. 3, it will be seen that the test points for each tank fall in a straight line. This indicates that the loss of heat by convection for various temperature rises of the surface follows this same law—*i.e.*, the loss varies as the 1·25 power of the temperature rise. The reason the line for tank No 3, having a plain surface, has a slope (1·15) less than 1·25 is no doubt due to the fact that radiation plays a more prominent part in the loss of its heat than it did for the other tanks. The relative amounts of loss of heat from the plain tank were approximately 60 per cent. radiation and 40 per cent convection.

If we plot on logarithmic paper the Stefan-Boltzman equation for radiation, we obtain, between the limits of 10°C and 50°C rise above a 30°C. room temperature, a line whose slope is about 1·12. The slope of 1·15 for the plain surface as given in Fig. 1 (for approximately equal losses by radiation and by convection) then looks reasonable. In practice, however, the slopes may vary slightly from 1·15 for plain and 1·25 for complicated surfaces, due to the fact that the height of oil which affects to some extent the surface effective for loss of heat, may change, due to expansion of the oil as the tem-

* Abstract of an article in the "General Electric Review" (U.S.A.).

Digitized by Google

perature increases. Again if the viscosity of the oil is such as to cause an appreciable change in the temperature gradient along the surface of the tank, the maximum oil rise when plotted on logarithmic paper against loss may not fall in a straight line.

The error due to change in oil height is usually small. The error due to change in viscosity of oil may be considerable with oils having a high viscosity at low temperatures, but the present day oils used in transformers do not change in viscosity to a great extent between about 40°C and 100°C. In practice then the maximum oil rise *v.* total loss supplied to self-cooled transformers should generally follow very closely the formula $W = K\theta^n$, where n has a constant value for any given tank, but varies from 1·15 to 1·25 for different tanks, depending upon the shape of the surface.

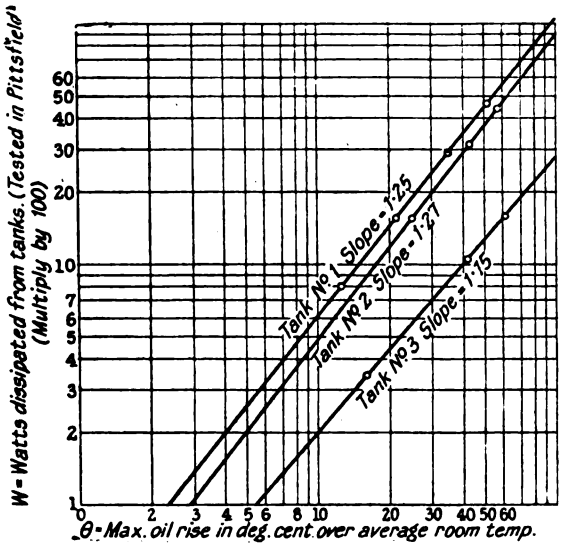

W = Watts dissipated from tanks. (Tested in Pittsfield) (Multiply by 100)
Tank No 1 Slope = 1·25
Tank No 2 Slope = 1·27
Tank No 3 Slope = 1·15
θ = Max. oil rise in deg. cent over average room temp.

FIG. 1.—WATTS DISSIPATED IN TEST FROM TANKS 1, 2 AND 3 AT VARIOUS TEMPERATURES ABOVE ROOM TEMPERATURE.

Effect of Shape and Height of Surface on Convection.—For the plain and for the corrugated surface having corrugations 3½ in in depth and 2½ in. pitch, the experimental tests indicated that K has about the same value—*i.e.*, $1{\cdot}5 \times 10^{-3}$, while for the surface having corrugations 9 in. in depth and 2⅜ in. pitch, the value was $1{\cdot}32 \times 10^{-3}$ or 88 per cent. of the value for the less complicated surfaces.

The reduction in the value of K for the 9 in. corrugations is no doubt due to a greater resistance offered to movement of the air through the deep vents. As surfaces become more and more complicated the value of K no doubt would be further decreased. Also for surfaces of this nature the height no doubt would prove to be an important factor, whereas for ordinary plain and simple corrugated surfaces, practice has shown that the effect of height usually has very little if any effect on the thermal efficiency.

EFFECT OF BAROMETRIC PRESSURE ON RADIATION AND CONVECTION.

Radiation is not affected by changes in air density. With regard to convection, in 1817 Dulong and Petit found that the velocity of cooling in a gas was proportional to the pressure raised to the power of—

0·45 for atmospheric air,
0·38 for hydrogen,
0·517 for carbonic acid,
0·501 for olefiant gas.

Kennelly and Sanborn found that the linear convection is nearly proportional to the 0·5 power of the atmospheric pressure.

According to Lorenz, convection varies as the 0·5 power of the pressure. It seems, therefore, that if we use 0·5 power of the pressure, the result should be fairly accurate.

CALCULATION OF THE EFFECT OF PRESSURE ON COOLING.

Assuming that the loss by convection W_c varies as the 0·5 power of the pressure and as the 1·25 power of the temperature rise, letting B represent the barometric pressure in inches of mercury, the general equation for convection becomes

$$W_c = K\theta^{1{\cdot}25}B^{0{\cdot}5}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

whence, by transposing, it can be shown that for a constant loss the temperature rise varies inversely as the 0·4 power of the barometric pressure, and the expression then reduces to

$$\theta = (29{\cdot}9/B)^{0{\cdot}4}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Applying the Smithsonian Institute formula for altitude *v.* pressure, the author next derives the equation—

$$\varphi_1 = 1{\cdot}46A, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where φ_1 is the percentage increase in temperature rise for a constant loss, and A is the difference in altitude between lower and upper elevations expressed in thousands of feet (that is, for 1,000 ft. $A = 1$).

Equation (6) is true only for a surface dissipating all its loss by convection when naturally cooled. However, this condition seldom exists in commercial transformers. For a plain surface the percentage of loss by convection is probably from 40 to 45 per cent. of the total loss, where as for surfaces with very complicated contours

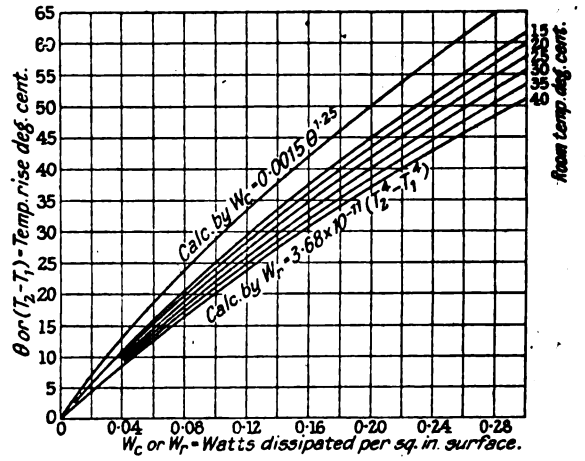

θ or (T2 - T1) = Temp. rise deg. cent.
Calc. by Wc = 0·0015 θ^1·25
Calc. by Wr = 3·68 × 10^-11 (T2^4 - T1^4)
Wc or Wr = Watts dissipated per sq. in. surface.
Room temp. deg. cent.

FIG. 2.—WATTS DISSIPATED PER SQUARE INCH SURFACE AT VARIOUS ROOM TEMPERATURES AND DEGREES RISE ABOVE ROOM TEMPERATURE.

the loss by convection may approach more nearly 100 per cent. It is evident, therefore, that the effect of altitude will be very different for different styles of surfaces—each one requiring special consideration.

This effect may be expressed in terms of the percentage of loss by convection to the total loss. For example, if only 50 per cent. of the loss is by convection and the remaining by radiation (unaffected by pressure) the effect of pressure will be approximately one-half that expressed by equation (6). Letting φ_2 equal the percentage increase

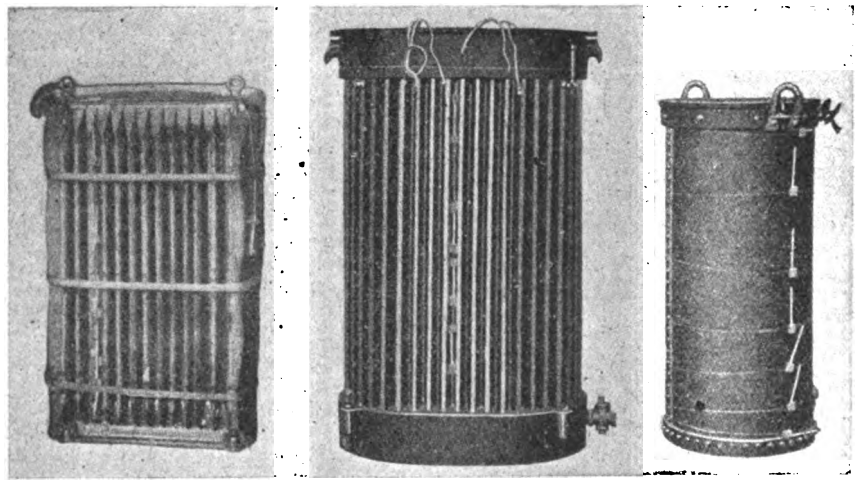


FIG. 3.—TANKS NOS. 1, 2 AND 3 (LEFT TO RIGHT).

in temperature rise for surfaces having both radiation and convection, we have

$$\varphi_2 = 1{\cdot}46A \times \frac{\text{loss by convection}}{\text{total loss}}, \quad . \quad . \quad . \quad (7)$$

$$\varphi_2 = 1{\cdot}46A \times \frac{W_c}{W_c + W_r}$$

$$= \frac{1{\cdot}46A}{1 + W_r/W_c}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Digitized by Google

Since the ratio of W_r/W_c does not remain quite the same when the altitude changes, equation (8) is not quite correct. However, the error is small especially for surfaces with irregular contours, such as corrugations, &c., where the greater part of the loss is by convection.

If we assume a standard room temperature and a standard temperature rise, we can for practical purposes, express W_c and W_r in terms of the developed and envelope surfaces reduced to equivalent values of loss per unit area. This makes it more convenient for practical application. For example, referring to Fig. 2, we find that for a 50 deg. rise above 30 deg. room temperature, the calculated watts dissipated per square inch of surface are approximately in the *ratio* of 1·0 for convection to 1·3 for radiation. If we let

$$R=\frac{\text{Envelope area of surface}}{\text{Developed area of surface}}=$$

equation (8) may be written

$$\varphi_2=\frac{1{\cdot}46A}{1+1{\cdot}3R}. \quad \ldots\ldots\ldots \quad (9)$$

Derivation of General Equation for Effect of Barometric Pressure on Temperature Rise.

We have seen that for temperature rises between 0°C. and 75°C. the general equation of temperature rise *v.* loss is $\theta=KW^n$, and that the equation of temperature rise *v.* altitude is

$$\varphi_2=\frac{1{\cdot}46A}{1+1{\cdot}3R}.$$

If we let θ = temperature rise at some high altitudes, and let

W_0 = loss at room temperature θ_0 for given load conditions on the transformer.

W = loss at temperature rise θ.

$$r=\frac{\text{copper loss}}{\text{(iron+copper) loss}},$$

we may put

$$W_0=W_c(1-r)+rW_0.$$

Since iron loss is practically unaffected by temperature, at temperature θ the copper loss

$$=rW_0\left(\frac{234+\theta_0+\theta}{234+\theta_0}\right).$$

If now θ_s we denote the temperature rise at the lower altitude considered for given load conditions, any corresponding rise θ at a higher altitude can be deduced from the following equation, which is derived mathematically from the foregoing without much trouble:

$$\frac{\theta}{\theta_s}=\left(1+\frac{\varphi_2}{100}\right)\left[1+\frac{\frac{\varphi_2}{100}nr\theta_s}{234+\theta_0+r\theta_s(1-n)}\right]. \quad \ldots\ldots \quad (10)$$

While equation (10) may be used for calculating the temperature rise for various altitudes and for various ratios of copper to iron loss, it is not in a convenient form and for commercial transformers conditions are usually such that we can assume definite values of r, θ_0, θ_s and n and the error introduced for other conditions is permissible.

Assuming a difference in altitude of 1,000 ft., that is, when $A=1$, and letting $R=0$, $n=0{\cdot}8$, $\theta_0=30$, $\theta_s=50$°C. and $r=0{\cdot}6$, and substituting these values in equation (10), we have $\left(\frac{\theta}{\theta_s}-1\right)100=1{\cdot}6A$; that is, we have increased in equation (9) the value $1{\cdot}46A$ to $1{\cdot}6A$ due to the fact that 60 per cent. of the total loss is in copper windings.

Then

$$\varphi=\frac{1{\cdot}6A}{1+1{\cdot}3R}. \quad \ldots\ldots\ldots \quad (11)$$

Curves calculated from equation (11) for different values of R are shown in Fig. 4, together with a curve representing the present A.I.E.E. (para. 308) rule.

Table I. shows a comparison between observed temperature rises and calculated temperature rises by equation (9), based on complete data on observations conducted at Pittsfield, Mass., Boulder, Colo., and at Leadville, Colo.

An inspection of Table I. shows that the calculated and observed temperature rises for all tests on tank No. 1, which is the most important of the three (because the effect is greatest) agree very well. Also there is only a slight difference, the observed being lower than the calculated values, for the Leadville tests on tanks Nos. 2 and 3. Why the observed and calculated values for the Boulder tests on tanks Nos. 2 and 3 do not agree any better is not clearly understood. This difference is no doubt mostly due to the fact that the room temperatures were from 3 deg. to 6 deg. higher at Boulder than at Pittsfield, which as seen before, has the effect of increasing the tank's effectiveness for radiation. The difference is largest for the plain tank where radiation plays the more prominent part. Also, it will be noted that the humidity of the air at the former place was somewhat higher, but in general this has been shown to have very little effect.

Experimental Observations.

Observations were made under exactly the same conditions, with the above exceptions, at Pittsfield, Mass., approximately 1,000 ft. above sea level; Boulder, Col., approximately 6,000 ft. above sea level; Leadville, Colo., approximately 11,000 ft. above sea level.

The housing consisted of pressboard walls made up into sections, so it could be easily assembled and disassembled. The room temperature was controlled by means of sliding covers. In a few instances when the supplied loss was small, in order to keep the room temperature from falling below the desired value, it was necessary to use a small electric heater.

Two 16 in. desk fans were operated in a vertical position in opposite corners of the room, with pressboard screens placed between the fans and the tank to prevent breezes from striking the surface of the tank. The room temperature used as a base was taken as the average of the four thermometers placed on a level with the centre of the tank, in each corner of the room. In addition to the room temperature being used as the base, the temperature of a small

Table I.

Test No.	Approx. average surface rise °C. at Pittsfield.	Temperature rise in percentage above rise at Pittsfield.					
		Tests at Boulder.			Tests at Leadville.		
		Calculated by equation (9).	Rise above		Calculated by equation (9).	Rise above	
			Average room.	Idle tank.		Average room.	Idle tank.
			Tank No. 1.				
1	17·5	6·2	6·83	8·32	12·0	10·0	11·0
2	29·7	6·1	5·5	7·0	12·6	13·5	14·6
3	44·4	5·7	6·7	7·5	11·0	12·6	13·3
Mean values		6·0	6·34	7·6	11·9	12·0	12·9
Mean value obtained by formula					11·05		
		Tank No. 2.					
4	15·8	4·6	0	0	9·5	6·06	7·40
5	31·4	5·0	3·3	1·85	10·7	8·75	9·50
6	44·4	4·8	1·95	1·78	9·6	8·65	9·95
Mean values		4·8	1·42	1·27	9·95	7·82	8·95
Mean value obtained by formula					9·3		
		Tank No. 3.					
7	9·85	3·1	0	0	6·4	5·77	5·6
8	31·5	3·55	−3·34	−3·34	6·6	3·82	4·05
9	48·3	3·43	−2·82	−3·26	6·4	4·32	5·0
Mean values		3·36	−2·08	−2·2	6·45	4·6	4·88
Mean value obtained by formula					5·85		

NOTE.—Instead of using here a constant value for W_r/W_c for different temperature rises, the values are based upon actual watts dissipated as given by equations (1) and (3) for surface temperature rises shown in second column above. Since the values for W_c and W_r change in opposite directions for change in altitude, the calculations are made for the proper values at an average altitude of Pittsfield and Boulder (5,000 ft. above sea-level).

Digitized by Google

lighting size transformer tank, filled with oil, set with its centre on a level with the centre of the tank under test, was also used. The percentage of humidity of the air, during all tests, was determined by means of wet and dry mercury bulb thermometers. The barometric pressure was observed with a mercurial barometer. Particular care was taken to see that the oil height was the same for similar tests at all three altitudes.

Tanks.—The covers for the three tanks were insulated thermally from the tanks proper. Also for tank No. 1 the two plain sides were covered each with two 1 in. thicknesses of hair felt, so as to make the loss by radiation a minimum. However, in order to determine the amount of heat passing out through these blanketed sides, the blanketing material was covered with a sheet iron casing of black colour. By observing the temperature of these insulated sides and covers it was possible to calculate the amount of heat lost.

These losses were small, but in making calculations for comparison of dissipated with input losses, these blanketed areas were considered.

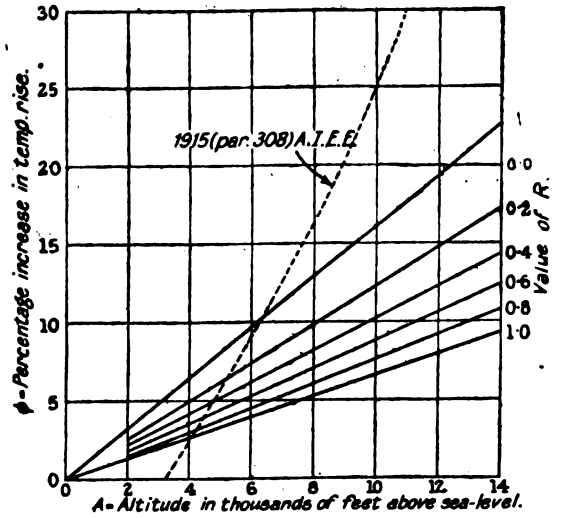


FIG. 4.—CURVE SHOWING EFFECT OF ALTITUDE IN HEATING OF DIFFERENT SHAPE TANK SURFACES CALCULATED BY FORMULA (11).

The developed surfaces effective for convection were as follows :—

Tank No. 1 (24 corrug. 9 in. in depth)	26,100 sq. in.
Tank No. 2 (43 corrug. 3½ in. in depth)	18,910 sq. in.
Tank No. 3 (plain sides) 23·25 in. × π × 51·25 in.	3,750 sq. in.

The envelope surfaces (not blanketed) effective for radiation were :

Tank No. 1	3,560 sq. in.
Tank No. 2	7,160 sq. in.
Tank No. 3	3,750 sq. in.

The values of R (envelope divided by developed surface) for the above tanks are as follows :—

Tank No.	R.
1	0·137
2	0·378
3	1·0

Method of Loading.—Each tank was fitted with tubes wound (non-inductively) with resistance wires of zero temperature coefficient, and so arranged that by connecting in parallel various combinations proper losses were supplied, at 100 volts pressure, to give three minimum oil rises ranging from about 20°C. to 60°C. These tubes were so grouped that for each test the loss was uniformly distributed over the tank. The regulation was within 1 per cent. under all conditions.

A wattmeter was used to obtain a check on the input losses as found by the voltammeter method (volts × amperes). All the thermometers were of the mercury bulb type, and only those reading accurately within ½°C. by calibration were used.

In order to obtain the temperature gradient along the surface of the tanks (for checking input against dissipated losses), thermometers were placed at short intervals from top to bottom on both the outside and inside bend of the corrugations. Small felt pads and putty were placed over the bulbs to protect them from the influence of the room. At Pittsfield thermocouples were welded to the tank surface adjoining five of these thermometer bulbs to obtain a check on the temperatures. The thermocouples and thermometers read together, in almost all cases, within 1°C., showing that the felt pads were not causing hot spots from a blanketing effect.

For each test the run was continued at least 8 or 10 and in some cases 15 hours after conditions became constant, and an average of these readings (observed hourly) was taken as the final value.

CORRESPONDENCE.

CONCERNING ILLUSTRATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : In one of the book reviews in your issue of the 14th inst., the reviewer deprecates the use of half-tone blocks, and recommends that of perspective line blocks.

For views of isolated machines, apparatus and parts this kind of block is, of course, much to be preferred in many cases. The drawings for such blocks, however, can only be executed by specially-skilled draughtsmen, and, as they are usually drawn from photos or half-tone impressions, there is great likelihood of details, and even outlines, being vaguely or incorrectly shown. To get the best results the draughtsman, or rather artist, must be skilled in such work, and must have access to general drawings and to the actual apparatus. Further, the perspective drawings should be shaded. It will be clear, then, that, even with small apparatus and parts that can be sent to and fro by post, such drawings are very expensive, and that the expense increases with the size of the apparatus.

Some books have very good illustrations of this kind, but there are cases where they are markedly unsatisfactory. One seldom finds illustrations of this description in manufacturers' publications, which proves, I think, that the necessary artists belong to a rare species.—I am, &c.,

London, Sept. 22. W. PERREN MAYCOCK.

INDUSTRIAL RECONSTRUCTION.

At Huddersfield on Saturday the Minister of Reconstruction (Dr. Addison, M.P.) delivered an interesting speech on industrial problems created by the war and on "social reconstruction" after the war.

Dr. ADDISON pointed out that the Germans had been busy for some time past endeavouring in different parts of the world to secure supplies of materials to acquire control of shipping and to arrange far ahead for the purchase of supplies that our people would need. In the past our traders as a whole had not recognised as they might have done that the securing of a sufficient supply of raw material, wherever it was to be found, was the first essential step in industrial security, and he found that the German Minister of Reconstruction had started there. Another aspect of the question necessitated careful forethought. If hostilities ceased to-morrow, what was going to happen to the hundreds of thousands now solely employed upon the production of war material ? In addition to those, some millions of men now in the Army would be thrown on to the industrial market. Of course, the Army would not be demobilised all at once, and he was glad to say that great progress had been made by a Committee, working with the War Office and others, in examining the problem. Throughout the country places were being held ready for the men to come back to, and, without stating the number with any real precision, it would certainly be over a million. Furthermore, men on railways, shipbuilding, and services of that kind would be badly wanted, and that question was being gone into with respect to the Army, with a view to ascertaining the men for whom places were ready, and who would be needed in occupations that would want to start ahead quickly. Apart from the labour aspect of the problem, was the question of the material for industry and money. It was only common sense and right that ordinary trade channels should be got back into normal working condition as quickly as possible ; but, while that was so there would, he was afraid, be a world shortage of some very important commodities, and it was very desirable in considering the question that the Government should carry with them the concurrence of business men, for it was the duty of the Government to secure to manufacturers and traders, whether great or small, material to work with, and to avoid, as far as possible, prices soaring any higher than could be prevented. That difficulty would be aggravated not only by the shortage of ships, but by the fact that ships had been taken off their ordinary trading routes, and a considerable interval would elapse before those route could be re-established. The more traders were able to do for themselves the more he would be pleased. Therefore, he proposed to consult the different trades as to the best way of effecting that. One obvious thing for the traders to do was to get together to help themselves. That would not solve all the difficulties, but it was of the greatest consequence that the different trades should, as soon as possible, associate themselves not only to help the Government but to deal with their own difficulties. It was of great national importance that trade differences, where they were not fundamental, should be overcome ; and he believed that both for workmen and employers the formation of proper trade associations was of the greatest consequence. The war had shown us very clearly not only that the elements of labour management, technical experience,

Digitized by Google

research, science, and marketing could not be worked successfully in water-tight compartments, but also that this country had never made the use that it ought to have done of brains. What they owed in this war to a number of highly trained scientific men in overcoming the difficulties of supplying our armies could never be expressed, and those men had been paid salaries in some cases by people who ought to have known better that were a disgrace to the community.

Basis of Increased Industrial Output.—But whatever the difficulties of the transition period, between war and the re-establishment of peace industries, we should never overcome the devastation of the war unless as a nation we could increase our productivity. Happily, we could do it, but to do it four things were necessary: (1) Better co-operation between capital and labour; (2) better conditions of life; (3) better training; (4) better industrial methods. The suggestion to form Labour and Employers' Councils had within it great possibilities for usefulness. Indeed, unless in some such form labour and capital could be got together for the settlement of differences we should make no real progress in increasing our output, for the essential thing was that labour, so far from desiring to limit output, should have an interest in the opposite direction. Labour, in short, was entitled to a share in the benefits of the increased output.

Coming to improved trade methods, Dr. Addison said that, whatever else the Ministry of Munitions had done for this country, it had taught us that to be successful we must look at things big. Trade was a very complex thing, but in this country we had nothing like the organisation that we ought to have. One of the chief reasons why the German industry invaded some of our markets was because they organised their buying and selling on comprehensive big lines. We had got to do the same. Our commercial intelligence had not been of the best, and steps were now being taken to remove some of its chief defects. Further, he was quite sure our manufacturers and traders ought to put their heads together and examine their processes and their plant to see if they had the very best for the purpose. No doubt, it would be found that a very great deal ought to be scrapped. Again, we must examine our methods of working and management with a view to getting the maximum amount of efficiency from plant. We wanted the same enthusiasm brought into industrial production as had been shown recently in the cultivation of waste ground for the production of food. The same held good of agriculture, of the proper utilisation of coal and its by-products, and the development of electricity. If, for instance, the power supply of this country were dealt with on comprehensive lines, with modern plant, we could save 55 million tons of coal and still produce the same amount of power, whilst with the consumption of the same amount of coal as at present we could supply continuously 15 million more horse-power. That would transform some of our country towns. Yet we had not yet started to look at the question. In oils alone we could be independent of foreign sources. Our means of transport, too, possessed great possibilities of improvement—greater, perhaps, than any other general service. That was essential, in fact, for the proper utilisation of our food-producing areas, together with the organisation of co-operative effort in marketing. When peace was restored there would come to us an opportunity as great as any in our history. Neglect it, and we might be handicapped for a generation.

AUSTRALIAN MINIMUM WAGES AWARD.

In June last Mr. Justice Powers announced the terms of his award in the case of the Engine-drivers and Firemen's Association. The award prescribes that

The minimum rate of wages shall be per day:—Locomotive drivers, 12s.; if they sometimes carry passengers, 13s. If the gauge be less than 3 ft., 1s. a day less. Winding engineers, 12s. 6d.; train drivers, lofty cranes, or hoists, 13s. 6d.; more than three motions, 12s. 3d.; not more than three motions, 11s. 3d.; traction engine-drivers, 12s.; other engine-drivers, with engines of single cylinder, having a 12-in. bore, two or more cylinders, the sum of whose total bores exceed 12 in., turbine engine, internal combustion engine of over 50 b.h.p., 11s. 6d., others, 11s.; condensing engine-drivers, 6d. additional. If attending dynamo engines with bores exceeding 24 in., 1s. extra; if less, 6d. extra. If engine-driver in charge of plant, 6d. extra; motor drivers, 10s.; motor attendants, 10s. 3d.; attendants in charge of sub-stations, 11s. Firemen attending one boiler or suction gas generator, 10s.; attending two, 10s. 8d.; attending three, 11s.; locomotive firemen, 10s. 6d.; trimmers and greasers, 10s.; if they sometimes start or stop engines, 1s. extra; engine cleaners and boiler cleaners, 10s.; with dirty work, 12s.; casual boiler cleaners, 3d. per hour extra.

In the case of employees other than locomotive drivers and locomotive firemen, eight hours shall constitute a day's work, and except in the case of a continuous process, 48 hours a week's work. Time of duty may be 8¾ hours on five days and 4¼ hours one day, or 8½ hours five days and 5½ hours one day. In the case of a continuous process, all time of duty in excess of 96 hours in any fortnight shall be deemed overtime, except when owing to the arrangements between employees thier rotation of shifts or the relieving men not coming on duty overtime to be paid time and a quarter the first two hours, and time and a half afterwards. For time on duty on Sundays and holidays time and a half is to be paid, with certain exceptions as to continuous processes in metalliferous mines in Victoria, or where pumping or repairs in a mining undertaking are necessary. In these cases time and a quarter to be paid. For locomotive engine-drivers and locomotive firemen, 48 hours a week is prescribed, with overtime and time and a quarter for the first two hours, and after time and a half; and time and a half after 10 hours in a day. Winding engine-drivers are not required to do any work other than to attend to their engines, if liable to raise or lower human beings, except in cases of certain responds, or of consent of the organisation, or a board of reference. The minimum wage is to be calculated on the highest function of work performed. The award is to operate until Nov. 27, 1918.

Before delivering his award the judge commented upon the difficulty of fixing a "basic" living wage, and the insufficiency of the data available, which were collected for statistical purposes and were largely unsuitable to the requirements of the Court. The greatest difficulty was in fixing a minimum rate for parts of States, because of new evidence on the question of a "living" wage. For the first time since the war began the Commonwealth statistician showed that for the last 12 months there has been a gradual decrease in the cost of living. The purchasing power of a sovereign in the six capital cities was represented by the following amounts:—1916: First quarter, 27s.; second, 26s. 8d.; third, 26s. 4d.; fourth, 26s. 1917: First, 26s. The completed figures for April showed that the reduction continued, but it was not safe to presume that it would continue. A graph put in evidence showed that prices had fallen for more than 12 months gradually, but consistently. It seemed strange that while the cost of living appeared to have increased during the war in most parts of the world, it had decreased in Australia, but it was not hard to understand when it was recognised that Australia was a self-contained country, producing far more than it could consume, in wheat and other things, which, for want of shipping, could not be got away. The Court had recognised that the time must come when it would not be justified in increasing the rate of wages each year, and that the basic rate would be less when there was a substantial fall in the price of food and groceries. A marked reversal to normal conditions, or a substantial fall, had not taken place. The reduction shown might not last, and did not warrant him in reducing the wage fixed by Mr. Justice Higgins in September, 1916, or his own late award of £3 a week, but in face of a general decrease over 12 months, and that decrease continuing, he did not feel justified in increasing the basic wage at the present time. The request for an increase was easily made, but, if granted, would mean an enormous extra charge on all industries, and that would only be warranted at times like the present if the Court was satisfied that it was necessary to enable workers with wives and families of three children to live in reasonable comfort.

Without questioning the value of the statistician's figures for the purposes for which they were obtained, he found them unsatisfactory as the only basis for fixing a living wage. Shortly put, the method of ascertaining the mass unit on the estimated consumption of all classes, made it impossible for the statistician to accurately ascertain the cost of living of a working man and his family. The figures given showed the increased price of food and groceries and of rent only; the cost of food and groceries and rent was estimated at about 60 per cent. of the ordinary expenditure of a labourer on a basic wage. The evidence given showed that the items referred to constituted more than 60 per cent. of the expenditure referred to; no figures were given as to the increased cost of clothing, or of the rest of the items of the 40 per cent. of the expenditure of a labourer; and the Court had had to assume that the increased cost of clothing was at the same rate as food, groceries and rent combined. The possible unfairness of that was shown by the fact that, if food and groceries alone had been taken, it would have been unfair to the employer, because rents had not increased materially, and food and groceries had increased about 25 per cent. It was likely that the cost of clothing had increased as much as food and groceries. The more shipping was interfered with the lower the price of necessaries they produced would become, but clothing would become dearer. That would make the statistician's figures more misleading as the basis for fixing a living wage. He had previously recommended the appointment of a commission to inquire into the question of a Federal living wage, and Mr. Justice Higgins had suggested a similar inquiry. He again strongly supported this suggestion. State wages boards were, generally speaking, established to prevent sweating, and to secure to employees a living wage. Industrial Courts were recognised as established to grant something more than a bare living wage. The Industrial Courts in New South Wales and South Australia, after special inquiries into the cost of living, had fixed the living wage at 9s. 3d. and 9s. respectively, considerably below the minimum wage fixed by that Court. The result of an inquiry would give all Courts a common basis on which uniform awards would be possible. The divergent views expressed by Commonwealth and State Courts were not in the public interest, or in the interest of industrial peace. Industrial unrest was being caused among the workers by different Courts fixing different basic wages for workers in the same locality, and dissatisfaction was caused to employers by different rates being fixed in different States, and different parts of States, based on a living wage arrived at by different methods. The difficulty might be met to some extent by a conference of the presidents of the Commonwealth and State Courts to see if some common basis could be found, pending the inquiry.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Gravitation: Discovery of its Cause and Mechanism," by H. Jamyn Brooks. (Bristol: J. W. Arrowsmith, Ltd.) Pp. 48. 1s. net.

"Practical Electric Illumination," by T. Croft. (London: The Hill Publishing Co.) Pp. xi.+225. 8s. 4d. net.

"Year Book of the Carnegie Endowment for International Peace, 1917." (Washington: Carnegie Endowment.) Pp. xvii.+213.

Digitized by Google

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 SPECIFICATIONS.

12,883 SCOTT. Electromechanical locks for the gates or doors of electric lifts or the like. (8/9/15.)

1916 SPECIFICATIONS.

2,375 HOPE. Combined plug, socket and switch devices for electric circuits. (17/8/16.) 108,685.

6,702 STUDT. Electrolytic deposition of copper from acid solutions. (10/5/16.) (Cognate application, 14,467/16.) 108,688.

6,780 BERRY. Electric heat radiators. (11/5/16.) 108,689.

11,381 LISTER. Electric knife switches. (11/8/16.) 108,703.

11,429 HEFBURN. Bipolar electrode electrolysers. (12/8/16.) (Cognate application 12,903/16; addition to 12,730/15.) 108,707.

11,604 RELAY AUTOMATIC TELEPHONE CO. & AITKEN. Automatic and semi-automatic telephone systems. (16/8/16.) 108,714.

11,605 RELAY AUTOMATIC TELEPHONE Co. & AITKEN. Automatic and semi-automatic telephone systems. (16/8/16.) 108,715.

11,617 SYKES' INTERLOCKING SIGNAL CO. & TARRANT. Electrically-operated indicator mechanism. (16/8/16.) 108,717.

11,710 CHARLES. Apparatus for heating water and other liquids electrically. (18/8/16.) 108,723.

11,769 CRUCIBLE STEEL CO. OF AMERICA. Electric motor gyroscopes and means for making electrical connection therewith. (3/11/15.) (Addition to 11,752/16.) 102,044.

11,789 BRITISH ELECTRIC TRANSFORMER CO. & MOUNT. Electric transformers. (19/8/16.) 108,727.

11,836 ALLDIS. Electrically-operated clocks and the like. (21/8/16.) 108,729.

12,299 BOOTH. Ignition terminals more particularly for use in aeroplane engines. (30/8/16.) 108,745.

12,535 DAVEY & CO. & JAMES. Electric signalling lamps, particularly for ships. (5/9/16.) 108,748.

12,558 LUCAS & EDWARDS. Electromagnetically-operated horns. (5/9/16.) 108,750.

12,624 B.T.-H. Co. (G.E. Co.) Systems of electric motor control. (6/9/16.) 108,752.

12,845 CHRYST. Starting systems for internal combustion engines. (30/9/15.) 101,626.

13,235 BRANDT. Incandescent electric lamps. (18/9/15.) 101,547.

13,277 SQUIER, AUSTIN & COHEN. Telegraphy. (19/9/16.) 108,763.

A system of electrical line signalling in which is superimposed upon a standard duplex equipment that operates with unbroken alternating current of determined frequency but varying amplitude, an extra simplex circuit operating with an unbroken alternating current of different frequency from that employed in the said duplex system, and the signals of the simplex circuit are interpreted by audition.

13,665 DEVENTER. Ignition mechanism for internal combustion engines. (28/10/15.) 101,965.

13,758 LATOUR. Dynamo-electric machines. (7/9/15.) 107,193.

13,825 HOGGMANN & WOLTER. Portable electric lamps. (25/9/15.) 101,637.

13,984 HULT & HULT. Magnets for magneto-ignition apparatus for explosion or internal combustion motors. (2/10/16.) 108,768.

14,291 HUNTER & DAVIS. Recording attachment for electric current measuring and testing apparatus. (7/10/16.) 108,770.

14,355 SUBMARINE WIRELESS Co. Sound-operated circuit controller. (19/5/16.) 106,463.

16,106 ELECTRIC CONTROL, LTD. & ELLEFSEN, O. Dash-pot retarding and time limit devices, particularly applicable for use in conjunction with electric apparatus. (10/11/16.) 108,974.

16,661 IRVINE. Electrodes as used for welding purposes. (21/11/16.) 108,789.

17,507 B.T.-H. Co. (G.E. Co.) Electrical discharge devices. (6/12/16.) 108,793.

An electrical discharge device comprising an envelope consisting of a conductive section and an insulating section sealed to each other, a cathode sealed into said insulating section, co-operating with said conductive section acting as anode, and a re-entrant tubular member connected to conductive section of said envelope extending into the insulating section thereof, spaced closely adjacent but out of contact with said envelope.

17,716 BRADSHAW & CALLENDER'S CABLE & CONSTRUCTION CO. Electric fuses. (9/12/16.) 108,795.

18,562 JOHANNSON, R. Automatic cut-outs for electric circuits. (28/12/16.) 108,998.

1917 SPECIFICATIONS.

640 IGRANIC ELECTRIC Co. (Cutler Hammer-Manufacturing Co.) Overload circuit breakers. (12/1/17.) 109,003.

Comprises in combination a tripping solenoid, a magnetic plug at one end of the solenoid, a plunger of varying section operating with the said solenoid, a dashpot of varying section, a piston connected to the said plunger and operating in the dashpot to provide a time element for the apparatus, external control means for the time element comprising a byepass and adjusting screw, a switch, a pivoted lever connected to the said plunger and operating to actuate the switch, and a weight adjustable on the said lever to vary the current limit for the apparatus.

2,617 MCCOLL, A. E. Protective devices for alternating current electric systems (20/7/16.) (Divided application on 10,227/16.) 109,009.

Controlling means for the protection of parallel feeders or circuits of single-phase or polyphase alternating current electric systems at the end adjacent to the source of supply, consisting of relays which act both as balanced and overload relays so that, if one feeder or circuit of a group of parallel feeders or circuits become faulty, it is immediately cut out due to alteration of the current balance between the sound and faulty feeders or circuits, whereas, if an overload or a fault develop of a nature such that equal currents flow in the feeders or circuits, the relays operate by overload to disconnect all the parallel feeders or circuits.

5,168 BRITISH WESTINGHOUSE ELECTRIC & MANUFACTURING CO. Systems of control for single-phase commutator motors. (12/4/16.) 105,913

5,295 FELTEN & GUILLEAUME CARLSWERK AKT. GES. Insulation of submarine telephone cables. (14/4/16.) 105,573.

5,315 FRANCE. A. G. Sparking plugs for internal combustion engines. (16/4/17.) 109,019.

6,036 HARTINGTON, J. Trigger mechanism of double-barrelled hammerless guns of the Anson & Deeley and like types. (28/4/17.) 109,023.

7,712 HEYWOOD, S. H. & HEYWOOD & CO., S. H. Over-winding preventing switch for electric cranes or the like. (30/5/17.) 109,029.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

September 3, 1917.

12,615 LAMKIN. Sparking plugs.

12,623 SULLIVAN. Telegraph relays.

September 4, 1917.

12,629 TEASDALE-BUCKELL. Sound filters for telephone receivers, &c.

12,655 ROSS & CO., BREMNER & SMITH. Portable electric lamps.

12,681 A. G. BROWN, BOVERI ET CIE. Balancing axial thrust in impulse reaction turbines. (27/9/16, Switzerland.)

September 5, 1917.

12,712 LUCAS. Wireless telegraph receivers.

12,721 IRELAND. Interrupters for electric circuits.

12,724 TURNER. Electro-pneumatic braking systems. (29/3/17, U.S.)

12,727 TURNER. Electro-pneumatic braking systems. (17/4/17, U.S.)

September 6, 1917.

12,789 TURNER. Magnetos.

12,796 CHLORIDE ELECTRIC STORAGE CO., BATT & DEAN. Device for indicating condition of secondary electric batteries.

12,814 GREVILLE. X-ray tube stand and table.

September 7, 1917.

12,816 CORNTHWAITE. Electric induction furnaces.

12,819 CARR. Electric vehicle or locomotive trolley pole manipulating means.

12,830 HARRISON. Electric ignition, lighting and starting of internal combustion engine. driven vehicles.

12,854 JAMES. Controlling means for electrically operated feed reel brakes.

12,855 BENTLEY & SCOTT. Control of electric crane, motors, &c.

12,857 ROSS. Electrical resistances.

12,858 POLINKOWSKY. (Western Electric Co., partly.) Automatic circuit changing switches.

September 8, 1917.

12,911 MARCONI'S WIRELESS TELEGRAPH CO. & FRANKLIN. Wireless telegraph transmitters.

12,917 IMRAY. (Schilowsky.) Electric transmission of rotary motion or signals.

September 10, 1917.

12,924 CRANHO. Luminous electric light switch.

12,925 FITTON. Device for winding telephones, &c., wire on drum or reels.

12,938 SANDYCROFT (LTD.) & CLEAVER. Insulation of windings of electrical machines, &c.

12,957 M. L. MAGNETO SYND. & WATSON. Ignition apparatus for internal combustion engines.

12,959 PARSONS & LAW. Dynamo-electric machines.

12,961 ARTER. Magnetic chucks.

12,980 LEYLAND MOTORS (LTD.) & THOMAS. Electric starting and ignition of aeroplane engines, &c.

September 11, 1917

12,993 HAIGH. Automatic time cut-off electric, &c., power.

13,008 FRANKLIN & WALLER. Searchlights.

13,019 SOC. LORRAINE DES ANC. ETABS DE DIETRICH ET CIE DE LUNEVILLE. Driving magnetos in connection with internal combustion engines. (30/9/16, France.)

13,020 A. G. BROWN, BOVERI ET CIE. Turbines.

13,028 OSRAM-ROBERTSON LAMP WORKS & DURDLE. Electrodes for ionic tubes for wireless telegraphy, &c.

13,029 SYKES INTERLOCKING SIGNAL CO. & TARRANT. Rheostats.

September 12, 1917.

13,057 SPENCER. Overhead trolleys or collectors.

13,066 WOODMAN. Electric incandescent lamps.

13,070 M. L. MAGNETO SYND. & HULSE. Magneto eleotric ignition apparatus for internal combustion engines.

13,072 WESTERN ELECTRIC CO. Wireless telegraphy and telephony.

13,083 SOC. LORRAINE DES ANC. ENGINES. ETABS DE DIETRICH ET CIE DE LUNEVILLE Driving magnetos for internal combustion engines. (29/1/17, France.)

13,084 SOC. LORRAINE DES ANC. ENGINES. ETABS DE DIETRICH ET CIE DE LUNEVILLE. Driving magnetos for internal combustion engines. (3/3/17, France.)

13,094 LATOUR. Audion or lamp relay or amplifying apparatus for wireless telegraphy and telephony.

13,098 ADAMS & WATKINSON. Devices for controlling intensity of electric currents.

September 13, 1917.

13,108 ROBINSON & WORKMAN. Apparatus for heating water by electricity.

13,126 AYRES & HAMMERTON. Cable suspender.

13,136 COOPER, LYON & TODMAN. Brush-gear for dynamos and motors.

13,139 STONE & DARKER. Brush and terminal contact mechanism of dynamo-electric machines.

13,141 BELEFIELD. Incandescent electric lamps.

September 14, 1917.

13,164 EDWARDS. Electric switches, &c.

13,166 CONNER & PACKETTE. Automatic electric switching apparatus.

13,167 CONNER. Telephone receivers.

13,172 TURNER, BLACKWELL & HAMILTON. Electrodes for furnaces, &c.

13,191 STEVENS. Automatic telephone system.

13,192 STEVENS. Automatic telephone sub-station mechanism.

13,193 STEVENS. Automatic telephone centralisation apparatus.

VOLUNTEER NOTICES.

COUNTY OF LONDON VOLUNTEER ENGINEERS.

Orders for the Week.

Officer Commanding, Lieut.-Colonel C. B. CLAY, V.D.

Officer for the Week.—Lieut. W. J. A. Watkins.

Next for Duty.—Second-Lieut. P. Bowden.

Monday, Oct. 1.—Drill and Elementary Bridge Construction for No. 3 Company, Right Half Company, 6.30 Signalling Class, 6.30. Recruits' Drill, 6.30.

Tuesday, Oct. 2.—Physical Drill and Bayonet Fighting, 7.30.

Wednesday, Oct. 3.—Drill and Elementary Bridge Construction for No. 1 Company, 6.30.

Thursday, Oct. 4.—Drill and Elementary Bridge Construction for No. 2 Company, 6.0. Signalling Class, 6.30. Ambulance Class, 6.30.

Friday, Oct. 5.—Drill and Elementary Bridge Construction for No. 3 Company, Left Half Company, 6.30. Recruits' Drill, 6.30.

Saturday, Oct. 6.—Commandant's Parade for Route March and Drill. Parade at Headquarters 2.45 p.m., uniform. "A" and "B" N.C.O.s and men are reminded that one route march per month is compulsory. Recruits' Drill, 2.30, with Corps Parade for Route March.

Musketry.—The range at Belvedere-road will be open on Tuesdays, Wednesdays and Thursdays every evening between 5.30 p.m. and 7 p.m. All N.C.O.s and men who have signed the "A" and "B" agreements are required to attend during this month to reclassify in order to enable the Corps to obtain the capitation grant. Preference will be given to these N.C.O.s and men in firing. This does not apply to those who hold the proficiency badge.

Armlets.—The new issue armlets can now be obtained at Headquarters, and every enrolled Volunteer *must* obtain one without delay. At the same time all old red armlets must be returned. Armlets must be worn when attending drills in plain clothes.

Note.—Unless otherwise indicated, all Drills will take place at Headquarters (Balderton-street, Oxford-street).

Digitized by Google

"Try the G.E.C. First"!

This phrase is frequently heard and is justified by reason of the large and varied stock of Wiremen's and Contractors' Sundries always available at the principal Showrooms in London and at their G.E.C. Branches.

CARBON BRUSHES. Diagrams of Stock Sizes.

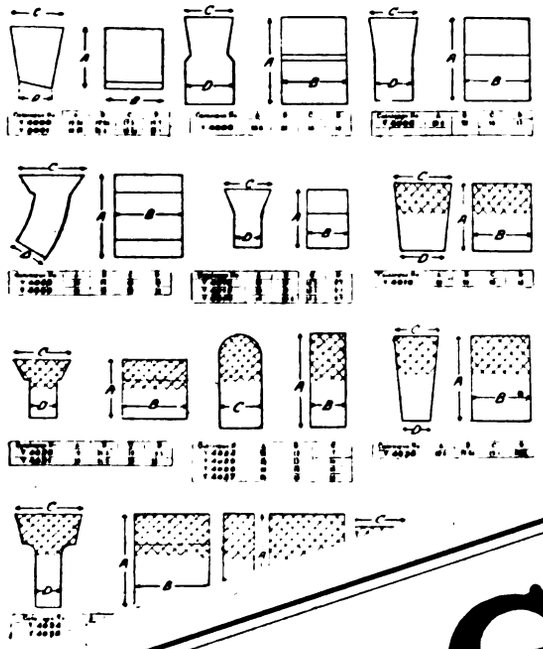
G.E.C.

These brushes are of best solid carbon, entirely free from flaw, and absolutely amorphous throughout. A stock is held of all these sizes, ready for prompt despatch.
Measurements are given in millimeters. For conversion table into inches and fractions see at foot hereof.

This sheet should be hung up on wall or elsewhere for easy reference.

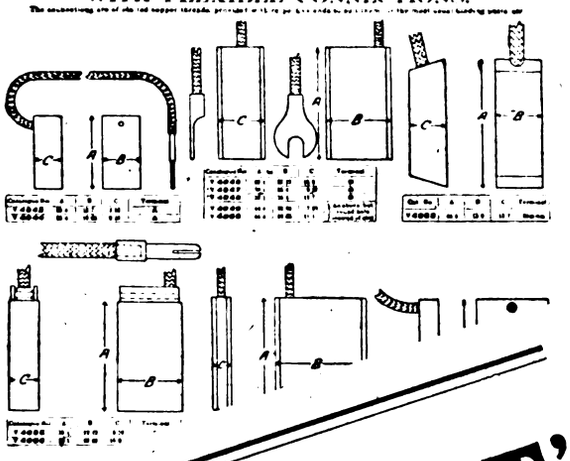
SUNDRY SHAPES.

When required DIFFERENT the repairing or substitution of terminal lugs

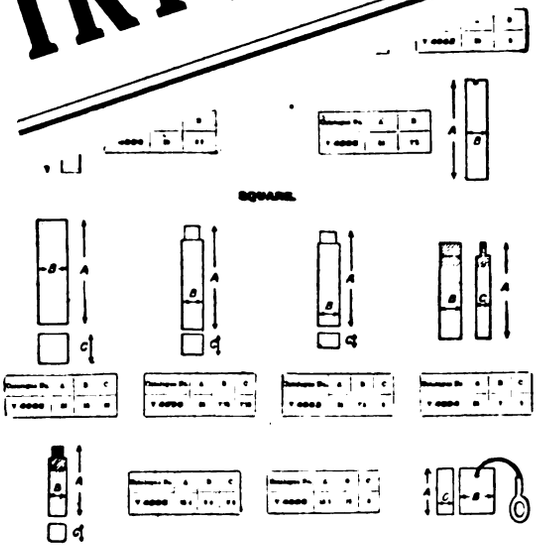


WITH FLEXIBLE CONNECTIONS.

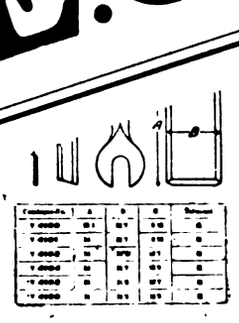
The connecting wire of the best copper threads, protected with tape and braiding, where necessary

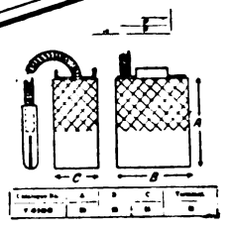


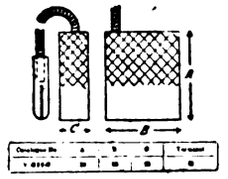
"TRY THE G.E.C. FIRST"

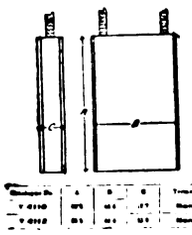


SQUARE.

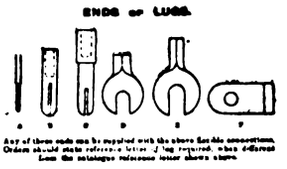








ENDS or LUGS.



Any of these ends can be supplied with the above flexible connections. Order should state reference letter of leg required, when ordered from the catalogue reference letter above shown.

MILLIMETER CONVERSION TABLE.

Equivalents in inches and fractions.

Millimeters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Inches	1/32	1/16	3/32	1/8	5/32	3/16	7/32	1/4	9/32	11/32	7/16	15/32	1/2	17/32	19/32	5/8	21/32	11/16	23/32	25/32
Millimeters	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Inches	13/16	27/32	29/32	15/16	31/32	1	1 1/32	1 1/16	1 3/32	1 1/8	1 5/32	1 3/16	1 7/32	1 1/4	1 9/32	1 5/16	1 11/32	1 3/8	1 13/32	1 7/16

THIS CHART MEASURING 20×16 SUPPLIED GRATIS ON APPLICATION (can be pinned on wall for reference, or folded for pocket).

A large assortment of carbon brushes is now held ready for prompt despatch, and any particular brush for which there is a demand will be added as time goes on. You need not have that motor out of commission long.

The General Electric Company, Ltd.,

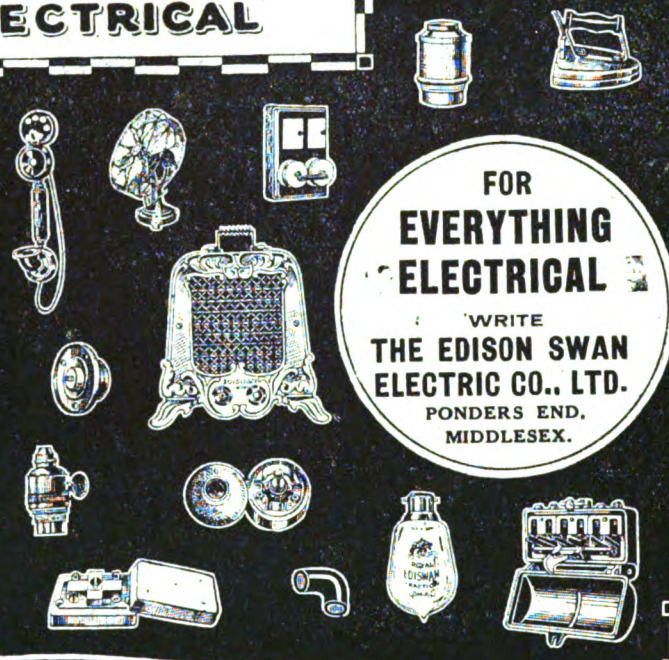
G.E.C.

Principal Showrooms & Sales Depot: **Queen Victoria Street, London, E.C. 4.**

Branches: Manchester, Leeds, Liverpool, Sheffield, Glasgow, Aberdeen, Newcastle, Hull, Birmingham, Nottingham, Cardiff, Bristol, Swansea, Dublin, Belfast, Cork, Southampton, etc.

Digitized by Google

ENGLISH EDISWAN
EVERYTHING
ELECTRICAL



FOR
EVERYTHING
ELECTRICAL
WRITE
THE EDISON SWAN
ELECTRIC CO., LTD.
PONDERS END,
MIDDLESEX.

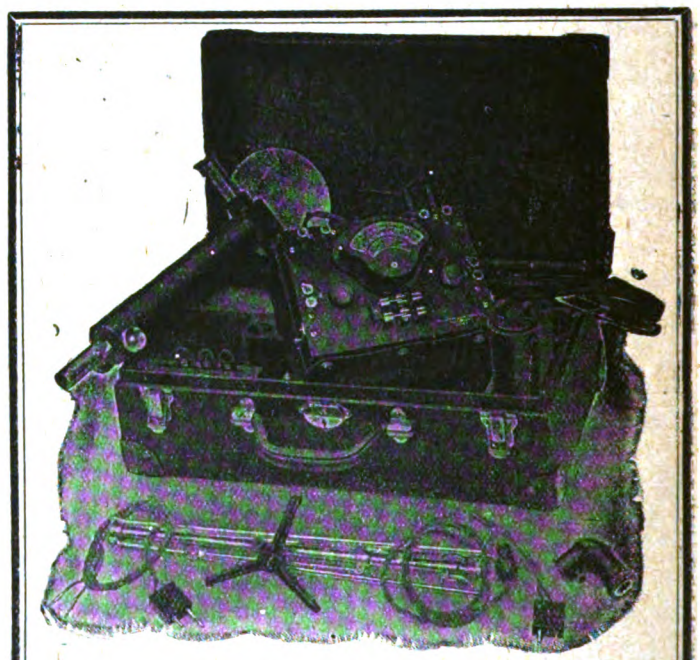
ROYAL EDISWAN
DRAWN WIRE CARBON AND HALF-WATT TYPE LAMPS
ARE UNSURPASSED
IN ALL RESPECTS.

Time costs money.
Save it with—
SUN PORTABLE
ELECTRIC DRILLS

The off-set Drill illustrated is one model of these wonderful little labour and time savers. Operating from any electric light lamp socket, and taking only a quarter of a unit an hour to run, it will drill up to ¼ in. holes in steel. The spindle is off set, so that drilling in corners and other difficult positions is easily carried out. Can be supplied for all circuits from stock, ready to use as soon as unpacked.

WRITE NOW FOR LIST 275.

The SUN ELECTRICAL COMPANY LIMITED
118-120, CHARING CROSS RD., LONDON, W.C. 2.



You can take photometric readings almost instantly with the
MACBETH ILLUMINOMETER

The complete instrument in its carrying case is shown above. To make a measurement, you hold a 20 ounce instrument in your hand and take the reading while in a convenient standing position
The equipment is complete, including a reference standard for checking purposes. You are independent of a laboratary. We want to send you, post free, a catalogue fully describing this device. WRITE US FOR IT.

The Leeds & Northrup Co.,
4925, Stenton Ave., Philadelphia, Pa., U.S.A.

Digitized by Google

COMMERCIAL & INDUSTRIAL SECTION.

Calcium Carbide.

The Minister of Munitions notifies that as from Sept. 24 he has taken possession of all calcium carbide, now or hereafter situated in the United Kingdom, except the stocks of persons who do not own more than half a cwt.

If any person having control of any calcium carbide to which the above Clause applies, without the consent of the Minister of Munitions, sells, removes, or secretes it, or deals with it in any way contrary to any conditions imposed in any permit that may have been granted, he will be guilty of an offence against the Defence of the Realm Regulations.

No person shall, until further notice, buy, sell, or supply, except for carrying out an existing contract in writing, enter in o any transaction or negotiation in relation to the sale or purchase of calcium carbide situated outside the United Kingdom, except under and in accordance with the terms of a permit issued under the authority of the Minister of Munitions.

No person shall offer to sell, sell, supply or deliver any calcium carbide situated in the United Kingdom, except under and in accordance with the terms of a permit.

All persons shall within seven days from the first day of each month commencing in the month of October, 1917, send in to the Controller of Non-Ferrous Materials Supply, monthly returns of:—

(*a*) All calcium carbide held by them on the last day of the preceding month; (*b*) All calcium carbide purchased or sold by them for future delivery and not yet delivered; and (*c*) All calcium carbide delivered to them during the preceding month.

No return is required from any person where total stock of calcium carbide in hand and on order for future delivery to him has not at any time during the preceding month exceeded half a cwt. All applications in reference to this order shall be made to the Controller of Non-Ferrous Materials Supply, AM2/H, Hotel Victoria, Northumberland-avenue, L ndon, W.C. 2, and marked "Calcium Carbide."

* * * *

Industrial Co-operation.

"The Times" of the 20th inst. announces that "we appear to be on the eve of highly important changes in industrial and commercial organisation in this country. We understand that important schemes for consolidating the interests of companies engaged in different industries are being elaborated, and in some cases the negotiations have reached an advanced satge. The electrical, brass and lead manufacturing interests have, like the explosives companies, drawn up projects for the establishment of the co-operative principle in their particular industries. The brass manufacturers' scheme, which contemplates the setting up of a central buying organisation, and also a central export selling agency, has met with unanimous approval among those connected with the industry."

The primary cause of the development is due to the fact that the war has led manufacturers to make a closer examination of the most economical methods of manufacture. Working at full capacity, as all of them have been for the past three years and more, has shown that the cost of production can be very materially reduced, to an extent, in fact, which had been undreamt of by many before the war. The idea of the consolidation policy is that manufacturers should specialise more than they have hitherto done, in order that efficiency may be carried to its highest point and that the maximum of output may be maintained. By co-operation it is hoped to secure in the different branches the highest technical advice, the speedy adoption of improved methods of manufacture and consequently low working costs.

It is also sought to eliminate the unnecessary middlemen, who are mere parasites of industry and whose operations add to the price but not to the value of an article. The war has also taught manufacturers that many articles formerly imported can be made equally well, if not better, in this country if the principle of specialised production is adopted. Without the adoption of the co-operative principle it will be impossible to satisfy the demands of labour. Some form of effective State supervision will have to be evolved in order that the interests of the different parties may be protected in this new development of modern industry.

* * * *

Glass and Glassware.

On Sept. 19 the Minister of Munitions made an Order containing the following provisions:—

Every person shall in the manufacture of glass and glassware comply with all directions and regulations applicable to such manufacture which may be given or made by the Director of Glassware on behalf of the Minister of Munitions. No person shall manufacture or supply any chemical or medical glass or any electric lamp glass or any glass tubing or rod, except (*a*) in fulfilment of an order in writing by a firm holding a direct contract from the Admiralty, War Office or Minister of Munitions; (*b*) in fulfilment of an order approved by the Director of Glassware; or (*c*) under a licence issued by the Director of Glassware. No person shall sell or deal in chemical and medical glass, or glass tubing and rod, or any electric lamp glass situated or manufactured outside the United Kingdom, except under a licence from the Director, provided that nothing in this clause shall prohibit the supply or delivery of any electric lamp glass in accordance with the foregoing provisions with regard to licences or any purchase or sale of or other dealing with any electric lamp glass which forms part of a manufactured article, the total value of which exceeds four times the value of the electric lamp glass forming part thereof and which is *bona fide* sold with such glass.

Returns as to manufacture of and dealings in glass and glassware are to be furnished when required by the Director. This order shall not affect any obligation from the Board of Trade (Department of Import Restrictions) or otherwise import licences for glass and glassware. Chemical and medical glass includes miners' safety lamp glasses, X-ray valves and tubes and glass for X-ray apparatus; and electric lamp glass includes all glass used or intended for use in the manufacture of electric lamps, except glass used in lamp caps for insulating purposes, but does not include glass shades or similar accessories. Orders for which approval is required must be sent in duplicate to the Director, and licences may be given for the manufacture of limited quantities of such glass or glassware for stock or export. In the case of electric lamp glass to be supplied by a dealer and not by a manufacturer, the order on the dealer must be sent in duplicate to the Director with a letter setting out the purpose for which the glass is required.

* * * *

Patents During the War.

Manufacturers and inventors are becoming anxious as to the policy of the Board of Trade in regard to the position of patents for articles and processes during the war. Some months ago the Board announced that the matter was under consideration and legislation was promised, but lately nothing has been heard about the subject, although chambers of commerce, manufacturers and others have made representations to the Board.

In the report of the Birmingham patents, trade marks and designs committee it is pointed out that it was a hardship on manufacturers and inventors holding patents, the working of which was seriously restricted or suspended owing to the war, and urged that the payment of renewal fees should be suspended and the life of the various patents extended so as to give manufacturers and inventors an opportunity of recouping themselves for their outlays. The Committee feel that in this fourth year of the war the time has arrived when the Board of Trade should make a definite pronouncement as to the policy they intend to pursue.

Mr. Marshall Freeman, in moving the adoption of the report, said inventors and manufacturers, after the exercise of great patience, were entitled to know definitely what the policy of the Board of Trade was. The position was one of great difficulty, and he was bound to say the Board were treating them rather unfairly. If their appeal met with no response, the view of the committee was that strong and united action would have to be taken in order to compel the Board to disclose their intentions. With regard to the British Empire trade mark, they thought at first this was a splendid idea, but now they considered it totally impractical.

The report was adopted.

* * * *

U.S.A. Electrical Exports.

According to statistics compiled by the National City Bank of New York the value of the electrical machinery, appliances and instruments exported from the United States in the fiscal year 1916-17 exceeded $50,000,000, against $30,000,000 in 1915-16 and $20,000,000 in 1914-15 and $6,000,000 in 1910. Included in the exports were dynamos, motors, electric fans, lamps, telephone and telegraph instruments and wireless apparatus, &c.

Of nearly $2,000,000 worth of telephones exported in 1917 more than $100,000 worth went to Asia, about an equal value to South America, nearly $100,000 worth to Oceania, $300,000 worth to Canada and practically $1,000,000 worth to Europe, the total telephones exported in 1917 being twice as great in value as in 1912. Of the nearly $500,000 worth of electric fans exported in 1917 the largest market was in India, where the boy operator of the "punkah" holds the world's highest record for somnolence, while Hong Kong, the Straits Settlements, China, Japan and even Siam show a disposition to substitute the new but reliable breeze producer for the uncertain methods of earlier generations.

Electrical apparatus of all sorts sent to Asia increased from $1,000,000 in 1910 to approximately £2,500,000 in 1917; to Africa, from $298,000 in 1910 to over $500,000 in 1917; to Oceania, from $650,000 in 1910 to approximately $2,500,000 in 1917, and to South America from about $3,000,000 in 1910 to approximately $4,000,000 in 1917; while the total of 1917 is nearly 10 times as much as in 1900, and 30 times as much as in 1890.

Digitized by Google

ELECTRICITY SUPPLY.

EXTENSIONS.

Bradford.—Extensions of mains, estimated to cost £600, are to be carried out by the electricity committee.

Sheffield.—The Local Government Board has authorised a loan of £15,000 for sub-station equipment.

Tonbridge.—The Council has agreed to raise a loan of £18,130 for extensions of the electricity works.

The Council has applied to the Board of Trade for an order under Sec. 601 Electric Lighting Act, 1909, for permission to supply electricity outside the Council's area.

GENERAL.

Board of Trade Electric Power Supply Committee.—At the last meeting of Watford Urban Council the chairman of the electric lighting committee reported on the resolutions passed by the committee of the Urban District Councils' Association, and also reported that he had been asked to give evidence before the committee on behalf of the Association.

Mr. Goodrich reported that, in his opinion, the position taken by the U.D.C.A. was not in the interests of local authorities owning electricity undertakings, and that therefore he could not see his way to give evidence. The committee had approved this attitude and had instructed the Clerk to inform the Association accordingly.

The report was adopted by the Council.

In a circular letter to the Metropolitan Borough Councils the London County Council intimate that since the Conference on May 19, 1915, upon the subject of London's electricity supply, the whole question, so far as the L.C.C. are concerned, has remained practically in abeyance. It is now stated that the Electric Power Supply Committee have arrived at certain preliminary conclusions, and are now about to take evidence from authorities interested. The Special Committee of the L.C.C. realise the difficulties of putting forward, in present circumstances, any comprehensive scheme, either for the County of London or for Greater London, but they feel that the time has arrived when public authorities in London, either owning or having powers of purchase in respect of electricity undertakings, should meet in order to discuss the whole situation as it affects Greater London. With this object the Special Committee would be glad to have an opportunity of conferring with the Metropolitan Borough Councils.

We understand that the Conference will be held at an early date and some of the Borough Councils have appointed their delegates.

Bristol.—The electrical committee has reported on the question of the salaries of the staff of the electricity department.

At present the salaries amount to £7,968, those under £165 amounting to £4,145, and those of £156 and over, £3,823. The committee recommend the Council to authorise them to deal with the salaries of members of the staff receiving between £156 and £500 per annum without submitting individual cases, in the same way that they can now deal with salaries up to £156; and to fix from time to time the salaries of all such officers under their control so long as the advances do not exceed in the aggregate a sum to be allowed each year by the Council. It is proposed that the sum to be allowed for the year ending March 31, 1918, shall be £500.

Electricians' Wages.—Workmen and junior officers of municipal electric supply departments are reported to have joined up in the Electrical Trades Union to a large extent, and the Union, with the National Union of General Workers, is bringing pressure to bear upon the Ministry of Labour with a view to securing a 48-hour week and increased normal pay equal to what is claimed to be paid in the Post Office, Dockyards and other Government works, and the awards of the Committee on Production in the engineering trades.

The question was considered by the Associated Municipal Engineers (Greater London) recently, and it was decided that steps should be taken to secure an agreement between the authorities and the Unions; that each municipal authority in Greater London owning an electricity undertaking be asked to appoint two (municipal) representatives and their chief electrical engineer to form a body to treat with the Electrical Trades Union in respect of uniform payment and conditions for electricians at power stations on the basis of the Union trade card, and in respect of the settlement of the war wages to be added to the wages which may be agreed, and with the National Union of General Workers for consideration of the wages of the semi-skilled and unskilled men employed at power stations, &c.

Epsom.—At the last meeting of the Urban Council, Mr. T. N. Young, engineer to the waterworks and acting engineer to the electricity undertaking, reported that since the last meeting circumstances had arisen which would affect the financial position of the electricity undertaking through the great advance in the price of fuel oil from 214s. per ton to 341s. per ton, and it was also difficult to obtain supplies.

In Mr. Young's opinion, the only solution was to convert the Diesel engine for burning tar oil, supplies of which could be obtained at 114s. per ton delivered to the end of March. By adopting that system there would be a loss of £200 on the waterworks undertaking and a gain of £1,000 on the electricity undertaking, thus making a total gain of £800.

The report was adopted.

Hackney (London).—In 1914 the Council entered into a contract with the General Electric Co. for the supply of arc lamp carbons of different dimensions, at 60s. and 70s. per 1,000 pairs. Recently the company pointed out that in August, 1914, almost all their output of carbons had been taken over for Government purposes, but in spite of this they arranged to supply the Council with sufficient carbons to meet urgent requirements; also that owing to the increase in the price of material, &c., the ruling prices per 1,000 pairs are now £12. 4s. 6d. and £10 respectively, and that if they had to complete the contract at the original contract prices, they would incur a serious loss. The company in these circumstances offered to supply carbons of different dimensions, in substitution for the outstanding balance of the carbons specified in the contract. The Electricity Committee offered to relieve the company of the completion of the contract, provided it agreed to supply the Council with 600 half-watt lamps within one month of the removal of the public lighting restrictions. The company accepted the offer, the 600 half-watt type lamps to be supplied at the list price in force on the date on which delivery is made, subject to a discount of 28 per cent.

Hebden Bridge.—The Urban Council has entered into a seven years' agreement with Halifax Corporation for a supply of electricity in bulk. Halifax Corporation has a reducing station at Hebden Bridge, and the Council of the latter district will lay the cable from there to the electricity works, but Halifax will supply the mains, plant and apparatus.

The Future of Electricity and Gas Supply.—In the course of his presidential address at the recent meeting of the Wales and Monmouthshire District Institution of Gas Engineers and Managers, at Briton Ferry, Mr. J. Mogford referred to the question of the competition between gas and electricity.

According to the "Gas World," Mr. Mogford said it was well, in the interests of both supplies, that a spirit of rivalry should be maintained, but there were limits within which such rivalry should be confined. Personally, he confessed to being a firm adherent to the opinions expressed by the late Mr. J. G. Newbigging in his address to the Manchester Institution in 1914. The two supplies were applicable to precisely the same uses. Both were indispensable to the comfort and well-being of the community, and for national economy and the welfare of the general public. The users of both commodities should be able to obtain sound impartial advice as to which was best suited to particular requirements. One could not but agree with Mr. Newbigging that "the avoidance of rash and unfair competition would result in the saving of large sums of money, make for better efficiency, and give greater satisfaction to the public whom we serve." The proposed linking up of electrical undertakings and its probable effect upon the gas industry was a matter which should command the attention of every gas engineer. The present proposals of the electrical industry might not have a serious effect on the largest gasworks, but medium-sized concerns would find that the resultant economies in electrical supply would accentuate the already keen competition, and smaller undertakings, wherever the high tension connecting lines touch or pass through their districts, may be faced with competition which may prove disastrous. Provision of a cheap supply of light and fuel would be of such importance in the coming commercial renaissance that Government departments would be compelled to give prominence to the question of gas and electricity supply. In any case, the interests of the industry should be protected by the formation of district committees for discussing the subject on the lines adopted by the electrical industry. Nine years ago he ventured to place before them a suggestion for the inter-connection of gasworks in the district. Many parts of the area had since been lit electrically, and were lost to the gas industry. Those installations would presently be incorporated in the larger scheme and linked up to central generating stations. The proposal of the electrical industry in South Wales was to link up the existing generating stations at Llanelly, Swansea, and Neath, and, subsequently, to connect up the valleys. Note was being taken of the large steam engines which are used in the district as prime movers for mills, &c., and also of the comparatively large electrical generating stations at collieries and works throughout the area. A feature which was of more interest to the gas engineer was that the smelting works consume large quantities of metallurgical coke, considerable quantities of which are produced in beehive and other non-recovery ovens. These ovens are now being replaced by modern ovens fitted with recovery plant. This combination of circumstances was interesting from the lighting, heating and power point of view. After quoting from the Lancashire and Cheshire report on the linking up of electrical undertakings, Mr. Mogford said that the time had fully come when the supply of light, heat and power to an industrial district should, in the interests of the trade of the nation, be obtained by the destructive distillation of coal, the recovery of its valuable by-products, the complete gasification of such of the residue as was not required for metallurgical purposes the distribution of gas of such composition as investigation should prove to be most suitable for general purposes, and the distribution of electricity generated by means of internal combustion engines.

Digitized by Google

Walsall.—The award of the committee on Production regarding an application by employees of the Walsall Corporation Electric Supply Department, is to the effect that the war bonus of 9s. per week is to be increased to men of 18 and over to 12s. per week, and youths under 18 get a further advance of 1s. 6d. a week.

Willesden.—The rate collectors are each to be paid £20 per annum for collecting electricity accounts. A supply cable is to be extended at a cost of £350 for the Williamson's Kinematograph Co., and it has been decided to purchase a 100 K.V.A. transformer for supply to some works and to erect a new switch pillar to control the Melrose-avenue transformers at a cost of between £50 and £60.

The North Metropolitan Electric Supply Co. recently stated its terms for supply of electricity in bulk for a minimum period of 15 years, but the Electricity Committee is not satisfied with the offer, and the company is to be asked to supply current in bulk for three years from March 31 next at the prices now being paid under the agreement dated March 31, 1910.

LIGHTING AND INDUSTRIAL POWER.

Aberdeen.—The Corporation has entered into an agreement with Messrs. J. M. Henderson & Co., who have decided to install an electric steel furnace.

It has been decided to increase the charges for electric current by 15 per cent.

Birmingham.—It has been decided to light 90 additional lamps at dangerous crossings on the tramway routes of the city.

Cardiff.—It has been decided by the Tramways and Lighting Committee to light 80 further street lamps.

The price of electric current for lighting has been increased by another 5 per cent., making 25 per cent. over the pre-war rate.

Harrogate.—The Acting Chief Constable of the West Riding has authorised the lighting of 200 electric street lamps within the borough, and leaving the question of a possible further increase in abeyance.

Italian Hydro-Electric Schemes.—Turin municipality are considering a project for a new 20,000 kw. hydro-electric station in Valle del Orco. The scheme comprises two basins with capacities of 7 million and 15 million cubic metres respectively, and the total cost is estimated at £1 629 600.

It is also reported that a recent Government inspection of the water courses in proximity to Italian railway lines shows that sufficient water-power exists for the electrification of numerous lines, thus economising fuel.

Swiss Hydro-Electric Power for Germany.—The "Morning Post" reports that "the Swiss Federal Council has authorised the Motor Co. (Ltd.) to deliver 12,000 additional kw. of electrical energy, being the extra output of its generating station at Laufenburg, to the Lonza." The Lonza is said to be identical with the "Kriegs-chemikalen A.G." a purely German company.

ELECTRIC TRACTION.

Edinburgh.—The Corporation have decided to apply for a provisional order to authorise the construction of a tramway to South Queensferry after the war.

In a preliminary report by the Burgh engineer two routes are indicated. One route, by way of the Dean Bridge, is over three miles with five miles on private land. The other route, by way of Comely Bank, would be 3⅝ miles with 5 miles on private land. The overhead trolley system of traction is recommended.

Morecambe.—The Corporation has decided to apply for powers to employ electric or some other form of mechanical traction on the tramways which are operated by horses.

Newcastle.—The town improvement and streets committee recommends the purchase of a second electric tipping wagon for the removal of house refuse.

The acting city engineer reported that in view of the shortage of horses and labour at present, together with the increased cost of hired cartage, the committee should purchase an electric wagon, which would cost £1,123 10s. A statement was presented showing the cost of 41 weeks' working of the existing wagon and the cost involved in carrying out the same work by horse traction. This showed that the saving effected by the employment of the electric tipping wagon was £195 3s. 8d. or 32 per cent.

Train Lighting in India.—A serious train accident recently took place in India owing to the use of gas for lighting.

It appears that a gas cylinder came adrift from underneath the coach of a passenger train whilst running on the Madras and Southern Mahratta Railway between Biccavol and Anaparthi, due to one of the supports failing. The cylinder appears to have been fully charged with gas, and when it fell at one end on to the permanent way, the bogie of the moving vehicle caught it, crushed and forced it up through the floor of the carriage, where it exploded, partially wrecking the carriage and seriously injuring several of the occupants.

West Ham.—The tramways manager (Mr. Lewis Slattery) in a report says:—

"It is inconceivable why no restriction is placed on competition with tramways; such would not be tolerated with other municipal trading departments. In my opinion all municipalities should have statutory powers to license and define routes of all competitive services, if such are deemed requisite, and to regulate fares and fix charges for the maintenance of the roads traversed by such services."

TELEGRAPHY AND TELEPHONY.

Telephone Work in Persia.—An interesting gathering took place at the Midland Hotel, Manchester, on Thursday evening last, when the staff of the firm of L. E. Wilson welcomed the safe return of Mr. D. G. Sumner, the chief engineer, after carrying out some important work for the firm in Persia. Those present, especially the telephone engineers, were interested in his account of the difficulties experienced in carrying out technical work in the far East.

Wireless Telegraph Progress.—The London correspondent of the "Yorkshire Post" states that "Although little information of any real importance has been made public regarding wireless telegraphy, I hear that substantial progress has been made. The various parts of the Empire are now much better equipped, and with the restoration of peace it will probably be found that in radio-communication very little will remain to be done. Big transmitting and receiving stations are being erected near Stavanger and Naerbo, in Norway, with a view to direct wireless connection with the United States, and in a few months the installation should be ready for service. A powerful station is also in course of construction in Italy. Ship-owners are complaining that they are compelled to use the Marconi Co.'s system, and pay a monopoly price for it.

IMPERIAL NOTES.

South Africa.—In view of the assertion that the development of local industries is handicapped by the cost of supplies, the president of the Chemical, Metallurgical and Mining Society of Johannesburg suggests the creation of a scientific investigation department.

Sydney (N.S.W.).—The Municipal Council has authorised the city electrical engineer (Mr. H. R. Forbes Mackay) to visit the United States and Canada in order to make himself acquainted with the latest developments in electrical power distribution.

FOREIGN NOTES.

Brazilian Manganese.—The Minister of Public Works has received information of the discovery of important manganese deposits at Soledada, in Para. It is stated that analysis of specimens shows 57 0 per cent. manganese.

Electric Railway Material in U.S.A.—It is reported that the price of electric railway material in the United States is increasing.

Rails are said to have increased 100 per cent. over normal prices. Quotations are now $55 a ton for delivery a year hence, and for short-time delivery $75 a ton. Two years ago steel rails were selling at $38·20. There is an even greater advance in special track work, the increase being fully 200 per cent. Copper for repairs to trolley and electric equipment has nearly trebled its normal price. Copper trolley wire is now quoted at 38 cents a pound, compared with 17 cents in 1915. Copper feeder cable has advanced from 18 cents to 34½ cents a pound in the same period.

MISCELLANEOUS.

Electrical Company's Employees and Vegetable Growing.—With the object of stimulating interest in the cultivation of vegetables and flowers amongst their employees, the Chloride Electrical Storage Co., of Clifton Junction, recently held a show at their works.

When the idea was first mooted a committee was formed of workmen representing every department of the works, with Mr. A. S. Barnard as chairman, and Mr. E. A. Bradford, secretary. The result of their efforts was seen in the fine exhibits at the show opened by Dr. E. Hopkinson (deputy chairman of the firm). There was a large attendance of work-people with their families and friends. The show was held in the new Canteen and Women's Welfare Department. The exhibits of vegetables were of a high quality, and there were some fine cut blooms in the rose and dahlia section. An exhibition of needlework attracted much attention, as did the section set apart for bread, cooked food and bottled fruits. During the afternoon tea was provided, after which the prizes were distributed on the lawn in front of the offices. Almost the entire vegetable produce exhibited was afterwards sent to a naval base for the use of sailors at sea.

Engineers' Wages.—The National Committee on Production will shortly hear applications for increases in wages under the agreement of the engineering and shipbuilding trades. At present a war bonus of 15s. per week is paid. An increase of 80 per cent. is demanded.

Digitized by Google

Federation of British Industries.—A meeting in furtherance of the objects of this Federation was held at Leeds on Tuesday when an important speech on commercial and industrial reconstruction was delivered by Sir Algernon Firth.

Household Coal Distribution Order.—It should be noted by the public in the Metropolitan area that all registered coal merchants have a stock of requisition forms, under the Household Coal Distribution Order, for every kind of house or premises.

Application should be made by consumers to their usual merchant for these forms and further explanatory information. Any information which cannot be obtained in this way can be afforded by the Local Coal Overseer for the district in which the consumer resides. Each local authority in the Metropolitan area has appointed a Coal Overseer, whose address can be obtained from the coal merchants.

Munitions Tribunal Case.—At Belfast last week the local tribunal had before it the adjourned charge preferred by the City Corporation against 32 employees in the electricity department.

It will be remembered that the charge was that the men had contravened the Munitions of War Act, 1915, by taking part in a strike in connection with a difference as to the terms or conditions of employment without such a difference having been reported to the Board of Trade, and 21 days elapsing without the matter being referred for settlement by the Board of Trade.

Mr. A. J. Lewis for the Corporation, said he was very glad to be able to inform the Court that since the order adjourning the cases who made, the men, in accordance with their undertaking, had returned to work, and there had been no cause of complaint against them since.

The President said that, having regard to the hopeful signs which had been mentioned, he did not want to be severe on the men, and the cases were adjourned for another six months, to see if they would keep their undertaking.

Leaving Certificates.—The Minister of Munitions (Mr. W. Churchill) has fixed Oct. 15 as the date on which the abolition of leaving certificates shall come into effect.

In an appeal to munition workers by the Trade Union Advisory Committee it is stated that on Oct. 15 workmen will be free to leave for other war work after giving their employer a week's notice, unless a longer period is provided by their existing contracts of service. If large numbers of men leave their work suddenly and a big movement of workpeople takes place, there is danger that the output of urgent munitions may be dislocated and the men at the front will suffer. We, therefore, appeal on behalf of the Trade Union Advisory Committee to all workmen not to change their employment without definite and substantial grounds, and to show that the output of munitions will not suffer by the abolition of leaving certificates.

Prohibited and Restricted Imports.—Corrections to lists of prohibited and restricted imports have been published.

Amongst the new classifications are: *Prohibited*—Lamp holders, brass or ebonite, with or without switch or key.

General Licence—Brass screw parts for use on telephones, and telephones and telephone parts (except brackets and parts thereof).

Theft.—At Nuneaton last week a miner named Wm. Docking was sentenced to three months imprisonment for stealing 11s., the moneys of Nuneaton Corporation.

The Town Clerk prosecuted, and stated that for some time past the electricity slot meters had been tampered with and money extracted. Prisoner had procured a key and gone about emptying slot meters. There were 18 cases altogether, but he only proposed to go into three, the amounts involved being £1. 15s., for which defendant's solicitor had sent a cheque. Prisoner's parents had offered to refund the whole of the money, £8. 4s.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country ( ) during August, 1917, and (?) the aggregate figures from Jan. 1 to Aug. 31, with increase or decrease compared with corresponding periods of 1916:—

Electrical machinery: (*a*) £82,676 (increase £8,930), (*b*) £931,606 (increase £122,558); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £23,549 (increase £1,715), (*b*) £175,444 (increase £34,468); and electrical machinery unenumerated, (*a*) £59,127 (increase £7,265), (*b*) £758,162 (increase £88,090); telegraph and telephone cables other than submarine, (*a*) £1,154 (decrease £702), (*b*) £50,434 (decrease £4,756); telegraph and telephone apparatus, (*a*) £1,981 (decrease £482), (*b*) £21,366 (decrease £180,326); other electrical wires and cables, rubber insulated, (*a*) £1,729 (decrease £3,800), (*b*) £30,484 (decrease £52,471); with other insulations, (*a*) £1,598 (decrease £235), (*b*) £8,530 (increase £1,480); carbons, (*a*) £3,203 (decrease £2,075), (*b*) £54,393 (decrease £15,634); glow lamps, (*a*) £805 (decrease £29,806), (*b*) £65,647 (decrease £126,668); arc lamps and electric searchlights, (*a*) £59 (increase £59), (*b*) £97 (increase £97); parts of arc lamps and searchlights (other than carbons), (*a*) £17,175 (increase £4,883), (*b*) £86,179 (increase £16,256); primary and secondary batteries, (*a*) £23,886 (increase £9,326), (*b*) £212,573 (increase £82,676); meters and measuring instruments, (*a*) £790 (decrease £9,326), (*b*) £22,697 (decrease £12,327); switchboards, (*a*) nil, (*b*) £451 (increase £224); electrical goods and apparatus unenumerated, (*a*) £44,938 (increase £20,021), (*b*) £353,444 (increase £129,530). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £97,318 (decrease £12,137), (*b*) £906,295 (increase £151,919.

Exports.—The exports of electrical machinery, material, &c., (?) during August, 1917, and (?) from Jan. 1 to Aug. 31, with increase or decrease compared with corresponding periods of 1916 were as follows:

Electrical machinery, (*a*) £136,710 (decrease £11,850), (*b*) £1,906,595 (increase £72,277) including railway and tramway motors, (*a*) £4,604 (increase £2,471), (*b*) £22,847 (increase £30); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £87,186 (increase £2,067), (*b*) £599,698 (increase £84,361); and electrical machinery unenumerated, (*a*) £44,920 (decrease £16,388), (*b*) £384,050 (decrease £12,173); telegraph and telephones cable, submarine, (*a*) £15,547 (decrease £101,846), (*b*) £129,088 (decrease £242,519); other than submarine, (*a*) £28,967 (increase £11,633), (*b*) £521,087 (increase £181,600); telegraph and telephone apparatus, (*a*) £29,536 (increase £6,724), (*b*) £180,521 (increase £5,970); other electrical wires and cables, rubber insulated, (*a*) £4,622 (decrease £43,319, (*b*)) £164,219 (decrease £175,070); with other insulation, (*a*) £29,759 (decrease £28,318), (*b*) £229,315 (increase £324,227); carbons, (*a*) £4,292 (increase £3,067), (*b*) £20,173 (increase £12,753); glow lamps, (*a*) £11,324 (decrease £9,859), (*b*) £92,998 (decrease £31,438); arc lamps and searchlights, (*a*) £6,087 (increase £5,760), (*b*) £17,517 (increase £11,358); parts of arc lamps and searchlights (other than carbons), (*a*) £9,036 (increase £8,383), (*b*) £54,806 (increase £42,757); primary and secondary batteries, (*a*) £15,106 (decrease £14,959), (*b*) £108,177 (decrease £79,935); meters and measuring implements, (*a*) £13,556 (decrease £4,529), (*b*) £95,546 (decrease £43,748); transformers, (*a*) £5,388 (decrease £5,995), (*b*) £48,953 (decrease £19,512); switchboards, (*a*) £6,010 (increase £1,425), (*b*) £27,590 (decrease £13,836); electrical goods and apparatus unenumerated, (*a*) £78,942 (increase £19,496), (*b*) £462,009 (increase £30,067). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £257,172 (decrease £122,337), (*b*) £2,151,999 (decrease £645,600).

EDUCATIONAL.

University of London, University College.—Prof. J. A. Fleming, M.A., D.Sc., F.R.S., will deliver a public lecture on "The Work of a Telephone Exchange," on Wednesday, Oct. 17, at 5.30 p.m., and a course of six lectures on "The Principles of Modern Telegraphy," on Fridays, at 5 p.m., beginning Oct. 26, 1917. The public lecture is open without fee or ticket, and the course is open both to members and non-members of the University. Application for tickets of admission should be made to the Secretary, Gower-street, W.C. 1.

King's College (University of London).—There are complete courses of study (extending over three or four years) in civil, mechanical and electrical engineering for the engineering degrees of the University of London and for the diploma and certificate of the College. The four years' course provides, in addition to the academic training, opportunity for practical training in "works." Considerable additions have been made to the engineering department, including a large drawing-office and lecture rooms for the mechanical and civil engineering departments, and lecture theatre and rooms for research, including wireless telegraphy, for the electrical engineering department. There are five well equipped laboratories for the purpose of teaching and research. The next term begins on Oct. 3. Full particulars may be obtained from the Dean, or the Secretary, King's College, Strand, W.C.

Armstrong College, Newcastle-on-Tyne.—The session 1917-18 will commence on Sept. 24. Full courses leading to the degree of B.Sc. in engineering are provided in mechanical, marine, civil and electrical engineering, naval architecture, mining and metallurgy, &c. Particulars can be obtained from the secretary, Mr. F. H. Pruen, M.A.

Manchester Municipal School of Technology, University of Manchester.—At this school there are courses leading to the Manchester University degrees (B.Sc.Tech. and M.Sc.Tech.) in the Faculty of Technology in the departments of mechanical, electrical and sanitary engineering, chemical industries, textile industries, printing and photographic technology and architecture. Prospectuses may be obtained from the Registrar.

Battersea Polytechnic.—In the electrical engineering department there are day courses for the B.Sc. (Eng.) of London University and for the Polytechnic diploma. There are also evening courses in d.c. and a.c., electrical design, generation and transmission, electrical costs, electric lighting and illuminating and electric traction. Sectional calendar 1d., post free 2d. Calendar of evening classes gratis on application to the secretary.

Dudley Technical School.—The Dudley Education Committee state in their annual report that there has not been at any time so large an influx as at present of young and new students to the Technical School for whom industrial and commercial training was so necessary. The war had given a great impetus to the cause of technical education and would probably result in a new apprenticeship scheme for training skilled workmen in which properly equipped technical schools would take a large part

Institute of Chemistry.—The regulations for the admission of students, associates and fellows of the Institute of Chemistry, which were revised in July last are now available in pamphlet form.

TENDERS INVITED AND ACCEPTED.

Converting Plant and Switchgear.

KIRKCALDY Corporation invites tenders for the supply and erection of converting plant and switchgear. Forms of tender from the borough electrical engineer, and tenders to Town Clerk by Oct. 2.

Electrical Stores.

Tenders are invited for six months' supply of electric fittings to the Midlothian and Peebles District Asylum, ROSSLYNLEE. Forms of tender from the clerk and treasurer, 19, Heriot-row, Edinburgh, to whom tenders by Oct. 1.

Buildings, &c.

WOLVERHAMPTON Electricity Department require tenders by Oct. 5 for pump-house buildings and reinforced concrete foundations for cooling towers. Forms of tender, &c., from Mr. H. Vale, Darlington-street, Wolverhampton.

Digitized by Google

AYLESBURY.—The Council has accepted the tender of Webster & Cannon for the extension of the electricity station buildings.

BRADFORD.—The tender of the Brush Electrical Engineering Co. for the supply of an 800 k.v.a. transformer has been accepted by the electricity committee.

KETTERING.—The Council has accepted the tender of Siemens Bros. & Co., for the supply of feeder cable, feeder pillar, &c., at £1,736. 18s. 3d.

Messrs. Johnson & Phillips tendered at £1,763. 13s. 8d.; W. T. Henley's Telegraph Works Co., at £1,788. 10s. 7d.; British Insulated and Helsby Cables, at £1,790. 6s. 8d.; Callender's Cable and Construction Co., at £1,827. 4s. 6d.; W. T. Glover & Co., at £1,838. 16s. 4d.; Macintosh Cable Co., at £1,753. 8s. (incomplete tender); Pirelli General Cable Co., at £1,103. 5s. (incomplete).

POPLAR (LONDON).—The Borough Council has accepted the following tenders: Herbert Morris, Ltd., overhead crane for sub-station, £447; Aiton & Co., steam piping for turbine generator, £224. 10s.

TONBRIDGE.—The following contracts have been sealed by the Urban Council:—

Western Electric Co., cables; Ed. Bennis & Co., stokers, &c.; Willans & Robinson, Diesel engine and dynamo; Verity's, Ltd., extension to switchboard.

Government Contracts.—The following tenders were accepted by the British Government Departments during August:—

War Office.—Houghton-Butcher Mfg. Co., dry batteries; T. & J. Hughes and F. Restall (Ltd.), battery boxes; Bullers Limited, Butterworth & Dickinson, Douglass Bros. and G. Wilson & Co., insulator brackets; British Insulated & Helsby Cables, Callender's & Construction Co., W. T. Glover & Co., W. T. Henley's Telegraph Works Co. and Hooper's Telegraph & India Rubber Works, electric cable and wire; Medical Supply Association, X-ray couches; General Electric Co., dynamos; St. Helens Cable & Rubber Co. and Siemens Bros. & Co., ebonite rod; Cavendish Electrical Co., X-ray equipment; Elm Works (Ltd.), Eveson Bros., E. Stevens (Ltd.) and J. Stevens (Ltd.), electric light fittings and accessories; British Thomson-Houston Co., electric lamps; Electric Construction Co., electric motors; Harland Engineering Co., electrical plant; General Electric Co., switches.

India Office.—T. Locker & Co., copper wire; Stothert & Pitt, cranes; R. Johnson & Nephew, Whitecross Co. and British Insulated & Helsby Cables, wire.

Post Office.—British L. M. Ericsson Mfg. Co. and Siemens Bros. & Co., telegraph apparatus; Automatic Telephone Mfg. Co., British Insulated & Helsby Cables, British L. M. Ericsson Mfg. Co., Peel-Conner Telephone Works, Siemens Bros. & Co., Thornton-Pickard Mfg. Co. and Waltham Cross Joinery Co., telephone apparatus; Siemens Bros. & Co. and Telegraph Construction & Maintenance Co., submarine cables; British Insulated & Helsby Cables, Hackbridge Cable Co., India Rubber, Gutta Percha and Telegraph Works Co. and Telegraph Construction & Maintenance Co., telegraph cables; British Insulated & Helsby Cables, Johnson & Phillips, New Gutta Percha Co., Telegraph Construction & Maintenance Co., Union Cable Co. and Western Electric Co., telephone cables; British Ever-Ready Co., dry cells; Victoria Rubber Co., indiarubber; C. MacIntosh & Co., insulator rings; Bullers Limited, stay swivels; Bolton & Sons, Shropshire Iron Co. and F. Smith & Co. (inc. in London Electric Wire Co. & Smiths), bronze wire; T. Bolton & Sons, Elliotts Metal Co. Johnson & Nephew, F. Smith & Co. (inc. in London Electric Wire Co. & Smiths) and Wilkes, Sons & Mapplebeck, copper wire; Fuller's Wire & Cable Co., enamelled and flame-proof wire; British Insulated & Helsby Cables, switchboard wire.

APPOINTMENTS VACANT.

A resident engineer is required on a gentleman's estate. *See advertisement.*

A head designer and an assistant designer are required for Admiralty establishment. *See advertisement.*

An advertiser requires a works electrician as working foreman for large controlled engineering firm in West London district. Must have knowledge of motors, telephones and lighting.

An assistant lecturer and demonstrator in electrical engineering is required at the Battersea Polytechnic, London, S.W. 11.

Chesterfield Corporation require a chief assistant electrical engineer. Commencing salary £230. Applications to the Engineer, Electricity Works, Chesterfield, by Oct. 1.

BUSINESS ITEMS.

The address of Mr. Ernest Garton, honorary secretary of the British Ignition Apparatus Association, is now 9, Northumberland-road, Leamington Spa, to which all letters and communications in connection with the Association should be sent.

Owing to its premises being requisitioned by the Ministry of Food, the Association of Municipal Corporations has removed to 12, New Court, Carey-street, W.C. 2.

Messrs. Creed & Co., Ltd., announce that by the mutual agreement of the parties concerned the arrangements for the acquisition by them of the wireless interests of the Indo-Europen Telegraph Co. and of the Printing Telegraph business belonging to Mr. Donald Murray have been cancelled. The board of Creed & Co., Ltd., now consists of Mr. F. G. Creed (chairman), Mr. W. Arthur Coulson, and Mr. Nicol Paton Brown.

The Automatic & Electric Furnaces (Ltd.), 6, Old Queen-street, S.W. 1, inform us that they have taken over the Wild-Barfield inventions in connection with the hardening and other heat treatment of steel, and they are now undertaking the manufacture and installation of complete equipments (furnaces, quenching apparatus, instruments, &c.) for carrying out precision hardening.

Plant for Sale.—Some private electric lighting plant at the Empire Cinema, Porth, is advertised for sale in another column. Particulars from Mr. J. M. Bowman, Electricity Works, Porth, Rhondda.

Patent Amendment.—The Igranic Electric Co. (Ltd.) give notice that they are applying for leave to amend the specification of patent No. 13,142/1909, granted to A. H. Curtis and the Adams Mfg. Co. (Ltd.) for "Improvements relating to electric rheostats, motor starters and the like." Notice of opposition within a month of Sept. 19.

BANKRUPTCIES AND LIQUIDATIONS.

An application for the discharge of Geo. Thos. Harrap, machinery merchant, &c., 5, Budge-row, E.C. (lately residing at 14, Holland Park-avenue, W. London, will be heard on Oct. 26, at Bankruptcy-buildings, London, W.C.

The liquidator of the Colston Electrical Works (Ltd.), 9, Denmark-street, Bristol, has been released.

CATALOGUES, &c.

DISCONNECTORS AND GATE END BOXES.—Messrs. George Ellison, of Birmingham, have recently issued new catalogue lists Nos. 27 and 28, dealing with disconnectors for a.c. and c.c. circuits and trailing cable sockets and plugs for oil break gate end boxes.

LABELS.—The Hughes Label Co. (Ltd.), 34, Great Titchfield street, W., and Enfield, have issued leaflets giving particulars of the name and address plates and labels manufactured by them. All goods are manufactured at their works, both capital and labour being British.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Aberdeen.—The accounts of the Corporation tramways department for the year ended May 31 show gross capital expenditure £369,392 (after deducting £14,722 written off out of revenue. The total amount of sinking fund is £63,241, of depreciation and renewal fund £177,665 and of reserve fund £49,113.

Revenue was £100,073 (compared with £94,328 in previous year) and working expenses were £64,026 (£58,197), leaving gross profit £36,047 (£36,130). Interest required £3,475 (£4,230) and sinking fund £5,741 (£5,519), leaving net balance £26,830. Depreciation and renewals required £13,822 (£13,799) and special expenditure £4,243 (£2,883). Of the balance £5,842 (£6,464) has been placed to reserve, £2,000 (as in previous year) to the Common Good and £921 (£1,232) devoted to city improvements. Average total revenue per car-mile was 11·81d. and working expenses were 7·55d. Passengers carried were 28,623,659, car miles run 2,033,793 and units used 2,543,875.

The manager and engineer (Mr. R. S. Pilcher) says in his report there has been some overcrowding, even with all the cars on service, but there is little hope of obtaining more cars until after the war. The decrease in profit is due to increased expenses, but the fares have not been increased. Women drivers have been trained, so far with success, and could be employed as drivers if there is a greater shortage of men.

Accrington.—The electricity department's accounts for the year ended March 31 show gross capital expenditure £172,032 (increase £7,761), of which £109,638 is outstanding.

Revenue was £35,775 (compared with £35,043 in previous year), and working and general expenses were £34,064 (£25,598). Interest required £4,702 (£4,583), and repayment of principal £6,228 (£7,628), the net result being a deficit of £9,507 (£2,987). Average price obtained was 1·1d. (1·146d.), total works costs, &c. were 1·14d. (0·912d.) per unit, and capital charges 0·376d. (0·443d.). Units delivered to feeders were 7,966,860 and sold 7,180,755 (6,734,932). Maximum load was 3,207 kw. (as in previous year).

Eastbourne.—The accounts of the electricity department for the year ended March 31 show total capital expenditure £213,467 (increase £2,340), of which £105,861 has been repaid or provided for repayment.

Revenue was £31,212 (compared with £27,567 in previous year), and working and general expenses were £16,768 (£15,705), leaving gross profit £14,444 (£11,861). Capital charges amounted to £13,601 (£12,773) and there was a net profit of £843 (against a net deficit of £911). Average total revenue was equal to 3·85d. (3·62d.) per unit, coal cost 0·77d. (0·86d.), total costs were 1·96d. (2·01d.), redemption required 0·80d. (1·04d.) and interest 0·60d. (0·69d.). Maximum load was 1,202 kw. (1,371 kw.) and load factor 18·45 (14·77) per cent. Total connections are equal to 205,980 (189,829) 30-watt lamps. Motors installed on con-

Digitized by Google

sumers' premises aggregate 928 H.P. (865 H P). Units generated were 2,460,671 (2,309,118) and sold 1,944,528 (1,773,737).

The report of the borough electrical engineer (Mr. J. K. Brydges) states there is again an enormous increase in the taxes, these being now £2,627, compared with £1,689 last year, and £842 the year before. The new 1,250-kw. Ljungström turbo-alternator was put into service on June 15 and has been in almost daily use since. By its economical running a saving of £127 has been effected in the cost of coal, despite an increase in the price of coal for four months of the year of 20 per cent. for an inferior grade. The installation of the Underfeed stoker to No. 3 boiler was completed in March and all the boilers in regular use are now equipped with mechanical stokers.

Portsmouth.—The accounts of the electricity supply department for the year ended March 31 show gross capital expenditure £375,427 (increase £2,103), of which £213,084 has been provided for redemption.

Income was £53,301 (compared with £50,605 in previous year), and working expenses and special charges amounted to £40,445 (£35,820), leaving gross profit £12,856 (£14,784). Instalment of principal required £11,124 (£10,987), interest on loans £9,985 (£10,079), income tax £186 (£588), and interest on bank balances £667 (£417), and to make up the amount required to meet these requirements £9,108 (£7,288), has been taken from reserve. Units generated were 4,536,170, and sold 3,527,503. total maximum supply demanded was 2,220 kw.

Stalybridge, Hyde, Mossley and Dukinfield.—The following is an abstract of the accounts of the Stalybridge, Hyde, Mossley and Dukinfield Tramways & Electricity Board for the year ended March 31.

Electricity Department.—Gross capital expenditure is £328,150 (increase £8,964) of which £94,501 is paid off or in sinking fund. Revenue was £73,816 (compared with £65,767 in previous year) and expenditure was £43,390 (£37,212), leaving gross profit, £28,580 (£28,555). Interest and special payments required £14,885 (£12,622) and sinking fund £13,203 (£12,220), leaving net surplus profit £2,573 (£3,712). Cost per unit sold was 0·406d. (0·375d.) exclusive, and 0·675d. (0·626d.) inclusive of capital charges, and average price obtained was 0·686d. (0·661d.) Units generated were 30,730,400 (28,351,600) and sold 24,602,782 (24,686,231).

Tramway Department.—The capital spent on the tramways is £282,443, of which £88,159 is paid off or provided for payment. Revenue was £44,186 (£41,569)=9·504d. (8·785d.) per car mile, and working expenses were £28,934 (£26,504)=6·224d. (5·602d.) per car mile. Interest and special payments required £11,618 (£9,041) and sinking fund £8,536 (£8,019), the net result being a deficit of £5,202 (£3,667). Passengers carried were 10,016,837 (9,435,194), car miles run 1,115,663 (11,35,554), and units used for traction 1,924,236 (1,928,216).

Yarmouth.—The accounts of the electricity supply department for the year ended March 31 show gross capital expenditure £127,624 (increase £238), of which £86,293 is outstanding.

Revenue was £18,307 (compared with £15,926 in previous year), and working expenses, including depreciation, were £14,176 (£13,572). Interest fund and income tax required £3,715, contributions to sinking fund being suspended, and discounts and rebates amounted to £383 (£342), the surplus being £33. The previous year, after contributing £8,990 for interest, sinking fund and income tax, showed a net deficit of £6,978. Total maximum supply demanded was 1,184 kw., equal to 34,533 (39,466) 30-watt lamps. Units generated were 1,679,412, and sold 1,322,032 (1,287,130).

COMPANIES' MEETINGS AND REPORTS.

BROWN, BOVERI & CO. (LTD.)—The report for the year 1916–17, which was adopted at the recent meeting of the company, stated that during the whole year, notwithstanding the increase in the selling prices, a large business was done. Great difficultues were experienced in connection with the obtaining of raw material. During the year the organisation of the S.S.S. (Société Suisse de Surveillance Economique) and its subsidiary syndicates was duly developed, and the supply of material commenced to be regular. On the other hand, commencing with the summer of 1916, a great reduction of incoming material from Germany took place, regarding which there arose international discussions which had a retarding influence on deliveries through the S.S.S. Owing to the difficult conditions, the pre-war production in quantity was not reached, but the money turnover and the business results corresponded to normal figures. The company's activity was limited principally to the lines produced in peace time. The affiliated manufacturing undertakings, which had all worked favourably, had tried to develop their normal manufacturing lines as far as conditions would allow, in order that at the end of the war they could again get going in peace industries without important changes. Connection with the companies abroad during war time had been very difficult, and in some cases it was nearly impossible. In their difficult position the independent boards and organisations of all the undertakings had worked excellently. In the case of the electrical supply undertakings there arose a large demand for energy, resulting in a considerable increase in the amount supplied. With the water power undertakings the production costs remained approximately within the usual limits, so that they could work favourably. With the others the extraordinary increase in the cost of fuel made itself felt, and the position was made more difficult, as the price of current had been fixed in most cases by long contracts. For the Swiss Trust Companies having large foreign investments, the loss in exchange was a matter of considerable importance. Owing to conditions in Switzerland brought about by the war, the question of the better utilisation of the water powers and the development of electric railways has been forced to the front. In connection with electric traction military opinion has now nothing to say against it, as the danger of steam working on account of want of coal could be seen. Unfortunately it was impossible to proceed quickly on account of the great difficulties in carrying out new installations and procuring machinery. For the electrification of the Gotthard Railway, the Ritom Power Plant and trial locomotives were in hand, but it was not possible to say when the latter could be completed. On the other hand, the Board of the Swiss Federal Railways had agreed to carry out trials with an existing locomotive in the company's possession, equipped with a new type of axle drive. If that type of locomotive turned out successfully a gain of one or two years would result. After giving an explanation of the figures in the balance sheet, the report stated that the net profit for the year amounted to 3,099,177.47 frs. A dividend of 5 per cent. on the share capital of 32 millions absorbed 1,600,000 frs., leaving 1,499,177.47 frs., and after certain adjustments, the available balance was 1,359,207.60 frs. A sum of 200,000 frs. was carried to the general reserve fund, and 200,000 frs. to the workmen's benefit fund; 250,000 frs. was paid in bonuses, and it was agreed to distribute 640,000 frs. as a 2 per cent. extra dividend on the shares, and to carry forward 69,207.60 frs. It was also agreed to increase the general reserve fund by 200,000 frs., in view of the proposed increase of capital. In view of the outlook for the future the shareholders sanctioned an increase in the capital by 4 millions to 36 million francs.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—Mr. A. E. Hadley, acting chairman and managing director, presided over the meeting last week, and stated that the net earnings were £70,000 higher than in the previous year. That satisfactory result enabled the directors to declare a dividend in respect of the year 1916 of 5 per cent. on the Ordinary hares and to raise the dividend on the Participating Preference shares to the full amount to which they could become entitled, namely, 10 per cent. The board transferred £150,000 to reserve. That fund was available to meet contingencies which might arise, to improve the property, &c. After making that provision for reserve and paying the dividends, there remained £72,425 to be carried forward. After analysing the accounts he said that the redemption of Debentures had caused a decreasing Debenture interest from £232,556 to £224,815. The position with regard to excess profits in the United Kingdom was clearer than last year, the pre-war percentage on capital having meanwhile been settled, and it had not been considered necessary to make any provision under that head in the 1916 accounts. The net earnings, after meeting a substantial increase in African taxation, but before providing for British income tax, Debenture charges and depreciation, had increased by £70,000, and after meeting the additional cost of these charges the amount carried to the balance-sheet was £254,607, compared with £223,080 last year, an increase of £31,527. Since the close of the accounts the financial legislation in South Africa had been greatly modified, throwing a heavier burden on the taxpayer. The modifications, while involving a reduction in the rate of the old Income tax, impose a dividend tax, together with an excess profits duty, at the rate of 25 per cent., calculated on the same general principles as adopted by this country. The taxation was retrospective, so as to apply partly to 1916, and a provision had been made to meet the charge in the accounts before them. Shareholders would be aware that the Finance Act of 1916 provides that in cases where United Kingdom and Colonial income taxes have been paid on the same income a repayment of part of the United Kingdom tax, equal to the rate of the Colonial tax up to 1s. 6d. is recoverable. The Act operated for the first time in respect of the fiscal year ended on April 5 last, but as no repayment had yet been received, the claim being under consideration, no credit had been brought in the accounts.

Mr. Hadley said that the station generating plant for electric power and compressed air had run successfully and been well maintained during the year. The overhead transmission and distributing lines and the consumers' sub-station plant, together with the compressed air pipe line, had been operated satisfactorily and had been kept in a good state of repair. There has been no extension to the generating or distributing plant, other than a small pole line extension to a new consumer in the Brakpan area, the Sub Nigel Co., the capacity of the generating plant being 270,680 H.P. The quantity of water for condensing purposes accumulated in the dams at the various generating stations remained normal and showed no sign of shortage. The supply of engineering spare parts had presented difficulties, owing to the shortage of supply from this country, but that had been overcome in some cases by the company's own engineering workshops, while the provision of general engineering stores had in spite of the difficulties of supply, been maintained. The prosperity of the company being so closely interwoven with that of the gold mining industry on the Rand, they had reason to follow with feelings of admiration the successful manner in which, in spite of the difficulties created by the war, the output of gold and the general activity of the mines had been maintained. The foresight and energy displayed by those responsible for the conduct of the mines, assisted by the sympathetic attitude of the Imperial and Union Governments, had enabled the difficulties of obtaining the necessary materials to be overcome, and had prevented the supply of gold from the reef, so essential to the conduct of the war, from falling away.

Digitized by Google

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—C.A.V. give their new electric starter a push off with a Press visit to their Acton works. The next item I hope will be a Press visit to their electric vehicle motor shop turning out 1,000 a day!

* * * * *

THIS WEEK'S CHESTNUT.—Examination question: State what you know of Copernicus and Galileo. Bright youth's answer: Copernicus is a mixture of copper and nickel, and Galileo cared for none of these things.

* * * * *

The difference between the peacock and the stork is that the peacock is a very fine bird, but it takes the stork to deliver the goods.—Mr. Goodwin, at the C.A.V. Press Luncheon.

* * * * *

Mr. Goodwin also said, at the aforesaid luncheon, that the British Press had done wonders for the British magneto; there would be so many British magnetos—two or three times the supply to meet demand—that there was no fear of any orders going to Germany!

* * * * *

From a daily paper:—

"Most scientists," a New Cross correspondent, aged 12, informs me, "admit that electricity is a state of movement (acceleration, deceleration, or escape) of the electrons within a body, or that it is a state of strain of the ether which pervades all matter." This apropos of a recent paragraph on thunderbolts. I hasten to make the assurance public. Youth will not be denied—but future correspondents on this subject will.

* * * * *

Miss Ada Ward, A.L.A., according to the "Huddersfield Examiner," has been lecturing in Canada and U.S.A. and writes home to describe a thunderstorm in Saskatchewan:—

Suddenly a great arch of electricity spanned the scene, and shafts of light ran from it in every direction. It is impossible to make you realise. I am glad I have lived to see it. I understand the legend of the Valkyrie, the rainbow bridge into Valhalla. I can understand angel hosts and heavenly messengers. But there is a serpent in the climatic Eden, the possibility of cyclones and electric storms. All at once it got unbearably hot, the sky became black and a regular cyclone of wind rushed down on the village and seemed to sweep everything before it. Clouds of dust filled the air and the rushing of the wind was like Pentecost. There were tongues of fire, too. Sheets of flame lit up the whole heavens—a curious mixture of sulphur and magenta colours. It was awful. I just lay quite still on a sofa, while the wind played the dickens with everything. I thought it would carry the house away bodily. Then came the rain, tons of it. It was fierce!

I must get Miss Ward to write up a "short circuit" in a cable tunnel when she comes back!

* * * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN, September 25, 1880.]

TOURISTS' TROUBLES.—Although the Eastern Company's station at Porthcurnow has been built over 10 years, it is surprising how few of the visitors to the Logan Rock and the Land's End know of its existence until they see on their way from the former to the latter place. Much amusement is caused by the passing comments, "What's this great place," says he? "A telegraph office," says another, "The guide called it the station." "Telegraph office your grandmother," says the first again; "what do they want of such a big place as this for a telegraph station?" in such a tone as if he felt hurt at being imposed on. A halt and consultation is then made, with the result that the name of some friend is thought of, and a telegram is to be sent to satisfy their curiosity, and so the Postal Telegraph Department is richer by one shilling, and the visitors are wiser than they were before.

THE IGNITION OF OIL TANKS BY ELECTRICAL AGENCY.—The "Scientific American" says:—"Again we have to record the destructive effects of lightning in the Bradford, Pa., oil regions. On Aug. 28, at 8.30 p.m., one of the 25,000 barrel oil tanks of the United Pipe Line Co., near State Line and Traport, was set on fire by electricity and burned; also four smaller tanks on the West Branch near Bradford. At the one time there was danger of a gigantic conflagration, as there were some 20 large tanks not far from the burning tank of the Pipe Co. By firing cannon shot into the tank its contents were run out and the adjacent property saved. From all we can gather there seems to be good ground for the theory that these numerous lightning disasters in the oil regions are not generally due to direct lightning strokes upon the tanks, but rather to the occurrence of slight electrical sparks within, upon, or near the tank, whereby the explosive gas that hovers about the tank is instantly set on fire. We have in our previous remarks suggested various ways in which the fatal spark may possibly be induced, to which suggestions the reader is referred. We have now to mention one other possible cause of the fires, and that is the electrified raindrops. Strong electrical effects are sometimes observed during the fall of sleet, hail, and rain, without the accompaniment of thunder or lightning. Prof. Tait, in a recent lecture in Glasgow, said:—'Falling rain drops are often so strongly charged with electricity as to give a spark just before they touch the ground.' As the development of the slightest spark in connection with an explosive mixture of air and gas will produce intense fire we here perceive the remarkable possibility that some of the great oil conflagrations may have been caused by rain. The whole subject is one of much interest to electricians, and, as we have before said, we hope they will investigate the matter, so as to ascertain surely the cause of these frequent disasters and discover the proper means of safety."

Prices of American Copper and Steel.—An agreement has been made between the producers and the U.S.A. Government, which fixes the price of copper for the next four months at 23½ cents per lb., this price to be available to the United States, the Allied Governments, and the public.

The producers will not reduce the wages of the miners and they also pledge themselves to maintain the maximum production, and prevent copper falling into the hands of speculators. Copper at 23½ cents is 3 cents below the existing market, more than 10 cents per lb. under the prevailing prices when the Government first undertook to fix the price, and about 10 cents above the pre-war average price.

A similar agreement has been made in regard to steel and iron prices.

Swedish Electric Power Stations.—"Engineering" announces that the Swedish Government has made regulations as to the supply of electric current and has made agreements with the Hemsjö and the Yngeredsfors Power Companies.

The State wishes to aid the interests of the general public and the National Household Commission by putting the supply of electric energy on ration in such parts of the country where such may be deemed expedient. It has, however, been considered to be to the interests of all concerned that the Hemsjö Power Co. itself sees to the distribution of current under the new arrangement, subject to this being done under strict observance of the regulations laid down by the working committee of the Industrial Commission. The reduction in the supply will, in the first instance, apply to such large industrial concerns where shortage of raw materials or other conditions make a more pronounced limitation or reduction of working desirable from a national standpoint. The street lighting and the tramway traffic will be reduced, and all advertising illumination will be prohibited, as it has already been done long ago in other neutral countries. Further, such lines and transformer stations where the industries are not at work throughout the 24 hours are to be switched off at least six hours every night, as a rule from 10 p.m. to 4 a.m., which time is found most expedient out of regard to the farmers. All subscribers will be urged to exercise the greatest economy in the use of current, and the functionaries have to see to everything being carried out in the most rational manner. The supply of private consumers and small concerns will, in the meantime, not be interfered with. The Hemsjö Power Co. has been lucky enough to secure fuel for its steam-driven power station for the whole of this and part of next year.

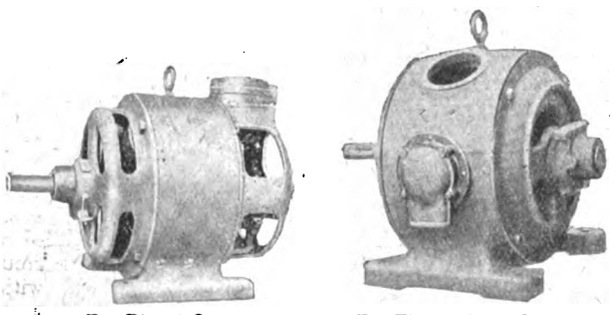
IGRANIC
"UNIT" TYPE VEHICLE
BATTERY CHARGING PANELS
Built up like a sectional bookcase. Fully protect the Batteries.
IDEAL FOR THE POWER STATION and GARAGE.
IGRANIC ELECTRIC Co LTD 147, Queen Victoria Street, LONDON.

Digitized by Google

SIEMENS

STANDARD

ELECTRIC MOTORS



For Direct Current. For Three-phase Current.

for

ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED
HEAD OFFICE: PALACE PLACE MANSIONS, KENSINGTON CT., W 8.
Telephone: WESTERN 6349. Telegrams: "SIEMBRALOS, KENS, LONDON."
Lamp and Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C. 4.
Telephone: CITY 5350 Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—198, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

FOR

High and Low Tension SWITCHGEAR

THE

NEW SWITCHGEAR CONSTRUCTION CO., Ltd.

SUTTON, SURREY, ENGLAND.

ABC Code 5th Edition. Telephone: Sutton 773.

VULCANIZED FIBRE. ELECTRICAL. MECHANICAL.

DYMFYBR

LARGE STOCK. PROMPT DELIVERY.

J. BURNS, Ltd., 187 & 189, Central Street, LONDON, E.C.

REWINDING AND REPAIRING

of ARMATURES, MOTORS & DYNAMOS.

PROMPT EXECUTION and MODERATE CHARGES.

A. BROWN, 1, Norgrove St., BALHAM, S.W. 12

ELECTRICITY IN U.S.A. ARMY CANTONMENTS.

In its issue for August 25 the "Electrical Review" of Chicago gives some particulars of the extent to which electricity is used for lighting and power in the 16 national Army cantonments. Our contemporary states that though handicapped by a serious shortage of men and materials the 16 central station companies located nearest the cantonments built transmission lines, erected transformers, installed lighting and power equipment and furnished service so that the camps would not only be in readiness in sufficient time but that their construction could be facilitated by the use of electricity. In the completed cantonments, electricity is used for every conceivable purpose. Lighting is the principal application, but electricity will also be used extensively for pumping, ice-making, in shops, kitchens, hospitals, &c., apart from telephone and telegraph service, which is an important adjunct. Electricity was also used extensively in the construction of the cantonments. In fact, it is generally conceded that only by the utilisation of motor-driven wood-working machines, mixers, &c., could work be completed in the prescribed time. In only one direction did the electrical industry fail to take advantage of the opportunities which the construction of the camps offered, namely, in the transportation of materials from city to camp and about the premises. Electric vehicles would have been admirably suited for this work since electricity for battery charging was available, and, furthermore, good roads were built to each cantonment before any construction work was undertaken. By the use of electric vehicles the petrol trucks that had to be employed could have been released for service in localities where they only could be used.

Each cantonment comprises about 1,000 unpainted timber structures of the simplest character. A few buildings used for storage and as garages and power plants will probably be metal-clad, and possibly corrugated iron siding and roofing may be employed. The two-storey buildings used for large barracks in the South will be heated by stoves on the lower floor, as is done in the Canadian cantonments. Electricity is used for lighting in all cantonments. The peak load for lighting at each is estimated at 600 kw. and the maximum power load 300 kw.

The minimum water supply for a cantonment has been fixed at 55 gallons per capita daily, equivalent to from 2,000,000 to 2,500,000 gallons per day for camps of 36,000 to 45,000 men. Storage is generally necessary to meet the peak-load requirement for an hour's draft at the rate of 156¾ gallons per capita daily. Either elevated storage capacity of at least 300,000 gallons is provided or a reservoir of at least 1,000,000 gallons from which water can be pumped directly into the mains. Electric motors are used in every instance to drive pumps.

DETAILS OF LOUISVILLE CANTONMENT.

Typical in every way of these cantonments is Camp Zachary Taylor, just outside of Louisville, Ky. This will be the first of the cantonments completed, and on August 25 (nine weeks after work was begun there) everything provided for in the original contract was turned over to the War Department. Temporary light, power and telephone service was provided for on rush orders at the outset. The Louisville Gas & Electric Co., which will supply the requirements for current from its Waterside power plant, the Cumberland Telephone & Telegraph Co., the Louisville Home Telephone & Telegraph Co., the Western Union and the Postal Telegraph Companies, immediately made temporary installations, while the Louisville Railway Co. increased its service and began construction of additional trackage. Permanent construction was rush work all the way through, under the direction of the Mason & Hanger Co., supervised by War Department representatives. On August 18th, there were 10,092 men at work, and the weekly pay-roll amounted to $256,000. Ten hours a day, seven days a week was the rule from the first. Installation of the street lighting and the power and lighting distributing systems was handled by the Louisville Gas & Electric Co. on a basis of cost, alone, with no allowance for profit added. Interior lighting installations were handled under a contract let by the general contractor to the Bland Electric and the Childers Electric Companies, representing the Louisville Association of Electrical Contractors, on the basis of cost, with a percentage for profit. Installation of the telephone service was by the Cumberland Telephone & Telegraph Co., while the telegraph companies also made their own installations, and construction work of the Louisville Railway Co. was done by that company. Probably the total cost of all the work will run well on toward a million dollars. The Louisville camp will shelter 12 regiments of infantry, three regiments of artillery; one regiment of engineers with an engineers' train; a division headquarters and a head quarters train; one field signal battalion, with a large collection of horses and mules, motor trucks, &c. Besides buildings to shelter these, there are eight divisional Y.M.C.A. buildings and a central Y.M.C.A. building; one large army auditorium and another auditorium of the Knights of Columbus; a large bakery group; a hospital group of 75 buildings with room for 1,000 beds and provisions for extension to 1,500 beds; 12 large warehouses; an extensive remount station, and 20 miles of steam railroad siding. There is also a cluster of retail stores rising on the outside of the reservation, at a cost of probably $200,000, and all around the vicinity of the camp new building has been stimulated. The camp was first reached by the Louisville Gas & Electric Co. with a transmission wire taken off the Ashbotton road line, and carried on poles already standing, for the most part, to the camp. A temporary step-down sub-station reduced the voltage from 13,200 volts

Digitized by Google

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite—Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1912 to 1917.

ATTWATER & SONS,

Telegrams: Attwaters, Preston. Telephone No. 1045 (2 lines).

Hopwood St. Mills, PRESTON.

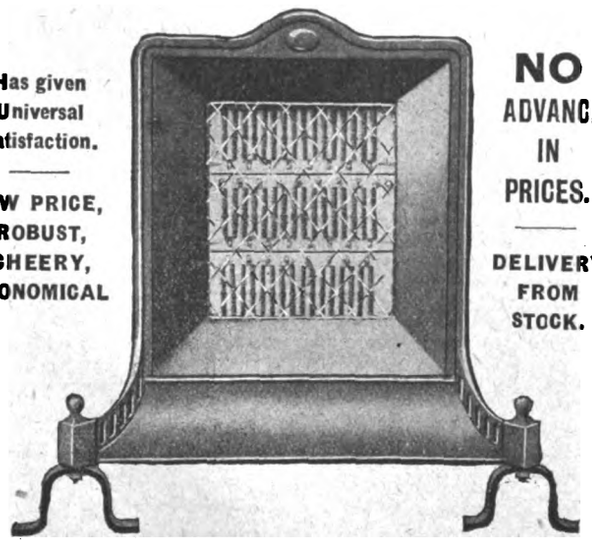
Established 1868. Codes: 5th Edition A B C & Western Union.

— THE —

ARORA

ELECTRIC

FIRE



Has given Universal satisfaction.

LOW PRICE, ROBUST, CHEERY, ECONOMICAL

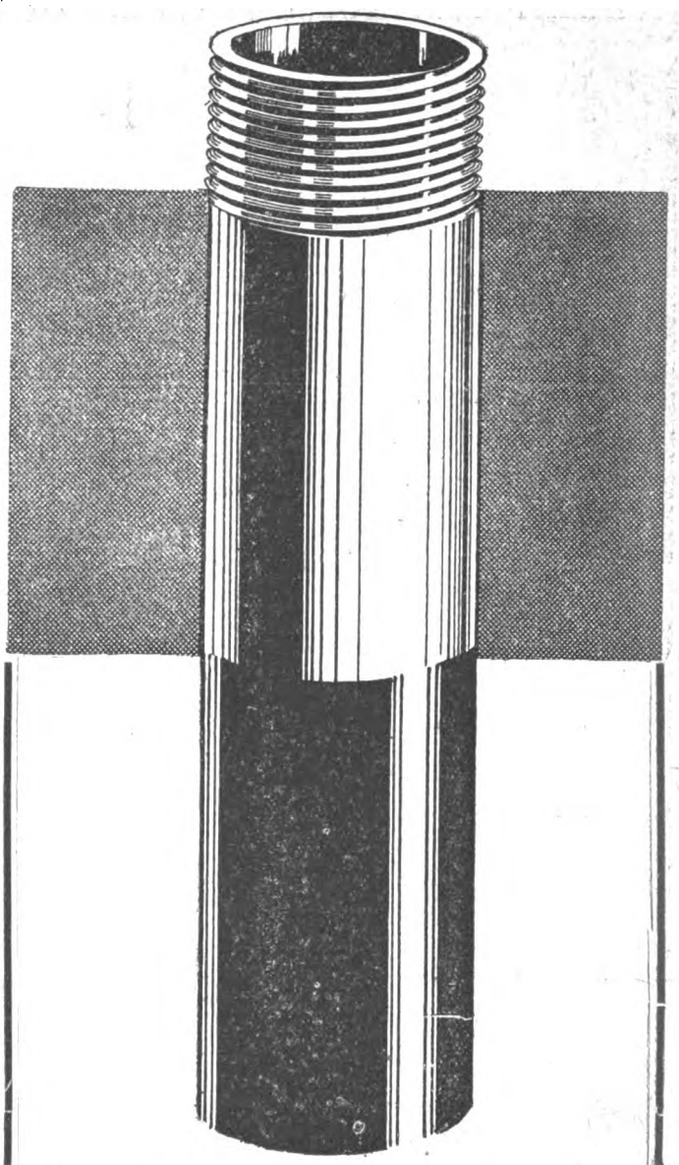
NO ADVANCE IN PRICES.

DELIVERY FROM STOCK.

Write for LIST G (Fires and Cookers),

to Sole Manufacturers—

THE ARORA CO., LOUGHBOROUGH.



We have at our Birmingham Works a large Automatic Electro-galvanizing Plant operating on the "Zenex" process.

This plant is capable of dealing with many million feet of Conduit per annum together with some hundreds of tons of Fittings.

Simplex Galvanized Conduit is supplied to the War Office, Admiralty and Government Departments, also to the leading Railway Companies.

We can give good delivery

SIMPLEX CONDUITS LIMITED

GARRISON LANE, BIRMINGHAM.

LONDON— 113-117, Charing Cross Rd, W.C.
MANCHESTER— 16, Corporation Street.
GLASGOW— 72a, Waterloo Street.
NEWCASTLE— 61, High Bridge.
BRISTOL— 10 & 11, Denmark Street.
LIVERPOOL— 96, Whitechapel.
LEEDS— 6, White Horse St., Boar Lane.
SWANSEA— 14, Heathfield Street.
CARDIFF— 4, Westgate Street.
ABERDEEN— 1, Crimon Place.
SHEFFIELD—281-3, Attercliffe Common.

Digitized by Google

LOAD AND EXPERIMENTAL

RESISTANCES

MADE TO ANY SPECIFICATION.

Particulars of Standard Types will be found in our List, to be had on application.

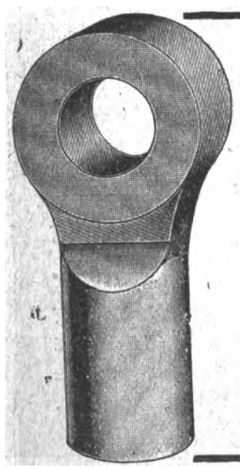
RAPID DELIVERIES GUARANTEED.

ISENTHAL & CO., Ltd.,

(DEPARTMENT 4)

Denzil Works, Willesden, London, N.W. 10.

Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, etc.



E. SHOWELL & SONS, LTD.

STIRCHLEY, BIRMINGHAM.

Cast Cable Sockets.

Suite E74. Made in all Sizes.

Type A.—Straight.
,, B.—Offset.
,, C.—Right angle.

Illustrated Dimensioned Showcard for Drawing Office use supplied free on application.

Sole Agent for the Electrical Trade:—

LIONEL ROBINSON, 3, Staple Inn, London, W.C.

TELEPHONE: Holborn 6323.

to 2,300 volts. A second transmission line of similar high voltage was then constructed out from the Waterside plant on the river bank to the camp (about eight miles) at a cost of $30,000. These two lines enter a step-down sub-station, with three 400 kw. transformers erected on a large steel tower, the transformers reducing the voltage to 2,300 volts three-phase 60-cycle. From this sub-station three copper feeder lines are run, one a power line, the others lighting lines. Service is metered at the sub-station and the estimated demand is from 800 kw. to 900 kw. The sub-station is completely equipped and the three feeders are served by General Electric automatic oil switches. The first, the power wire, leads to the pumping station, and serves five 50 H.P. motors of 2,200 volts driving the centrifugal pumps which raise the water to the million-gallon elevated storage tank from which it is distributed around the camp. The line that serves the buildings is tapped by single-phase branches which feed the distributing transformers. There are 81 of these, ranging from 1 k.v.a. to 20 k.v.a., and reduce the primary voltage to 110-220 volts, the voltage of the secondary mains, which are all No. 6 three-wire. The service connections are of No. 10 copper-clad wire. The street-lighting system consists of seven 5 k.v.a. constant-current pole-type transformers, each provided with a weatherproof oil switch. From each of these is taken a series circuit feeding about 45 type C Mazda 100 c.p. lamps, of 6·6 amperes. They are mounted on goose-neck fixtures with reflectors, and light the roads, entrances and grounds. A total of 1,100 poles were set, mostly cedar poles, ranging from 35 ft. to 45 ft. All construction was strictly in accordance with the N.E.L.A. standard specifications for overhead lines. These poles were also used as telephone and telegraph lines. Where both systems made use of the same poles construction was in accordance with the specifications of the American Telephone & Telegraph Co. for joint use of poles under 5,000 volts. The cost of the interior wiring will range around $75,000. There is nothing out of the ordinary about this work. The buildings are little more than glorified barns of all sizes, and all the construction is open, porcelain cleats being used. Up to date the installations include about 20,000 sockets, and about 1,000,000 ft. of No. 14 wire has been used. Mazda 40-watt lamps have been installed throughout and standard construction has been the rule. The Okalona interurban line of the Louisville Railway Co. ran immediately past the camp. It was a single-track line, but additional property to widen the right of way was acquired, and two miles of double-track construction and about the same amount of single-track construction, with the wire systems to correspond, was pushed to completion. A mile of double track was constructed into the camp toward its centre, with a loop.

Rockford (Ill.) Cantonment.

The national Army cantonment near Rockford, Ill., is known as Camp Grant and will comprise 1,100 buildings. There will be 16 60-watt lamps in each. This is in addition to street lighting, for which lamps will be bracketed to the corner of each building. The total lighting load will approximate 600 kw. and the power load about 300 kw., although a total of 700 kw. in motors has been installed, mainly for pumping. The Rockford Electric Company constructed a transmission line 1·5 miles from the plant to a point well within the reservation. Transmission is at 13,800 volts and distribution in the camp at 2,300 volts.

Ayer Cantonment.

The Army cantonment being built in the vicinity of Ayer, Mass., is officially known as Camp Devers. The location is about 40 miles from Boston. The camp is within the range of ready access to the 66,000-volt transmission lines of the New England Power Co. This cantonment is being built with a force of about 5,000 workmen, and will comprise 1,118 buildings, of which 622 were to be completed by Sept. 1. It is designed to accommodate 37,800 troops of the National Army, during the periods of training. A line of steel towers (12 miles long) to carry a two-circuit transmission line, is under construction. This line will extend from Leominster district to a sub-station within the cantonment, where current will be reduced from 66,000 to 2,300 volts by three 500-kilovolt-ampere General Electric transformers. Lighting and power service will thus be extended to the 1,118 buildings in the camp. This requires about 2,000,000 ft. of wire, of sizes running from No. 0 to No. 14 B. & S.; and close upon 30,000 incandescent lamps rated at 25 to 200 watts. This distribution will be carried on

H. Weidmann, Ltd., Rapperswil, Switzerland.

WE ARE SPECIALISTS IN THE MANUFACTURE OF—

PRESSPAN (2)

(Pressboard)

Best Quality.——Proved by repeated tests,

Sheets in thickness from 0·1 upwards.
Endless Rolls and Strips from 0·1 to 1 mm. thickness.
Presspan Coils and Tubes for Transformers.
Presspan Armatures, Discs and Shaped Articles.

VARNISHED PRESSPAN. BLACK PRESSPAN.
OILED PRESSPAN. MICA-COVERED PRESSPAN, &c.

Grand Prix: Marseilles 1908. Gold Medal: Berne 1914. Silver Medal: Paris 1900.

Digitized by Google

See what we do with our 20,000 Volt Working Pressure 3-Phase Star Cable.

	Volts.
ROUTINE TEST PRESSURE—	
½ hour between phases	50,000
½ hour between phases and earth	50,000
MECHANICAL TEST—	
Bent 6 times to a 21″ radius	
TEST AFTER BENDING (WITHOUT BREAKDOWN)—	
½ hour between phases	100,000
½ hour between phases and earth	70,000
DESTRUCTION TEST (ON SAME PIECE OF CABLE)—	
½ hour between phases without breakdown	100,000
½ hour between phases and earth, without breakdown	70,000
2 minutes between phases and earth, before failure	120,000

THE CUSTOMER'S ENGINEER REPORTED ON THE CABLE AFTER BENDING:—

"I then stripped the outer paper off a short piece cut from this cable, and found the paper in excellent condition throughout, and practically free from all cracks. The impregnation was most satisfactory, and on the whole I have never examined a better cable."

SEE OUR ADVERTISEMENT NEXT WEEK.

BRITISH INSULATED & HELSBY CABLES, LTD.,

Cablemakers and Electrical Engineers,

PRESCOT, LANCASHIRE.

Works: PRESCOT and HELSBY.

Branch Offices in: LONDON, MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE, CARDIFF, DUBLIN, LEEDS & BELFAST.

QUARANTEED SECOND HAND

MOTORS

THE VICTORIA ELECTRIC PLANT CO.,
SPENSER STREET, WESTMINSTER, S.W.
Phone: Victoria 4026. Grams: Victoriaetw, Sowest London.

For Effective Impregnation

use "LACWATT"
Black or Golden Brown.
JENSON & NICHOLSON, Ltd.,
Insulating Varnish Department,
Goswell Works, Stratford, E.15.

Digitized by Google

chestnut-pole lines, each pole 30 ft. in length, and these are being erected. Numerous induction motors (7·5 h.p. each) are already in service, operating saws, &c. The sawmill units are served by 600 to 1,000-c.p. "Novalux" lighting. A 12-in. cross-cut saw is driven by the connection with a short belt to a 7·5-h.p. 220-volt Westinghouse induction motor, running at 1,740 r.p.m. and controlled by a Westinghouse starter, the wiring being carried in an armoured flexible cable. The lumber, after being sawed, is hauled to the several centres of construction by army motor trucks. The capacity of the saving equipment has been proved equal to about 200,000 ft. of lumber in 13 hours. Included in the equipment is a lumber clipping machine, with gang-saws, operated by a Westinghouse 50-h.p. motor and three petrol engines. The cantonment is also to be provided with a sewer system, the water supply for which to be brought in from a pump station, where the pumps are to be driven by a 100-h.p. motor. In connection with the water supply for other purposes, there is to be another installation of pumps to be driven by two motors, 150 and 250-h.p. respectively. The telephone service is supplied by two exchanges, one required by the military authorities and the other by the construction contractor. The military switchboard, a 12-postion board, is of the latest type, the installation including storage battery service and charging apparatus. The contractor's exchange contains a two-position vertical board and a four-position order board, connecting with 65 stations. Ten trunk lines extend from this exchange to Ayer, two to Boston and one to Springfield.

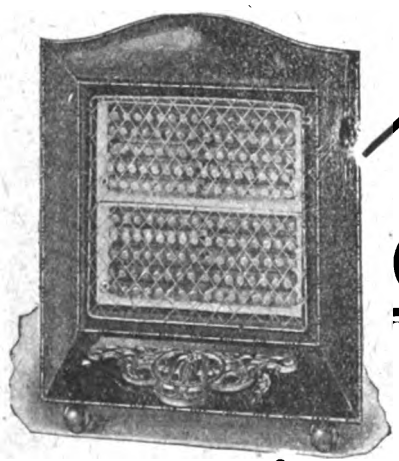
CAMP GORDON.

Camp Gordon, otherwise known as the Silver Lake cantonment, is situated about 10 miles from Atlanta, Ga. The complete electrical installation work involves the wiring of all buildings, 20 miles of streets, and the installation of motors and various fixtures, probably requiring the services of 250 electricians to complete the same by the required time. The Georgia Railway & Power Co. is to extend a line to the cantonment from the Brookhaven terminus to provide necessary transportation facilities. Current from the company's 22,000-volt transmission line (at Morgan Falls) will be available, and a sub-station (near Buckhead) will contain seven 185-kilovolt-ampere, 22,000/430/287/143-volt, single-phase, 25-cycle transformers; and two 500-kilowatt, 25-cycle rotary converters. The company will supply light and power for all purposes. Its extension from its Boulevard-Gainesville 22,000-volt line will be carried on a line of 30-foot, creosoted poles, using ¼-in. g.i. wire, triangular spacings of 5-foot centres. The transformer station at the cantonment, to which the current will be transmitted, is the out-door steel-structure type, and will contain three 250-kilovolt-ampere, 22,000/2,300-volt, single phase, 60-cycle transformers.

One of the requisites of the camp is an ample supply of water, and to provide for this the city of Atlanta is laying a pipe line to the cantonment from Hemphill pumping station, a distance of nine miles. Additional pumping equipment will be required, consisting of five centrifugal pumps, one of 300 gallons capacity, and four of 1,200 gallons capacity each, direct-connected to a.c. induction motors. The number of buildings required in the cantonment will be close to 1,054, and the estimate of electric power requirements is thus outlined: Total maximum demand, 750 kw.; approximate lighting demand, 300 kw.; power demand, 400 kw.; and series lighting, 50 kw. Street-lighting and power and other lighting service material are provided for, but estimates for power for refrigerating, bakeries and other utilities have not been made.

C.A.V. STARTERS.

With characteristic enterprise Messrs. C. A. Vandervell & Co. arranged for a Press view of their works at Acton on Tuesday last in order to give some idea of the size of the factory and also to direct attention to a new geared type of electric starter for motor cars. The party were received at the works by Mr. Goodwin the general manager, and were shown over the extensive shops by the officials of the Company. Our readers will remember that we desribed this factory some months ago and fully detailed the policy of expansion which has been adopted with a view to capturing German trade, particularly in magnetos, car lighting dynamos and starter sets with their necessary battery equipment. After an inspection of the works, the Pressmen were entertained at luncheon, the chair being taken by Mr. Goodwin in the unavoidable absence of Mr. C. A. Vandervell. Mr. Goodwin made the interesting statement that there was so much activity amongst British electrical manufacturers in the making of magnetos, the supply would be such that there was no fear of a single order going to Germany. He also referred to the exceptional growth of the motor and electric vehicle movements, and expressed the hope that before long there would be more commercial and public service vehicles in use in this country than pleasure cars; the opposite was the case at present. This visit to the C. A. V. works is extremely timely, because too little is being said by the British electrical manufacturer of what he is doing in the way of works organisation to produce articles which before the war were the exclusive purpose of the German maker and trader. We shall refer in subsequent issues to the design and construction of the starters which were shown in course of manufacture.



Place your
Order NOW for
CARRON ELECTRIC FIRES

Illustration represents the Company's No. 222A, a popular design fitted with Carron Standard elements and made in various finishes and voltages.

Orders despatched same day as received, conditional to stocks not being sold out.

¶ *Write for No. 22/m Pamphlet, Free—which contains full particulars of this and other equally efficient Electric Heating Appliances.*

By Appointment.

CARRON

A touch of the switch does it.

CARRON COMPANY INCORPORATED BY ROYAL CHARTER 1759 CARRON, STIRLINGSHIRE; Branch Works: Phoenix Foundry, Sheffield.

Showrooms: LONDON—(City), 15, Upper Thames Street, E.C.; (West End) 50, Berners Street, W. LIVERPOOL—22-30, Redcross Street. BRISTOL—6, Victoria Street. BIRMINGHAM—218, 220, 222, Corporation Street, NEWCASTLE-ON-TYNE—18, Prudhoe Street. EDINBURGH—114, George Street. GLASGOW—125, Buchanan Street.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

YF 00017

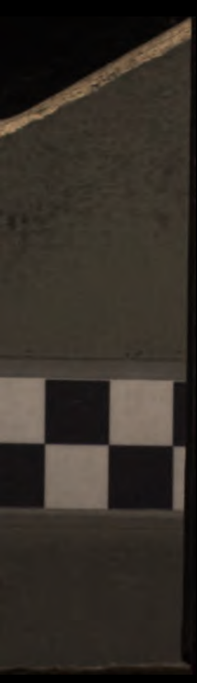
TK1
E54
v.79.

353624

Electrician

UNIVERSITY OF CALIFORNIA LIBRARY

Digitized by Google



Digitized by Google